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Are Firearms Causing An Increase In Gun Crimes? A Granger Causality Test Of Dallas' Street Gun Arsenal

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ARE FIREARMS CAUSING AN INCREASE IN GUN CRIMES? A GRANGER CAUSALITY TEST OF DALLAS' STREET GUN ARSENAL

by

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This thesis, submitted by Dustin Thompson in partial fulfillment of the requirements for the Degree of Master of Science Applied Economics from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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This thesis is being submitted by the appointed advisory committee as having met all of the requirements of the School of Graduate Studies at the University of North Dakota and is hereby approved.

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Dean of the School of Graduate Studies

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Department	Economics
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Dustin Thompson
April 25th, 2017

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ABSTRACT

From 1980 to 1992, Dallas, Texas saw an increase in both gun violence and the number of firearms. Nine firearm measures that define Dallas, Texas' street gun arsenal along with two gun violence measures are used to test whether firearms are causing an increase in gun violence or gun violence is causing an increase in firearms. By estimating vector autoregressions and employing Granger causality tests on one firearm measure and one gun violence measure, the result is that the rising number of homicides committed with a gun are causing an increase in the total number of firearms. There is little evidence to suggest that firearms are causing the increases in gun violence.

CHAPTER I

INTRODUCTION

This thesis looks at the issue surrounding the topic of gun availability affecting gun violence. Specifically, this study tests the hypothesis that when the total number of firearms among criminals increase in a metropolitan area, the amount of gun violence will also increase. The opposite hypothesis is that when gun violence increases in a metropolitan area, the number of firearms among criminals increase in response to the elevated danger. This study also tests the impact different types of firearms have on gun violence.

The paper uses a dataset comprised of multiple firearm measures and gun violence measures. The firearm measures included in the dataset define Dallas' street gun arsenal from 1980 to 1992. During this time period, Dallas police confiscated firearms from arrests or incidents and also captured firearms that citizens found and willingly turned in. They did this to examine what types of firearms were circulating among criminals and potential criminals in Dallas. A total of nine firearm variables were created. To capture gun density, the total number of guns confiscated is used as a proxy. The remaining eight firearm variables represent the different types of firearms. Dallas police characterized each firearm according to caliber size and whether or not the firearm had semi-automatic firing capabilities. This allows for an extensive look into what specific firearms are affecting or being effected by gun violence. The gun violence measures define crime in Dallas from 1980-1992. The two measures this study targets are gun homicides and gun aggravated assaults. Homicide is one of the most feared violent crimes people are faced with. Firearms play an important part in homicide studies. In Dallas, on average, 70% of all homicides were committed with a firearm from 1980-1992. During this time, both gun homicides and gun aggravated assaults were increasing in Dallas, Texas.

To analyze whether it is the case firearms are affecting gun violence or gun violence is affecting firearms, a vector autoregression (VAR) framework is used. A limitation some time-series models have is that they impose a unidirectional relationship between two variables. VAR models allow for multi-directional relationships between a set of two or more variables. In a VAR, variables are treated as symmetric (the variables influence each other equally). Using this framework, we can observe how both firearms and gun crimes are impacting each other. After performing a VAR on a set of two variables (one firearm measure and one gun violence measure), Granger causality tests are also performed to test if lagged regressors are significantly useful in predicting the dependent variable. It is important to note that Granger causality is not a measure of true causality. Instead, Granger causality tests are only useful in observing if past values of a certain variable contain information that is significant in predicting another variable.

Southwick (1997) was one of the first studies to use Granger causality tests on whether firearms were causing gun violence and vice versa. The firearm measures used in Southwick (1997) are different time series of sales and stocks of handguns, rifles, and shotguns in the United States approximately from 1945 to 1990. The study found that crime was causing gun ownership more than gun ownership was causing crime. This thesis follows Southwick (1997) by using Granger causality tests to determine whether crimes cause guns or guns cause crime. What differs from Southwick (1997) is the ability of this study to more deeply analyze how different types of firearms affect crimes. This study not only decomposes the total number of guns into handguns, rifles, and shotguns, but separates these gun classifications according to handgun caliber sizes and whether or not a firearm has a semi-automatic firing mechanism. The scope of this study is also much smaller. Whereas Southwick (1997) looked at the whole of the United States, this paper focuses on one metropolitan area, Dallas, Texas.

