Senior Project

Department of Economics

"Examining the Effect of Income Inequality on Violent Crime"

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Abstract

This paper estimates the effect of income inequality on violent crime rates in United States counties. This paper is intended to revisit and compare to the findings of Kelly (2000). Data used by Kelly is dated to 1994, while the data used in this paper is from 2014, providing a new look at an old issue. Kelly found that inequality has a strong impact on violent crimes committed. This paper finds that the effect of income inequality on murder, rape, and robbery are statistically insignificant. However, increasing levels of income inequality is found to have a significant positive effect on the number of violent assaults.

Acknowledgements

I would like to thank Dr. Francesco Renna and Dr. Elizabeth Erickson for their support and suggestions throughout the process of this project. Dr. Renna introduced a wide variety of econometric techniques that were not only valuable towards the completion of this paper, but will be carried with me through any and all future work. He pushed me to keep refining my thought process and to continue to strive for better results. Dr. Erickson provided extremely valuable feedback throughout my draft process, asking important questions and consistently pushing me to improve my work. Thank you both for all of the support provided throughout the course of this paper.

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Introduction

Over the past two decades, Americans have been relieved by decreases in the overall instances of violent crime occurring nationwide, however, there have been few reductions in the number of crimes committed since 2011. While there is certainly room to rejoice at the gains made over the past few decades, sadly, there are still a great many of Americans whose lives are touched by senseless acts of violence each and every day. In fact, according to the Federal Bureau of Investigations (FBI), an American still becomes a victim of a violent crime, on average, every 26.3 seconds, with 1.2 million total violent incidents reported to law enforcement agencies in 2014 alone. For a crime to be considered violent it must fall into the category of either murder, rape, robbery or assault. Certainly, no rational individual wants to become the victim of any one of these violent acts, meaning it is crucial to understand not only what is happening, but why it is happening.

In this respect, previous literature, such as Kelly (2000), have explored the relationship between rising income inequality and crime. The level of income inequality has steadily increased in the United States, with the top 0.1% of individuals controlling 7% of the national wealth in 1979, increasing to the same 0.1% controlling 22% of the total national wealth by 2012 (Saez, Zucman, 2014). Not only do individuals at the top of the wealth distribution control more of the national wealth than in the past, but their wages have grown more as well. Since the 1970s, real wages have increased very little for the majority of U.S. workers, while "…wages for the top one percent of earners have risen 165 percent, and wages for the top 0.1 percent have risen 362 percent" (Piketty, 2013).

This paper will follow in the steps of Kelly (2000) to test the hypothesis that increasing levels of income inequality will lead to increased occurrences of violent crime.

Literature Review

In a significant early contribution to the economic theory on crime, Gary Becker developed a formal model of crime (Becker 1968). Becker, while running late to examine a doctoral student, could not find a free parking spot, so he then weighed the cost and benefit associated with parking illegally. After thinking about it, he ultimately decided to park illegally and risk accepting the ticket, thus sparking his economic theory on crime. Becker's paper, "Crime and Punishment" theorized that criminals balance the potential payoffs with the potential cost of punishment associated with committing a crime. Becker's theory applies to crimes against property, as he theorized that individuals will commit a crime to gain an economic benefit, as he did with illegally parking. He theorized that those most likely to commit a crime are individuals who have lower costs associated with punishment and higher benefit from succeeding in their illegal venture. This theoretical framework was an important first step in explaining what encourages and deters criminal behavior, however it would be recognized that his theory does not fully encompass economic causes of crime.

A few short years later, Ehrlich further developed the economic theory on crime, proposing an economic link between income inequality and crime, expanding upon the framework of Becker (1968). In regard to violent crimes, Ehrlich says that it may decrease as individuals spend more time engaged in market activity, whether that activity be legitimate or illegitimate. As with Becker, he theorizes that individuals will commit a property crime for economic incentive, however Ehrlich theorizes a violent crime may be committed to increase personal utility. This theory, supported by an empirical study, provides the link showing that increasing income inequality within a community has strong positive effect on the rate of crimes against property (Ehrlich, 1973). His two stage least square estimates show a positive relationship between his measure of inequality, percent of families below one-half of median income, and violent crime. His empirical study finds evidence that increasing levels of income inequality will lead to increased levels of both property and violent crime occurrences.

