An Econometric Analysis of The Factors Playing into Gun Violence Within the United States

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Author Note

The code for this project will not compile without the project data folder in the root of your C folder.

A GitHub repository was created with all relevant files used, and it is available [here.](https://github.com/Kyle5432/399data)

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Abstract

This study seeks to establish a causal relationship between gun ownership and gun crime, in a manner that can be extrapolated to overall levels of murder. The study found a strong correlation (P=0.01) between gun ownership levels and gun violence levels. Additionally; marriage rates, educational attainment, gun ownership levels in neighbouring states and poverty were also found to be significant predictors of overall level of gun crimes.

*Keywords:* Econometrics, Gun Violence, Gun Ownership, Interstate Variance

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# Introduction

Violent crime within the United States is a very poignant issue at this point in time, and one that represents a ripe area for econometric study. Of key note, despite an environment which may very easily lead one to believe the contrary, gun crime within the United States has actually declined significantly over the last 40 years. This fact alone can help omit numerous claims often made by the media, such as blaming violent video games (these became prevalent right around the same time crime rates started dropping). This highlights socio-economic factors, as well as gun prevalence as a more likely cause. Within this study, it is sought to develop a model that explains the interstate variation in homicide, and explore the connection between firearm ownership rates and firearm homicide rates. It is also worth noting that overall murder rates and firearm murder rates are almost collinear, with an *R*2 of 0.85 for a simple model regressing the former on the later. This means that whilst the firearm homicide rate is used as the dependent variable within this study, the results can be quite accurately extrapolated to overall murder rates as well.

# Literature Review

The topic of gun violence and murder has been a keystone topic within the United States for decades. Contrasted with developed countries of similar levels of economic development, the United States has a murder rate several times higher than average. Siegel, Ross, and King (2013) provides an excellent overview of the relationship between gun violence and gun ownership. Using panel data from 1981 to 2010, firearm ownership is found to be a strong indicator of gun homicide (incidence rate ratio=1.009). This study also suggests the usage of age-adjusted homicide rates over generic homicide rates, which proved crucial in finding an accurate predictor.

Webster et. al. (2012) provides an excellent overview of current firearm laws across the

**US Gun death rates over time**

13

14

15

1980 1985 1990 1995 2000 2005 2010 2015

Gun deaths per 100,000

10

11

12

Time

*Figure 1*

United States, which proved invaluable in putting together binary variables to test the efficacy of various gun control measures. Along with this, the study provides a good oversight of the current climate surrounding gun ownership restrictions within the United States.

Colonescu (2016) gave an excellent overview of all econometric methods relevant to the research performed, as well as providing many examples of well designed regression models to use as a template.

Moody (2002) provides a plausible explanation for a causal relationship between gun crime and gun ownership levels. The paper finds that through a larger pool of available guns, the amount of people willing to sell there guns into the black market is almost certain to go up, dropping the resulting price of obtaining a weapon illegally. This is important, as regression can generally only show correlation. This literature gives us a probable reason to

suspect causation as well.

Finally, Caceres-Delpiano & Giolito (2008) provides a basis for a causal relationship between divorce rates and overall crime rates. The study establishes a positive relationship between divorce rates and the likelihood of incarceration by the children of the divorced family. Divorce within a family was also associated with a higher chance of repeating a grade and higher levels of childhood stress.

# Methodology & Data

**Methodology.** For this study, murder rates and gun ownership levels are hypothesized to have a positive correlation. In order to show this, we must show a statistically significant correlation between crime and gun ownership levels even when socioeconomic factors are properly controlled for. This would run contrary to the logic stated by the NRA and other guns-rights movements within the United States that an increased presence of guns serves to deter crime.

Our methodology will consist of initially constructing a simple linear regression model with gun murder per capita as the dependent variable, and gun ownership per capita as the independent variable. From here, the regression model will be expanded to account for numerous socio-economic factors that may also explain the discrepancy in gun violence levels. Finally, regression diagnostics will be used to confirm the overall validity and robustness of these predictions.