The results of this study are consistent with the findings of Southwick (1997). Southwick (1997) found that murder or homicide was affecting gun ownership positively. The results in the study also saw no significant effect of guns on aggravated assault. In this thesis, the results show that the growing number of gun homicides in Dallas affected the level/number of guns on Dallas' streets positively. Different from Southwick (1997), there seems to be a relationship between gun aggravated assaults and firearms. This result could be from the fact that Southwick (1997) used all aggravated assaults whereas this thesis uses only gun aggravated assaults as the violence measure.

The rest of the thesis is organized as follows. Chapter II discusses previous literature on the topics surrounding firearms and crime. Chapter III will discuss the data used in the study. Chapter IV presents the methodology behind the process of obtaining results. Chapter V will present the results from estimating vector autoregressions and performing Granger causality tests. Finally, Chapter VI discusses how to further refine research behind firearms and crime by including not just seasonal variations in crime but socioeconomic and cultural factors as well.

CHAPTER II

LITERATURE REVIEW

Gregg Lee Carter (2012) has stated that multiple theories have been offered in order to understand the effect gun availability has on crime. The theories are “guns facilitate crime by those inclined to it”, “guns allow victims to resist attack”, “guns deter criminal attack”, and “firearm availability causes violence”.

Guns are most commonly used in robberies. Also, guns are much more widely used than other weapons during robberies. Using some weapon other than a gun limits the criminal/robber to attacking the individual they are robbing. Guns allow criminals to attack higher profile stores such as banks (Kleck, 1997). Because guns are mostly used in robberies, the victim is less likely to suffer injury. The victim is more likely to comply when confronted with a gun. Although, if a criminal/robber shoots the victim, death is more likely from using a gun than using a less lethal weapon (Cook, 1987).

The notion behind the second theory that guns allow victims to resist attack is essentially the use of guns for self-defense. Jacobs (1989) noted that the use of chemical sprays or physical combatives do not allow a victim to stop their attacker as well as someone who is armed and physically stronger. He states that attackers may be high on alcohol or other drugs or intensely angry or excited (the people most likely to be the ones attacking and be most dangerous) and will not feel the effects of these lesser self-defense options. So, what are the effects of using guns in self-defense? In a study by

Kates (1991), he concluded that handguns are used as or more often to prevent the commission of crimes than by felons attempting them. When victims resist criminals with a gun, the victim is half as likely to be injured as compared to a victim who submits to the criminal (Kleck, 1997). A reason for victims not being as likely to be injured when using guns in self-defense is that victims who pull guns on their attacker generally find that the attacker flees. Kleck (1997) has estimated that handguns are used in self-defense of criminal attacks 2 million to 2.5 million times per year nationally.

The third theory is similar to that of the self-defense theory. If a criminal believes a potential victim is armed, the criminal will decide not to commit the crime. In Monti, Sheley, and Wright's (1998) and Kessler, Wright, and Rossi's (1986) study, between 34 and 36 percent of inmates worried that they might be shot at by a victim. The study also showed that 56 percent of these inmates agreed with the statement that most criminals are more worried about meeting an armed victim than they are about running into the police.

The theory behind firearm availability causing violence is now considered widely incorrect. Stated in Carter (2012, p. 61), "The theory that increased gun availability generally does increase homicide seemed plausible in the late 1960s when a substantial increase in guns coincided with a doubling of the American homicide rate. However, correlation does not prove causation. Instead of more guns causing more crime, it appears that the vast crime increases of that era caused more people to buy guns. If more guns were, as is often asserted, "the major cause" of high American murder rates, the vast increases in guns since the 1960s should have coincided with vast increases in homicide."