Influenced by the previous work of Becker (1967) and Ehrlich (1973), Morgan Kelly (2000) develops and proposes an alternate theory on the economics inputs of crime. This theoretical model recognizes that these previous theories contain important pieces to explain crime, however there are remaining gaps which limit their predictive capability, especially when concerned with violent crime. Adopting from Becker and Ehrlich, Kelly maintains that would-be criminals will perform a cost-benefit analysis before committing a crime. Also consistent with previous theory, Kelly includes criminal deterrence as a function of levels of policing. Finally, Kelly retains the effect of income inequality from Ehrlichs' theory. Kelly hypothesizes that increasing levels of inequality will have a positive effect on crime rates, both violent crime and property crime. Kelly's' theory controls for factors that have been previously ignored, such as levels of poverty, and population density. Kelly runs a Poisson analysis as he considered the dependent variable, crime, to be count data as all numerical observations are zero or positive integers. Kelly's findings, similar to Ehrlich, predict that increasing levels of income inequality leads to increased levels of both property and violent crime.

Jesse Brush explores the relationship between violent crime and inequality in a manner similar to that of Kelly (2000), however he differs by utilizing a first difference estimation model (Brush 2007). He utilizes this model to control for result bias that may be the result of omitting important yet unidentified explanatory variables from the analysis. Utilizing his first difference regression, he finds that there is an insignificant relationship between the income inequality and crime. Brush suggests that a first difference estimation may not be an ideal model to attempt to improve upon Kelly (2000) and suggests further research may want to utilize an alternative model.

Daniel and Joan Hicks, referencing the theoretical contribution by Kelly (2000), reexamine the relationship of income inequality and violent crime in the United States (Hicks, 2014). They suggest that income inequality is an “opaque measure” to criminals, and that examining inequality through visible consumption is a better fit. Their hypothesis, that individuals are more likely to commit a crime against an individual with visible signs of wealth, is derived from previous works which have shown higher savings rates in areas of high crime, and that the wealthiest neighborhoods in a geographic area have higher burglary rates. The authors, following in the steps of Kelly (2000), originally run a Poisson regression model, but determined that the model was not a good fit for the type of data, owing to the fact that crime data is usually “intrinsically heteroskedastic, right skewed, and have a variance that increases with the mean of the distribution”. Taking up the challenge to utilize a more appropriate regression model (as attempted previously by Brush (2007)), to account for these violations of the Poisson model, a negative binomial regression model is used, which allows for more variability in the data. The authors test their primary hypothesis, while also testing the relationship between increasing income inequality and violent crime. Their study finds that there is a positive relationship in both models tested, utilizing the different dependent variables. The authors conclude that there is a strong relationship between income inequality and violent crime and an even stronger one between visible consumption and violent crime. The authors note that while the negative binomial regression model utilized is more appropriate than the Poisson model, its results are not better than that of the OLS model. Although this paper will utilize a measure of income inequality as defined by Kelly (2000), the findings of the authors will influence the regression model of choice to be utilized in this paper.

Theoretical Model

The theoretical model adopted in this paper is the same as used by Kelly (2000).

This model takes the form:

$$\lambda = N\delta\chi\pi$$

Where the total population in a region is given by N. An individual living in a particular county will encounter and interact with other individuals who are unknown to him at a rate of δ. This rate, δ, is an increasing function of population density. Increasing levels of population density leads to increasing crime rates owe to increasing numbers of potential victims who will have no knowledge of a criminals' identity (Kelly 2000).

However, even if an opportunity arises, not all individuals in a region will commit a crime. There is a subset of a regions population which has a higher predisposition to commit a crime. This predisposition to commit a crime, χ, is modeled as a function of inequality, poverty rate, unemployment rate, and level of educational attainment. These predisposed individuals will interact with other individuals in their community at an "exponential rate of $\chi\delta N$" (Kelly, 2000).

Finally, similar to the notion that not all individuals will commit a crime, not all individuals who are predisposed to commit a crime will. Of those individuals who may commit a crime, many will not choose to violate the law at all times. This is because the opportunity cost of committing a crime may be considered too risky by the would-be criminal. These situations, (1 - π), which are deemed to be too risky, are the result of a high probability of arrest, and subsequently punishment, for the crime.