**Data.** One of the key objectives when compiling the data set was to properly minimize omitted variable bias. Crime is a complex and multifaceted problem with many factors leading into it, so great care was taken to properly control for any relevant

socio-economic factors, particularly those identified within the literature review. The data set includes the variable poverty, which is the percentage of population within a state living below the poverty line. The variable educ gives the number of people within a state who have attained at least a bachelor’s degree. The data for both of these variables came from the United States Census Bureau. Within the appendix is a chart detailing the nature, source and comments of all variables used.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | gun | border | poverty | education | divorce |
| median | 32.250000 | 40.6366667 | 14.8000000 | 28.2000000 | 3.7000000 |
| mean | 33.086000 | 38.2455258 | 14.8020000 | 29.0120000 | 3.7560000 |
| SE.mean | 1.912592 | 1.3470657 | 0.4339895 | 0.6977786 | 0.1142200 |
| CI.mean.0.95 | 3.843498 | 2.7099467 | 0.8721345 | 1.4022387 | 0.2295336 |
| var | 182.900412 | 87.1001288 | 9.4173429 | 24.3447510 | 0.6523102 |
| std.dev | 13.524068 | 9.3327450 | 3.0687689 | 4.9340400 | 0.8076572 |
| coef.var | 0.408755 | 0.2440219 | 0.2073212 | 0.1700689 | 0.2150312 |

Table 1: Descriptive Statistics

In addition to socio-economic factors, one also must consider the effects of availability of guns in neighboring states. If a state has extremely strict gun laws, but an individual can easily travel to a different state to circumvent these laws, this must be captured in the data. In order to do so, an index was created via the formula below. This gives a rough measure of the ease of circumventing local gun laws and restrictions.

*Gb* = Gun ownership of bordering states B = Number of bordering states

In order to conduct our multiple linear regression analysis, it must be ensured that the data meets the Gauss-Markov assumptions. The first assumption, the linearity of parametres, is met as the regression is in the form:

*y* = *β*0 + *β*2*x*1 + *β*2*x*2 + *...* + *u*

The second assumption of random sampling is almost entirely met. The data used is almost entirely complete, aside from extrapolated marriage data for California, and the border index having two. For the third assumption to be met, we cannot have complete

collinearity and no variable may be constant. Table 2 confirms these assumptions are met. For the fourth assumption, the expected error term must be zero. This can be tricky to prove, and indeed much of econometrics involves dealing with violations of assumptions.

However, by using a robust multiple regression model we should be able to minimize violation of this assumption. Finally, the assumption of homoscedasticity is confirmed through the Breusch-Pagan test, the output of which is discussed later in the paper.

Table 2: Correlation Matrix

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | agemurder | gunrate | borderchainav | poverty | educ | divorce |
| Firearm Homocide | 1 |  |  |  |  |  |
| Gun ownership | 0.69 | 1 |  |  |  |  |
| Border Index | 0.56 | 0.69 | 1 |  |  |  |
| Poverty Rate | 0.56 | 0.32 | 0.14 | 1 |  |  |
| Education | -0.72 | -0.59 | -0.42 | -0.7 | 1 |  |
| Divorce Rate | 0.64 | 0.51 | 0.33 | 0.35 | -0.54 | 1 |

# Results & Analysis

The regression model used follows the form discussed in the data and methodology section. For our initial benchmark model, we will use age-adjusted murder rate as the independent variable, and percentage of households owning guns as the dependent variable. It is worth noting that no correlation exists without using the age-adjusted rate, suggesting demographic shape plays a significant role in crime determination. Our baseline case shows a strong correlation with gun ownership rates and age-adjusted homicide rates, this is displayed in Figure #, and the relationship given by the formula below:

*m*^*urder* = 4*.*68847 + 0*.*212 ∗ *gunrate* + *u*

From here, the model will be refined by adding further independent variables in order to control for socio-economic factors. The first additional variable included was the poverty