Using data from Dallas from 1980 to 1992, Koper (2001) hypothesized that gun availability is an explanatory factor for increases in gun homicides. He also hypothesized that changes in the lethality of the criminal gun arsenal drove up these gun homicide rates. He concluded that semi-automatic firearms (very high lethal weapon) did not influence gun homicides. In addition, the overall gun availability, measured as the percentage of robberies committed with guns, did not influence gun homicide rates. Koper (2001, p. iii) states, "These results suggest that the availability of more lethal guns among criminal/high risk groups (particularly high powered weapons) exerted more influence on gun homicides in Dallas than did the general availability of firearms among these groups." Expanding upon Koper's (2001) analysis, Graham (2007) included social and economic factors that have been linked to lethal violence. He also introduced an improved way to observe the differences in lethality of firearms, which will be used in this study. Graham (2007) concluded that when these social and economic variables are introduced, the availability of these lethal firearms and the overall availability of firearms does not impact gun homicides although gun aggravated assaults was influenced by the overall availability of firearms. These previous analyses of Dallas' gun crime arsenal have only explained the impact guns have on gun crimes. This paper not only explores the effects firearms have on gun crimes but also the opposite scenario of the effects gun crime has on firearms.

Southwick (1997) is one study that focuses on both scenarios. Southwick (1997, p. 2) poses the question, "How is crime affected by the level of gun ownership and how is gun ownership affected by crime?" Using a Granger causality framework, Southwick (1997) tests this question. Southwick's (1997) dataset included time series of sales of guns and the stock of guns for each of handguns, rifles, and shotguns in the United States. The sample period observed in this study is approximately from 1945-1990 (some time series variables started a year or two later and ended a year or two later). Among murders and homicides, Southwick's (1997) results show murder or homicide is positively affecting gun ownership. There is little to no effect from gun ownership to murder or homicide. The other crime measure of importance to this study is aggravated assault. Southwick's (1997) results show aggravated assaults resulted in no apparent relationships between gun ownership.

In summary, this thesis continues the research of the relationship between firearms and crime. Specifically, this paper tests the impact firearms have on crime and the impact crime has on firearms by using a Granger causality approach similar to Southwick (1997). The next two chapters in this thesis presents the data and methodology behind testing these hypotheses.

CHAPTER III

DATA

The data used in this study was obtained from the Inter-University Consortium for Political and Social Research (ICPSR) and is titled, "Gun Density, Gun Type, and the Dallas Homicide Rate, 1980-1992 (ICPSR 3145)". For the years of 1980 through 1992, a study was performed in Dallas, Texas by Christopher S. Koper of the Crime Control Institute, which was aimed at providing information about all firearms confiscated by Dallas police during that time period. The Dallas police from 1980 through 1992 confiscated approximately 58,000 firearms. The firearms seized were associated with arrests or other incidents and ones in which citizens found and willingly turned in. In this dataset, emphasis was put on tracking not only the total number of firearms on Dallas' streets, but the characteristics of the firearms as well. Dallas police analyzed and characterized the confiscated firearms according to weapon type and caliber groupings.

Firearm Measures

The number of firearms confiscated by Dallas police will be used as a measurement of Dallas' street gun arsenal. In this analysis, nine firearm variables of interest were created from the dataset. The first variable is the total number of firearms. The other eight variables, created by Graham (2007), allow for an examination of whether or not the different lethality of firearms is impacting gun homicides or gun aggravated assaults. The remaining eight firearm variables are total numbers of large semi-automatic handguns, small semi-automatic handguns, large handguns, small handguns, semi-automatic shotguns, shotguns, semi-automatic rifles, and rifles. Staying consistent with the literature, Koper (2001) defined the large caliber handgun groups as handguns larger than .32 caliber. The small handgun groups included handguns .32 caliber and smaller. Handguns with larger calibers are said to have more stopping power and thus increases the lethality of the firearm (DiMaio, 1985). Koper (2001) categorized the most lethal types of firearms into shotguns, rifles, and large handguns. When a weapon is considered semi-automatic, this means that the firearm has a self-loading mechanism. Each shot of the firearm will reload itself by automatically inserting a new round into the chamber after ejecting the fired round. This allows the shooter to have an increased rate of fire due to the automatic reloading. Therefore, when a firearm is in the semi-automatic class, it could be considered more lethal than that of its categorical counterpart of a non-semi-automatic firearm.