Econometric Model

To test the hypothesis that increasing levels of income inequality will lead to increased occurrences of violent crime, this paper utilizes the econometric model used by Kelly (2000). While estimating this model, it is to be assumed that there is a log-liner relationship between π, χ and δ. The model takes the form:

Log (Crime) = β0 log(Population) + β1 log(density)+ β2 log(Gini) + β3 log(UnemploymentRate)+ β3 log(PovertyRate) - β4 log(HighSchool) - β5(Bachelors) – β5 log(police) + ε

This model is created by taking the natural log of both sides of the theoretical model.

Data

Data for this paper has been gathered from three sources: The FBI Uniform Crime Reports, the Census Bureau, and the Bureau of Labor Statistics. All data points utilized in this paper are from the year 2014. Violent crime counts and number of police officers in a given county were collected from the FBI. Data for unemployment rate was obtained from the Bureau of Labor Statistics. The remaining data for the Gini Index, poverty rate, educational attainment, county land area, and population were all obtained from the Census Bureau.

The GINI index will be utilized a measure of income inequality within a given county. Density is determined by taking census population estimates for 2014 and then dividing that by the area of the corresponding county. Educational attainment is broken down into two pieces which are the percentage of the population in a county who have earned a high school degree and the percentage of the population in a county who have earned a bachelor's degree. Poverty and unemployment rates are measures of the percentage of the population in a given county who are impoverished or unemployed in 2014.

Results – OLS Regressions – All Violent Crimes

This section reports the results for two separate OLS Poisson regressions on the determinates of all violent crime for all United States counties with all available data points.

The first OLS model predicts that a one percent increase in the unemployment rate is expected to lead to an increase in the violent crime rate by 0.32 percent. This is to be expected as economic theories on crime assume that individuals allocate their time between legitimate or illegitimate market activities. As the unemployment rate increases, unemployed individuals will be left with unoccupied time and may shift to illegitimate activities

Counties which have a higher percentage of its population holding a bachelor's degree are predicted to have lower overall instances of violent crime. This model predicts that by increasing the percentage of those who hold a bachelor's degree in a county by 1 percent, a corresponding decrease in violent crime of 0.64 percent will occur. A decrease was expected with the theoretical model and the results of this analysis predict that increasing the level of bachelor's degree holders in a county will have the largest impact in reducing violent crime.

Surprisingly, this analysis indicates that increasing police levels leads to increasing levels of crime. This seems counterintuitive as we would expect to see decreasing levels of crime arising from more police. The problem lies in the endogeniety between the variables crime and number of police owe to the likelihood of more police officers being necessary as crime levels increase. Also surprisingly, the model predicts that a 1 percent increase in the population with a high school degree, we will witness a 0.89 percent increase in violent crime occurrences. The may be because those with a high school degree are not considered highly educated, lessening their opportunity for employment.

What may be most striking is that the effect of Gini on violent crime rates is indistinguishable from zero, with a p-value of .998. This outcome is surprising, as theory states this should be an important predictor in crime. This unexpected result leads to investigation of correlation among key some variables.

The variables Gini, Poverty rate and Unemployment rate at a glance seem likely to have high levels of correlation between them as they are often associated with measures of economic or financial well-being, so a test for correlation is ran between the variables. The test finds that there is a correlation value between Gini and Poverty of 0.48, between Unemployment and Poverty of 0.6, and between Gini and Unemployment of only 0.19. This test shows that while Gini and Unemployment are lowly correlated, Poverty is highly correlated with both Gini and Unemployment.

The seconds OLS model excludes poverty owe to its strong correlation with Gini and Unemployment and relatively low correlation between Unemployment and Gini. This model does have a significant effect on the Gini estimate, moving from statistically insignificant to significant at the 95 percent level. An unexpected, yet interesting result on the effect of density on violent crime was found. The model predicts that a 1 percent increase in population density will lead to a -0.1 percent decrease in the number of violent crime committed. While it is not a significant reduction in crime overall, the sign is the opposite of what we had expected. I theorize that this result contradicts Kelly (2000) because of a key technological difference between his observation period, 1994, and mine, 2014. In 2014, a majority of the U.S. population owns a smartphone[1]. This means that the denser an area is, the more likely that an individual with a smartphone will witness, or be victim of a crime. This smartphone allows instant communication with law enforcement, as well as the capability to capture an image of the offender.