15

20

10 20 30 40 50 60



Age−adjusted murder rate

5

10

Percentage of households owning guns

*Figure 2*

­­rate, which in itself is a strong predictor of crime. It is worth noting that from here the intercept coefficient ceases to be significant; also that controlling for poverty causes reduction of 0.037 murders per 1% increase in households owning guns. The overall relationship is given by the formula below:

*m*^*urder* = −1*.*606 + 0*.*17535 ∗ *gunrate* + 0*.*50771 ∗ *poverty* + *u*

The percentage of households owning guns serves to a reasonable degree to capture the degree of gun control measures enacted within a state. However, given the lax nature of interstate border enforcement, the ease circumventing local laws must also be accounted for within the model. This is done via the border chain index variable. The additional of this control presents an interesting finding in of itself; the effect of a 1% higher gun ownership per capita in neighbouring states has only around half the impact on a states homicide rate as a

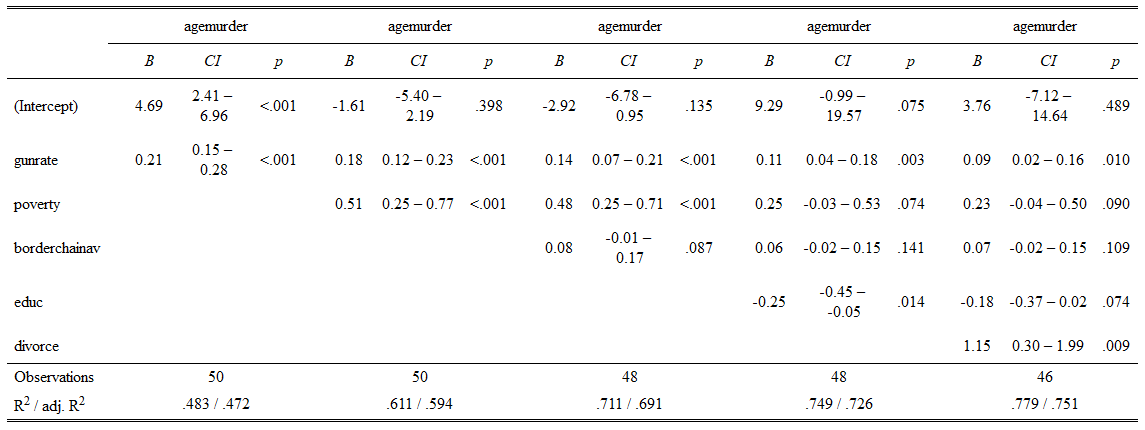
1% increase of ownership in the state itself. The overall relationship in this model is given below:

*m*^*urder* = −2*.*918 + 0*.*140 ∗ *gunrate* + 0*.*480 ∗ *poverty* + 0*.*0772 ∗ *borderchainav* + *u*

Educational attainment also serves as a strong predictor of overall crime and captures a number of factors we should wish to control for. As expected, education has a negative overall impact on murder rates, and the inclusion of this control sees the impact of gun ownership decline slightly over the previous model. As usual, the relationship given by this model is given in the formula below:

*m*^*urder* = −2*.*918+0*.*140∗*gunrate* +0*.*480∗*poverty* +0*.*0772∗*borderchainav* +−0*.*250∗*educ* +*u*

The final control variable used was the per capita divorce rate for each state. This captures a number of key factors should be controlled for, such as the stability of home life during childhood. It is worth noting that within the American political arena, decline in family values is often blamed for gun violence. This is only a half truth, as the overall divorce rate has been steadily dropping for several decades within the United States.

However, the final model did find divorce rates to be a strong predictor of homicide rates.

The final model (as well as the earlier models) has homoskedasticity, meeting the Gauss-Markov assumption. This is shown in the Breusch-Pagan heteroskedasticity test output below:

Table 1

*Breusch-Pagan heteroskedasticity test*

|  |  |  |  |
| --- | --- | --- | --- |
| statistic | p.value | parameter | method |
| 1.730861 | 0.8849891 | 5 | studentized Breusch-Pagan test |

**A Comment on Causation.** In order to give validity to the obtained results, it must be attempted to establish causality between our independent variables and the per capita murder rate. Doing so relies largely on qualitative reasoning. The easiest to establish is the relationship with educational attainment and poverty rates. There is are few relationships within criminology supported by more evidence than the relationship between poverty and education. This is largely due the incentive structure a would be criminal faces. An individual with low education and low income stands to gain much more and lose much less than an individual with higher income and education.