Figure 1 shows the total number of firearms confiscated from 1980 to 1992. In 1980, there were around 750 firearms confiscated from Dallas' streets. The number of firearms being confiscated continued to rise in the following years reaching a peak of just less than 2,000 firearms in the first quarter of 1992. Figure 2 is a breakdown of each type of firearm that was confiscated. This figure separates the total number of firearms into the eight firearm categories created by Graham (2007). In 1980, large handguns and small handguns were more present among Dallas' street gun arsenal. Figure 2 shows approximately 250 large handguns and 250 small handguns were confiscated. The next most confiscated firearm was the small semi-automatic handgun with approximately 100 being confiscated. However, in the first quarter of 1992, semi-automatic handguns were more prominent than that of non-semi-automatic handguns. There were approximately 550 large semi-automatic handguns, 450 small semi-automatic handguns, and 390 large handguns confiscated. Shotguns were the only other firearm category to see a vast increase. The other firearm measures were relatively stagnant from 1980 to 1992. Summary statistics for the total number of guns and each firearm are reported in Table 1. The table displays the mean number of guns for each variable throughout the years of the sample. The correlations between each type of firearm are reported in Table 2. Most firearms are positively correlated with each firearm. The only firearm that is not significantly correlated with other firearms are the small caliber handguns.

To summarize, we see an increasing number of firearms circulating within Dallas' streets. When firearms are classified into their respected categories, we see the number handguns exceedingly outweigh shotguns and rifles. Dissecting these firearm categories into large or small calibers and non-semi-automatic or semi-automatic firearms, it appears criminals are substituting lesser powered firearms for higher powered firearms over time. This is specifically true for handguns.

Violence Measures

The several violence measures included in the dataset created by Koper (2001) were obtained from the Federal Bureau of Investigation's Reports. The FBI data was included in the dataset. The dataset retrieved the violence data from the FBI's Uniform Crime Reports, Supplemental Homicide Reports, and Return A data files. These violence measures consist of the number of homicides committed, number of homicides committed with a gun, and the number of aggravated assaults committed with a gun.

Much like the firearms in the streets of Dallas, Texas, the total number of homicides and aggravated assaults rose from 1980 to 1992. Figure 3 shows the number of homicides committed during these years. Beginning in 1980, 80 homicides occurred. In 1992, approximately 140 homicides were committed. What this study is specifically concerned with however, is the number of homicides committed with a gun and the number of aggravated assaults committed with a gun. In Figure 4, there were approximately 55 gun homicides. The number of gun homicides rose through the 1980's and reached a peak of approximately 115 gun homicides committed in the third quarter of 1991. On average, over the dataset's time period, 71% of homicides were committed with a gun. Figure 5 compares gun homicides with non-gun homicides. The figure shows that the changes in gun homicides were largely responsible for the changes that were taking place among homicides.

Figure 6 displays the timeline of the number of aggravated assaults committed using a gun. There were approximately 500 instances in Dallas, Texas where an aggravated assault was committed with a gun in 1980. The number of these crimes substantially increased throughout the 1980's and eventually reached a peak of 2,100 aggravated assaults committed with a gun again in the third quarter of 1991.

The remaining chapters of this thesis will focus only on gun homicides and gun aggravated assaults as the gun crime measures. The following chapter explains the methodology of testing whether or not the increases in firearms are causing the increases in gun crimes.

CHAPTER IV

METHODOLOGY

This study makes use of a vector autoregression (VAR) framework in order to run Granger causality tests. The Granger causality tests allows for the ability to test whether firearms are useful in predicting gun violence or whether gun violence is useful in predicting firearms. The data allows us to test nine firearm measures on two gun violence measures. One gun violence variable is paired with one firearm variable in each VAR while using the correct order lag length selected by Akaike information criteria (AIC). Thus, we have the ability to run Granger causality tests on 36 total equations and can determine whether firearms are Granger causing gun violence or gun violence is Granger causing firearms. It should be noted that crime might show seasonal fluctuations. If there are seasonal effects for crime, the same process of testing is performed but with seasonal dummies included in the VAR as exogenous variables.