Changes in parameter estimates for the remaining variables are relatively miniscule. Due to this, the changes in parameter estimates for these variables will not be reported in the body of the paper, but can be viewed in the appendix.

[1] The United States has 110 mobile phones subscriptions per 100 people http://data.worldbank.org/indicator/IT.CEL.SETS.P2

While the results of the second OLS support the hypothesis of this paper, OLS modeling is not the proper technique to be utilized in this analysis. OLS estimation assumes that there is a linear distribution of variables, spanning an entire range of continuous values from $-\infty$ to $+\infty$. Crimes committed in a county cannot be a negative number, having a minimum value of zero. This requires the use of a more appropriate model which has the ability to censor the left side of the distribution.

Results – Tobit Regression – All Violent Crimes

The tobit regression model is a type of censored normal regression, which is typically used for data that is, in some way, censored. In the case of violent crime occurences, the data is left censored, with no observations taking a value below zero. Hicks (2014) found that while a negative binomial regression was used as an improvement over the Poisson utilized by Kelly (2000), it was not a better predictor than OLS. This censored tobit regression is more appropriate for the data than the previous OLS estimates of this paper.

This section reports the results for the tobit Poisson regression on the determinates of all violent crime for all United States counties with available data points. Poverty is again excluded from this model due to the high correlation found in the previous section.

A one percent increase in Gini is predicted to have a 0.72 percent increase on violent crime, which is statistically significant at the 95 percent level, supporting the hypothesis of this paper. The tobit regression predicts that a one percent increase in the unemployment rate will lead to a 0.41 percent increase in violent crime. Also contributing to an increase in violence is an increase in the population of a county. A 1 percent increase in county population is predicted to lead to a 0.33 percent increase in violent crime occurrences.

Consistent with previous OLS results, increasing the percentage of the population with a high school degree by 1 percent is predicted to increase violent crime by 0.71 percent. Increasing population density is also again predicted to have a negative effect on violent crimes committed within a county, with a 1 percent increase in density leading to a -0.1 percent decrease in violent crimes. Seemingly, the most effective way to reduce violent crime occurrences is to increase the percent of the population who holds a bachelor's degree, as a 1 percent increase is predicted to reduce violent crime by -0.69 percent.

This model continues to be plagued with an endogeneity problem between crime and officers, with the model predicting an increase in officers to increase crime occurrences.

Results – Tobit Regression – Individual Crimes

The initial analysis of all violent crimes lumped together seemed to look at the effect of inequality on violent crime too broadly, as each crime may have a different motivation. Robbery may be influenced by want of material gain, while murder or assault generally don't lead to financial gain and these crimes may result from mentally strained individuals who experience an increase in personal utility through violence. In strain theory (Merton, 1938), individuals who are low in the social structure experience difficulty in meeting success goals, which are determined by society, grow frustrated at their inability to meet the measures of success. These unsuccessful individuals may feel alienated when faced with the successes of individuals around them and may reject social values and engage in deviant, rebellious behavior.

This rebellious behavior can increase utility for the actor, as predicted by Ehrlich (1973), as they obtain a mental benefit, or utility, from committing the crime.

Violent crime is subsequently broken down into categories of violent crime: murder, rape, robbery and assault. This section reports the results for the tobit Poisson regression on the determinates of violent crime when broken down by crime type for all United States counties with available data points. Poverty is again excluded from this model due to the high correlation found in the previous sections.

Upon analyzing the effect of income inequality on specific crimes, it is found to be a statistically insignificant predictor for murder, rape, and perhaps surprisingly, robbery. However, income inequality as measured by the GINI index is a significant predictor of assault both statistically and economically. This model predicts that a 1 percent increase in income inequality will lead to a 0.85 percent increase in assaults. This effect that income inequality has on violent assaults may be partially explained by strain theory and Ehrlichs theory of utility maximization by violent criminals.