As discussed in the literature review, Moody (2002) provides solid reasoning for a causal relationship between firearm ownership rates and crime rates. A higher gun ownership rate increases the amount of weapons being directed into the black market, thereby lowering the costs and increasing ease of access to firearms by those who cannot obtain them through legal channels. In lockstep with this, the border chain average can be reasoned to have a causal relationship through similar logic.

Overall, it is reasonable to conclude that the relationship demonstrated is causal in nature.

# Conclusion

Overall, this paper finds gun ownership per capita to be a significant factor in explaining the large variation of overall level of homicide between US states. Within the final

model, a 1% increase in households owning firearms causes an increase in the per capita homicide rate by 0.09 per 100,000, significant at the 1% level. Along with this, socioeconomic factors of poverty and divorce rate were found to be significant at the 1% level, with educational attainment level being significant at the 10% level. The border chain index was found to be almost significant at the 10% level, with a p-value low enough to not omit the variable from the final model. These results are in line with the majority of existing literature on the subject and support the initial hypothesis that the level of gun crime increases as guns become more prevalent within an American state.

In keeping with this however, it must be noted that this study also highlights that gun violence is a multifaceted issue with no singular solution. Using the regression parametres from the final model, if the state with the highest per capita gun violence rate (Louisiana) were to eliminate all of its guns, it would still rank within the 10 highest. This implies heavily that much more detailed policy than gun control must be undertaken to address the epidemic of violence within the United States. Further research is needed to make meaningful policy prescriptions from the results found within this study, it is clear that the hypothesized relationship exists. However, a number of factors which cannot be quantified should also be examined. Factors like cultural differences between states do warrant further study on their own merit.

# References

Bloomberg, M. R. (2013). Reducing gun violence in America: informing policy with evidence and analysis. JHU Press.

Koop, C. E., & Lundberg, G. D. (1992). Violence in America: A public health emergency: Time to bite the bullet back. JAMA, 267(22), 3075-3076.

Kleck, G. (1993). Gun ownership and crime. CMAJ: Canadian Medical Association Journal, 149(12), 1773.

Wintemute, G. J. (2015). The Epidemiology of Firearm Violence in the Twenty-First Century United States. Annual Review of Public Health, 36(1), 5-19.

doi:10.1146/annurev-publhealth-031914-122535

Sleek, Scott. “Gun Violence: Prediction, Prevention, and Policy.” PsycEXTRA Dataset, doi:10.1037/e529802010-011.

# Appendix

A.1 Details of Variables Used Within Model

Model

Full Name Name Source Comments Link

Age-Adjusted Firearm Death Rates

Percentage of Households Owning Firearms Poverty Rate by Household Income

agemurder CDC Center for

Health Statistics gunrate Gun Ownership &

Social Gun Culture poverty United States

Census Bureau

Complete for all [1](https://www.cdc.gov/nchs/pressroom/sosmap/firearm.htm)

states, 2014

Complete for all [2](http://injuryprevention.bmj.com/content/injuryprev/early/2015/06/09/injuryprev-2015-041586.full.pdf?keytype=ref&amp;ijkey=doj6vx0laFZMsQ2)

states, 2013

Complete for all [3](https://www.census.gov/content/dam/Census/library/publications/2015/demo/p60-252.pdf)

states, 2014

Divorces per 1,000 divorce CDC Center for

Health Statistics

Indiana and [4](https://www.cdc.gov/nchs/data/dvs/divorce_rates_90_95_99-11.pdf)

Louisiana missing, 2011

Percentage of Residents With Bachelors or Higher

educ United States Census Bureau

Complete for all [5](https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_5YR_S1501)

states, 2014

Average Gun Ownership of Neighbouring States

borderchainSaevlf Created Index Null entry for NA

Hawaii and Alaska