Vector Autoregression

One way to perform Granger causality tests is through the estimations of vector autoregressions. From Stock and Watson (2011, p. 632), "a vector autoregression is a set of k time series regressions, in which the regressors are lagged values of all k series. A VAR extends the univariate autoregression to a list, or "vector", of time series variables. When the number of lags in each of the equations is the same and is equal to p, the system of equations is called a VAR(p).

In the case of two time series variables, Y_t and X_t, the VAR(p) consists of two equations,

$$Y_t = \alpha_1 + \gamma_{11} Y_{t-1} + \cdots + \gamma_{1p} Y_{t-p} + \beta_{11} X_{t-1} + \cdots + \beta_{1p} X_{t-p} + e_{1t} \quad (1.1)$$

$$X_t = \alpha_2 + \gamma_{21} X_{t-1} + \cdots + \gamma_{2p} X_{t-p} + \beta_{21} Y_{t-1} + \cdots + \beta_{2p} Y_{t-p} + e_{2t} \quad (1.2)$$

where the β's and the γ's are unknown coefficients and e_{1t} and e_{2t} are error terms."

In this study, the Y_t variables will be the gun violence measures, which are gun homicides and gun aggravated assaults. The X_t variables will be the firearm measures. The goal of this study is to understand the impact each firearm measure has on gun violence and the impact gun violence has on each firearm measure. Therefore, each vector autoregression is ran with one gun violence measure and one firearm measure.

Under VAR assumptions, it is appropriate to model each time series as having a stochastic trend. Before any transformations of the variables, each time series appears to follow a non-stationary process. In order to treat each variable as having a stochastic trend, each time series measure is transformed by computing its first difference. Dickey-Fuller tests were performed on all of the time series measures to test for a stationary process.

The results of the Dickey-Fuller tests are presented in Table 3. Without first-differencing the original series, each time series variable was non-stationary at the 1% level. After first-differencing, each time series variable is stationary with each test statistic being significant at the 1% level. Therefore, the VAR(p) model for the rest of the paper will be as follows,

$$\Delta Y_t = \alpha_1 + \gamma_{11}\Delta Y_{t-1} + \cdots + \gamma_{1p}\Delta Y_{t-p} + \beta_{11}\Delta X_{t-1} + \cdots + \beta_{1p}\Delta X_{t-p} + e_{1t} \quad (2.1)$$

$$\Delta X_t = \alpha_2 + \gamma_{21}\Delta X_{t-1} + \cdots + \gamma_{2p}\Delta X_{t-p} + \beta_{21}\Delta Y_{t-1} + \cdots + \beta_{2p}\Delta Y_{t-p} + e_{2t} \quad (2.2)$$

Lag Length Selection

Lag lengths in each VAR are determined using information criteria. The criteria used in this study is the Akaike information criterion. Pre-estimation tests are run for lags of up to six periods. Each equation will have one to six lags included for each of the series. The number of lags used for each VAR model specification will be shown in tables in Chapter V of this thesis.

Seasonal Effects

In examining Figures 4 and 6, seasonal fluctuations seem to appear. Block (1984) performed a study asking whether crime is seasonal. She ascertains that certain types of homicide may be varying with the season; however, seasonal fluctuation may be too weak to affect policy decisions. On aggravated assault, Block (1984) concludes there is no doubt that aggravated assaults show seasonal fluctuations. McDowall et. al (2015) also denotes that seasonality stands out in aggravated assaults while homicides may or may not show seasonal fluctuations.

If there are underlying seasonal fluctuations in gun homicides and gun aggravated assaults, it would be important to include seasonal effects in the VAR. Thus, two sets of VAR's will be estimated; one with seasonal dummy variables which are included as exogenous, and one without the seasonal adjustments.