Consistent with the findings of the second OLS regression, this model predicts that a 1 percent increase in population density will lead to a -0.1 percent decrease in the number of assaults. Staying consistent with theory that highly educated individuals will help to reduce crime, this model predicts that a 1 percent increase in the percentage of the population who has obtained a bachelor’s degree will lead to a -0.57 percent decrease in the number of assaults. This indicates that the most effective way within this model to decrease the occurrences of assault within a county may be to enact policies which will increase the percentage of the population who have obtained a bachelor’s degree. This model still predicts that as we have more police officers in a county, we will see an increase in crime rates. This was to be expected as this model still does not control for the endogeneity problem that exists between assaults and number of officers

In regard to murder and robbery, theory doesn't completely fail to predict significant inputs. Although income inequality is statistically insignificant, increasing unemployment rates are predicted to cause an uptick in murder and robbery, with a 1 percent increase in the unemployment rate leading to 0.24 percent and 0.38 percent increase in the occurrence of the crime, respectively.

Among violent crimes, rape, a particularly heinous crime, is the biggest outlier when it comes to the economic theories on crime. The inputs which lead to an individual to commit this crime and the desired outcome this crime is vastly different than the other violent crimes. None of our variables which may relate to financial well-being are statistically significant when it comes to explaining what causes this crime to occur.

Conclusions and Limitations

The goal of this paper is to test the hypothesis that increasing income inequality leads to higher levels of violent crime. Looking at violent crime as a whole paints the picture with too broadly. To get more precise estimates on the effect of income inequality on violent crime, it is analyzed by type of crime. At the county level the effect of income inequality on violent crimes of murder, rape and robbery are not statistically significant. However, income inequality, as measured by GINI, is positively and significantly related to the number of assaults committed.

The results of this paper would leave me to suggest for county officials to enact policies which encourage decreased income inequality and increased college attendance and completion in order to reduce the occurrences of violent assaults in their counties.

Limitations in this study include crime underreporting bias, failing to utilize data over multiple years, and endogeneity between crime and police. For one reason or another, not all crimes are reported by the victims to a law enforcement agency, leading to an issue of underreported crimes. The data used is also limited in that the crime information reported is only the sum of total instances reported to a county agency, meaning important crime figures from local police departments may not be fully captured in the data. This paper looks at data from 2014, so it may not capture the true effect of inequality of violent crime over time.

Future studies on crime and inequality may improve results by utilizing a two stage least squares regression model to provide an unbiased estimate of the effect of law enforcement on violent crime. Although economic theory doesn't consider visible consumption as used by Hicks (2014) a determinate of crime, it may be an improvement over more traditional measures of income inequality. As mentioned, this paper only uses data from 2014, and future studies may improve by utilizing data over a multiple year period as Brush (2007) had done. Finally, reducing the size of the observation area from county level to city or zip code level analysis would increase accuracy and can be helpful for suggesting specific policy at the city government level.

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Appendix

Table 1: Data Description

Variable	Variable Meaning	Source
Violent	Sum of total instances of violent crime in a particular county	Fbi.gov – Uniform Crime Reports - 2014
Population	Number of persons inhabiting a particular county	Census - Estimates of the Resident Population for Counties - 2014
Murder	Sum of total instances of murder in a particular county	Fbi.gov – Uniform Crime Reports - 2014
Rape	Sum of total instances of rape in a particular county	Fbi.gov – Uniform Crime Reports - 2014
Robbery	Sum of total instances of robbery in a particular county	Fbi.gov – Uniform Crime Reports - 2014
Assault	Sum of total instances of assault in a particular county	Fbi.gov – Uniform Crime Reports - 2014
Density	Persons per sq. mile	Census - Estimates of Resident Population Change for counties
GINI	Gini income distribution in a particular county	Census Gini Index by county - 2010-2014 American Community Survey 5-Year Estimates
Unempl	Percent of labor force that is unemployed in a particular county	BLS – Local Area Unemployment Statistics – 2014 http://www.bls.gov/lau/#cntyaa
Povrate	Percent of individuals living in poverty in a particular county	Census – Small Area Income and Poverty Estimates
HSchool	Percent of population in a particular county with a high school diploma	Census Bureau - American Community survey
Officers	Police officers per 1,000 residents	Fbi.gov – About Uniform Crime reports
Bachelors	Percent of population in a particular county with a Bachelors Degree	Census Bureau - American Community survey