Granger Causality

After estimating VAR's on each pair of firearm measure and gun violence measure, a Granger causality test was executed for each VAR. The definition of Granger Causality is X_t is said to Granger cause Y_t if X_t helps in the prediction of Y_t. Simply, how much can Y_t be explained by previous values of Y_t and does adding previous values of X_t help improve the explanation? Noted by Stock and Watson (2011, p. 538), "Granger predictability is a more accurate term than 'Granger causality'. Meaning, X_t Granger causing Y_t is not to imply that Y_t is the effect or result of X_t.

The next chapter provides results for the VAR models and Granger-causality tests. Using the Granger causality tests, this study can narrow down what types of firearms are useful in predicting gun crimes and also if gun crimes are useful in predicting certain types of firearms. In the discussion of the results, "Granger cause" will be used to reflect the prior definition of Granger causality.

CHAPTER V

RESULTS

The following sections report the results from each estimation of a VAR model specification and each Granger causality test. The first section will attempt to explain the relationships between firearms and gun homicides in the streets of Dallas, Texas from 1980 to 1992. The second section will attempt to explain the relationships between firearms and gun aggravated assaults. The third and fourth section will be reported the same as above but with the addition of seasonal effects in the models.

Results without Seasonal Effects

The reported statistics are the results of estimating the VAR system of equations 2.1 and 2.2, which include one firearm measure from Dallas' street gun arsenal and one gun violence measure. Granger causality tests were performed on these VAR's in order to test whether firearms are useful in predicting crime or crime is useful in predicting firearms. Meaning, causalities are tested in both directions.

Gun Homicide

Table 4 presents the results from running Granger causality tests on each VAR model in Tables 5a-5c. At a 5% significance level, the number of gun homicides are Granger causing the following firearm measures; total number of guns, small handguns, and rifles. At a 10% significance level, the number of gun homicides are Granger causing these following firearm measures; small semi-automatic handguns, large handguns, and shotguns. The only firearm measure that is Granger causing gun homicides is the semi-automatic rifle, significant at the 10% level.

The direction of the effect will next be discussed for each of the series above. Each column in Tables 5a-5c display the VAR results for the number of gun homicides and each firearm measure. The three firearm measures that were Granger caused by gun homicides at the 5% significance level were the total number of guns, small handguns, and rifles. Column 1 of Table 5a shows that the past values of gun homicides were positively affecting the total number of guns. Column 5 of Table 5b shows the past values of gun homicides were positively affecting the number of small handguns. In addition, column 6 of Table 5b shows that the past values of gun homicides were positively affecting the number of rifles.

Next are the three firearm measures being Granger caused by gun homicides at the 10% significance level. Columns 3, 4, and 8 display the VAR results of small semi-automatic handguns, large handguns, and shotguns. These results also show that past values of gun homicides are positively affecting these firearm measures.

The semi-automatic rifle firearm measure was the only variable to be Granger causing gun homicides. In column 7 of Table 5c, the second lagged value for semi-automatic rifles is positively affecting gun homicides.

Gun Aggravated Assault

The Granger causality results are presented in Table 6 for gun aggravated assaults. The two firearm measures that are Granger causing gun assaults are large semi-automatic handguns (1% significance) and semi-automatic rifles (5% significance). There is one firearm measure that is being Granger caused by gun assaults at a 5% significance level; small semi-automatic handguns. Three firearms are being Granger caused by gun assaults at the 10% significance level; large semi-automatic handguns, rifles, and semi-automatic rifles.

Tables' 7a-7c display the VAR results between gun aggravated assaults and each of the nine firearm measures. It is interesting to note that large semi-automatic handguns are Granger causing gun assaults and being Granger caused by gun assaults. Column 2 of Table 7a displays this. It appears that the past values of large semi-automatic handguns are negatively affecting gun aggravated assaults and gun aggravated assaults are positively affecting large semi-automatic handguns. Semi-automatic rifles show a slightly similar case in that the Granger causality direction is going both ways. However, column 7 of Table 7c shows that past values of semi-automatic rifles are very positively affecting gun aggravated assaults and seems to outweigh the fact that only the fifth lagged value for gun assaults affects semi-automatic rifles.

For gun aggravated assaults Granger causing large or small semi-automatic handguns and rifles, gun aggravated assaults are positively affecting these three firearm measures. Results can be seen in columns 2, 3, and 6 of Tables 7a-7b

Results with Seasonal Effects

Granger causality tests are ran the same way as that of above. The only difference is that seasonal dummy variables are input into each VAR to account for seasonal fluctuations (if there are any) in crimes. The data is quarterly; therefore, three seasonal dummies will be included in the VAR. With the inclusion of seasonal dummy variables as exogenous, the number of lags chosen by AIC to reflect the best model sometimes changes. If it is the case that AIC chooses zero lags as the best fit model for some pair of firearm measure and violence measure, then that VAR will be excluded from estimation and excluded from the results tables.

Gun Homicides

When seasonal effects are controlled for, slight changes can be seen between the results with and without seasonal effects. These results are displayed in Table 8. In the first column for a firearm measure Granger causing gun homicides, semi-automatic rifles have a higher F-test statistic than Table 4 (Granger causality test without seasonal effects) and gains significance from the 10% level to the 5% level. Every other firearm measure still shows no significance. In the second column, large handguns, small handguns, and rifles being Granger caused by gun homicides also have higher F-test statistics. Gun homicide is still positively affecting these three firearm measures. The firearm measures to drop significance are small semi-automatic handguns and shotguns.

In Chapter IV, there was discussion of whether or not it is important to control for seasonal fluctuations in gun crimes. Tables' 9a-9c display the results of each VAR with the inclusion of seasonal dummy variables. In all nine VAR model specifications, the variable controlling for the third quarter of the year shows significance at the 1% level (VAR model with semi-automatic shotguns shows 5% significance for the third quarter). From the results, there is an increase of about 15 to 20 gun homicides per every third quarter. There is no significance for the second and fourth quarters affecting gun homicides.

Gun Aggravated Assaults

There are three firearm measures showing significance when seasonal dummies are included in the VAR. These are large and small semi-automatic handguns, and semi-automatic rifles. From the Granger causality tests, the large semi-automatic handguns and semi-automatic rifles are Granger causing gun aggravated assaults. In column 2 of Table 11a, past values of large semi-automatic handguns are negatively affecting the number of gun aggravated assaults. In column 7 of Table 11c, past values of semi-automatic rifles are positively affecting gun aggravated assaults.

For small semi-automatic handguns, Granger causality is going in both directions. From Table 10, gun assaults are Granger causing small semi-automatic handguns at the 1% level whereas small semi-automatic handguns are Granger causing gun assaults at the 10% level. Much like the large semi-automatic handguns, column 3 of Table 11a shows past values are negatively affecting gun assaults. However, since there is dual Granger causality, the opposite case must be looked at. The results show that gun assaults are positively affecting small semi-automatic handguns.

In the nine VAR model specifications, most seasonal dummy variables are significant. Tables 11a-11c show that gun aggravated assaults increase anywhere from 100 to 200 gun assaults (significant at the 1% and 5% levels) per second quarter and per third quarter. In some instances, gun aggravated assaults decrease about 150 gun assaults (also significant at the 1% and 5% levels) per fourth quarter.

CHAPTER VI

DISCUSSION

From 1980 to 1992, Dallas, Texas seen an increase in homicides committed with a gun and aggravated assaults committed with guns. Gun homicides increased from 60 in 1980 to 110 in 1992. Gun Aggravated assaults also increased from 500 gun assaults committed in 1980 to 2,000 gun assaults committed in 1992. Over that same time period, the number of guns among Dallas' street gun arsenal was also increasing. The total number of guns on Dallas' streets increased from 750 to almost 2,000 during these years. There was also a change happening among the different types of guns being used among criminals. Criminals started substituting less lethal firearms for more lethal firearms (semi-automatic firing capabilities; larger calibers).