Table 2: Descriptive Statistics

Variables	Observations	Mean	Standard Deviation	Minimum	Maximum
Violent	1661	60.44	212.88	0	5551
Murder	1661	0.668	1.581	0	19
Rape	1661	6.437	13.728	0	180
Robbery	1661	5.242	22.525	0	550
Assault	1661	38.198	84.886	0	936
GINI	1661	0.439	.033	.3346	.6519
Officers	1661	54.92	139.09	1	2257
Population	1661	84581	251347	86	5246456
Unempl	1661	6.08	2.24	1.2	23.6
Povrate	1661	16.667	6.146	3.7	47
Area	1661	999.04	1256.28	46.19	18618.85
Hschool	1661	84.96	6.77	46.7	98.1
Bachelor	1661	19.71	8.21	2.6	60.4

Table 3: OLS – Results – Model 1 – Dependent Variable: Violent Crime

Variable	Parameter Estimate	Standard Error	P - Value
Intercept	-5.366	1.956	.0062
LNGINI	0.5411	.3876	.1629
LNOfficers	.8512	.0446	.0001
LNPopulation	.0320	.0512	.0001
LNUnempl	.3808	.0911	.0001
LNPovrate	.1211	.1152	.2933
LNDensity	.3808	.0911	.0001
LNHschool	.8927	.44202	.0436
LNBachelor	-.6448	.1788	.0003
Adjusted R2	.6544		

Table 4: OLS – Results – Model 2 (Drop Poverty) Dependent Variable: Violent Crime

Variable	Parameter Estimate	Standard Error	P - Value
Intercept	-4.1029	1.6567	.0134
LNGINI	.7253	.3358	.0309
LNOfficers	.8426	.0441	.0001
LNPopulation	.0331	.0502	.0001
LNUnempl	.4167	.0823	.0001
LNDensity	-.1087	.0324	.0008
LNHschool	.7132	.4206	.0902
LNBachelor	-.6987	.1723	.0001
Adjusted R2	.6542		

Table 5: Tobit – Results – Model 1 Dependent Variable: Log Violent Crime

Variable	Parameter Estimate	Standard Error	P - Value
Intercept	-5.3668	1.950	.0059
LNGINI	.5411	.3863	.1613
LNOfficers	0.8512	.0445	.0001
LNPopulation	0.32	.0510	.0001
LNUnempl	0.3808	.0908	.0001
LNPovrate	0.1211	.1148	.2916
LNDensity	-0.1021	.0330	.0020
LNHschool	0.8927	.4405	.0427
LNBachelor	-.6448	.1782	.0003

Table 6: Tobit – Results – Model 2 (Drop poverty) Dependent Variable: Log Violent Crime

Variable	Parameter Estimate	Standard Error	P - Value
Intercept	-4.1029	1.6518	.0130
LNGINI	0.7253	0.3348	.0303
LNOfficers	0.8426	0.0439	.0001
LNPopulation	0.3314	0.0501	.0001
LNUnempl	0.4167	0.0820	.0001
LNDensity	-0.1087	.0323	.0008
LNHschool	0.7132	0.419	.0890
LNBachelor	-.6987	0.1718	.0001

Table 7: Tobit – Results – Model 3 (Drop poverty) Dependent Variable: LogMurder

Variable	Parameter Estimate	Standard Error	P - Value
Intercept	-1.847	1.772	.0297
LNGINI	0.315	0.393	.4234
LNOfficers	0.274	.0446	.0001
LNPopulation	0.150	.0493	.0024
LNUnempl	0.247	.1000	.0132
LNDensity	-0.085	.0325	.0088
LNHschool	0.131	.4540	.7728
LNBachelor	-0.266	.1167	.0226
Sigma	.551	.0106	.0001

Table 8: Tobit – Results – Model 4 (Drop poverty) Dependent Variable: LogRape

Variable	Parameter Estimate	Standard Error	P - Value
Intercept	-10.049	1.908	.0001
LNGINI	0.047	.3748	.8993
LNOfficers	0.396	.0493	.0001
LNPopulation	0.498	.0544	.0001
LNUnempl	0.047	.0858	.5815
LNDensity	-0.153	.0344	.0001
LNHschool	1.545	.4834	.0014
LNBachelor	-0.460	.0858	.0001
Sigma	.8152	.0171	.0001

Table 8: Tobit – Results – Model 5 (Drop poverty) Dependent Variable: LogRobbery

Variable	Parameter Estimate	Standard Error	P - Value
Intercept	-1.648	2.2231	.4583
LNGINI	0.674	.4416	.1267
LNOfficers	0.721	.0559	.0001
LNPopulation	0.164	.0613	.0075
LNUnempl	0.387	.1104	.0005
LNDensity	0.068	.0388	.0776
LNHschool	-0.247	.5607	.6592
LNBachelor	-0.319	.1342	.0175
Sigma	.8042	.0198	.0001

Table 9: Tobit – Results – Model 6 (Drop poverty) Dependent Variable: LogAssault

Variable	Parameter Estimate	Standard Error	P - Value
Intercept	-3.112	1.7397	.0737
LNGINI	0.8481	.3537	.0165
LNOfficers	0.771	.0462	.0001
LNPopulation	0.317	.0531	.0001
LNUnempl	0.501	.0809	.0001
LNDensity	-0.103	.0340	.0023
LNHschool	0.434	.4390	.3221
LNBachelor	-0.571	.1076	.0001
Sigma	.9353	.0170	.0001

SAS Coding

```
/*Import*/
proc import datafile = "E:\PROJECT\crime.csv"
Out=WORK.Crime
DBMS=CSV
REPLACE;
RUN;

Proc import datafile = "E:\PROJECT\COLLEGE.csv"
Out=WORK.college
DBMS=CSV
REPLACE;
RUN;
Proc import datafile= "E:\PROJECT\GINI.csv"
Out=WORK.GINI
DBMS=CSV
REPLACE;
RUN;
PROC IMPORT DATAFILE= "E:\PROJECT\POLICE.CSV"
OUT=WORK.POLICE
DBMS=CSV
REPLACE;
RUN;
PROC IMPORT DATAFILE= "E:\PROJECT\POPULATION.CSV"
OUT=WORK.POPULATION
DBMS=CSV
REPLACE;
RUN;
PROC IMPORT DATAFILE= "E:\PROJECT\POVERTY.CSV"
```

```
OUT=WORK.POVERTY
DBMS=CSV
REPLACE;
RUN;
/*PROC IMPORT DATAFILE = "E:\PROJECT\RACE.CSV"
OUT=WORK.RACE
DBMS=CSV
REPLACE;
run;*/

PROC IMPORT DATAFILE= "E:\PROJECT\SIZEMILES.CSV"
OUT=WORK.SIZEMILES
DBMS=CSV
REPLACE;
RUN;
PROC IMPORT DATAFILE = "E:\PROJECT\UNEMPLOYMENT.CSV"
OUT=WORK.UNEMPLOYMENT
DBMS=CSV
REPLACE;
RUN;
proc import datafile = "E:\PROJECT\crimebreakdown.csv"
Out=WORK.CrimeBreakdown
DBMS=CSV
REPLACE;
RUN;


/*Sort & Merge*/

proc sort data = Crime Out = Crime1;
By County state;
run;

Proc sort data = college out = College1;
BY COUNTY state;
RUN;

DATA MERGE1;
MERGE CRIME1 COLLEGE1;
BY COUNTY state;
RUN;

Proc sort data = Gini Out = Gini1;
By COUNTY state;
RUN;

DATA MERGE2;
MERGE MERGE1 GINI1;
BY COUNTY state;
RUN;

PROC SORT DATA = POLICE OUT = POLICE1;
BY COUNTY state;
RUN;

DATA MERGE3;
MERGE MERGE2 POLICE1;
```

```
BY COUNTY state;
RUN;

proc sort data = Population OUT = POPULATION1;
BY COUNTY state;
RUN;
DATA MERGE4;
MERGE MERGE3 POPULATION1;
BY COUNTY state;
RUN;
PROC SORT DATA = POVERTY OUT = POVERTY1;
BY COUNTY state;
RUN;
DATA MERGE5;
MERGE MERGE4 POVERTY1;
BY COUNTY state;
RUN;
PROC SORT DATA = SIZEMILES OUT= SIZEMILES1;
BY COUNTY state;
RUN;
DATA MERGE6;
MERGE MERGE5 SIZEMILES1;
BY COUNTY state;
RUN;
PROC SORT DATA = UNEMPLOYMENT OUT = UNEMPLOYMENT1;
BY COUNTY state;
RUN;

DATA Merge7;
MERGE MERGE6 UNEMPLOYMENT1;
BY COUNTY state;
RUN;
proc sort data = crimebreakdown out = crimebreakdown1;
by county state;
run;
data finalmerge;
merge merge7 Crimebreakdown1;
by county state;
run;
data work.one;
set work.finalmerge;
if violent = "" then delete;
if Gini = "" then delete;
if officers = "" then delete;
if popul = "" then delete;
if Area = "" then delete;
if unempl = "" then delete;
IF PROPERTY = "" THEN DELETE;
IF MURDER = "" THEN DELETE;
IF RAPE = "" THEN DELETE;
IF ROBBERY = "" THEN DELETE;
IF ASSAULT = "" THEN DELETE;


run;
proc means;
proc corr data = work.one;
```

```
run;


/* Manipulation */

Data work.two;
set work.one;



DENSITY = popul/area;

/*SOCIAL IS SUMMATION OF ALL VARIABLES FROM SOCIAL THEORIES*/
/*SOCIAL = POVRATE + GRADUATE + HSCHOOL + BACHELOR;

/* Log */
LNPOVRATE = LOG(POVRATE);
LNHSCHOOL = LOG(HSCHOOL);
LNBACHELOR = LOG(BACHELOR);
LNGRADUATE = LOG(GRADUATE);
LNCRIME = LOG(Violent);
LNGINI = LOG(GINI);
LNPOPULATION = LOG(POPUL);
LNDENSITY = LOG(DENSITY);
/*LNSOCIAL = LOG(SOCIAL);*/
LNOfficers = LOG(Officers);
LNUNEMPL = LOG(UNEMPL);
LNPCRIME = LOG(PROPERTY);
CRIMEPER= POPUL/VIOLENT;

LNMURDER= LOG(MURDER);
LNRAPE = LOG(RAPE);
LNROBBERY = LOG(ROBBERY);
LNASSAULT = LOG(ASSAULT);


run;

proc sort;
by county state;
run;


/*WITH POVERTY*/
proc reg;
id state county;
model lncrime = LNPOPULATION lngini LNHSCHOOL LNBACHELOR LNPOVRATE
LNofficers LNDENSITY LNUNEMPL;
run;
/*WITHOUT POVERTY*/
proc reg;
id state county;
model lncrime = LNPOPULATION lngini LNHSCHOOL LNBACHELOR LNofficers LNDENSITY
LNUNEMPL;
run;
```

```
/*Poisson*//*
proc genmod data = work.two;
 model LNcrime = LNPOPULATION lngini LNHSCHOOL LNBACHELOR LNPOVRATE
LNofficers LNDENSITY LNUNEMPL / link=log dist=Poisson;
run;
/*Negative Binomial
proc genmod data = work.two;
 model LNcrime = LNPOPULATION lngini LNHSCHOOL LNBACHELOR LNPOVRATE
LNofficers LNDENSITY LNUNEMPL / dist= negbin;
run;*/


   /*-- Tobit Model WITH POVERTY --*/
   proc qlim;
      model lncrime = LNPOPULATION lngini LNHSCHOOL LNBACHELOR LNPOVRATE
LNofficers LNDENSITY LNUNEMPL  ;

   run;

   /*-- Tobit Model WITHOUT POVERTY --*/
   proc qlim;
      model lncrime = LNPOPULATION lngini LNHSCHOOL LNBACHELOR LNofficers
LNDENSITY LNUNEMPL  ;

   run;


   /*-- Tobit Model WITHOUT POVERTY --*/
   proc qlim;
      model lnMURDER= LNPOPULATION lngini LNHSCHOOL LNBACHELOR LNofficers
LNDENSITY LNUNEMPL  ;

   run;

  /*-- Tobit Model WITHOUT POVERTY --*/
   proc qlim;
      model lnrape = LNPOPULATION lngini LNHSCHOOL LNBACHELOR  LNofficers
LNDENSITY LNUNEMPL  ;

   run;
  /*-- Tobit Model WITHOUT POVERTY --*/
   proc qlim;
      model lnrobbery = LNPOPULATION lngini LNHSCHOOL LNBACHELOR  LNofficers
LNDENSITY LNUNEMPL  ;

   run;
     /*-- Tobit Model WITHOUT POVERTY --*/
   proc qlim;
      model lnassault = LNPOPULATION lngini LNHSCHOOL LNBACHELOR LNofficers
LNDENSITY LNUNEMPL  ;

   run;
quit;
```