The focus behind this study was to determine whether increases in gun levels on Dallas' streets was increasing gun crimes and vice versa. With Koper's (2001) dataset, there is also the ability to understand what types of weapon were causing the increases of crimes or what crimes were causing the increases of different firearms. Making use of a vector autoregression framework, Granger causality tests were performed in order to test Granger causality among these firearm and crime measures in both directions. It is important to note that Granger causality tests do not imply that a variable is the net effect or result of another variable. However, it is a good tool to use as a predictor.

The results show that gun homicides are Granger causing most of these firearm increases, which is consistent with Southwick's findings (1997). Hypotheses can be made to explain why this occurs. When homicides in a metropolitan area such as Dallas are increasing, criminals are responding to this increased risk by having more guns in order to protect themselves. Also, because we see an increase of more lethal weapons in the data, it could be the case that criminals are supplying themselves with more lethal weapons in the sense that this may make the criminal feel safer and have a greater ability to fend off an attack.

This thesis also tests whether seasonal fluctuations occur in gun crimes. In previous literature, the case was made that aggravated assaults do show seasonal fluctuations whereas researchers were still uncertain about homicide showing seasonal fluctuations. The results presented in this paper find that seasonal fluctuations in gun aggravated assaults do occur (increase in second and third quarter and decrease in fourth quarter) and should be controlled for when modeling what affects aggravated assaults. This thesis also finds that gun homicides in Dallas increase during the third quarter but show no signs of significance in other quarters.

For future research, the inclusion of socioeconomic and cultural factors as exogenous variables may change the results of this study. Such factors could include the level of gang activity, the changing of racial neighborhoods, the level of drug activity, and the level of economic prosperity in Dallas, Texas during time period of 1980 to 1992. Much like Moody (2005), one could conclude that gun crimes are not influencing firearms at all and it is the socioeconomic and cultural factors driving the effect.

Figure 1: Total Number of Firearms

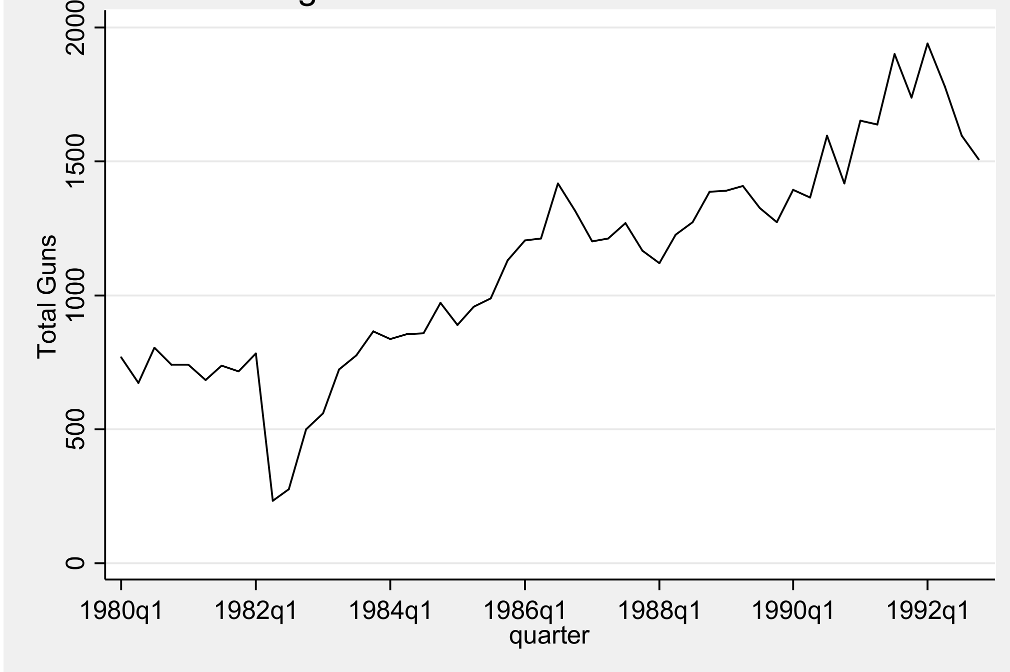
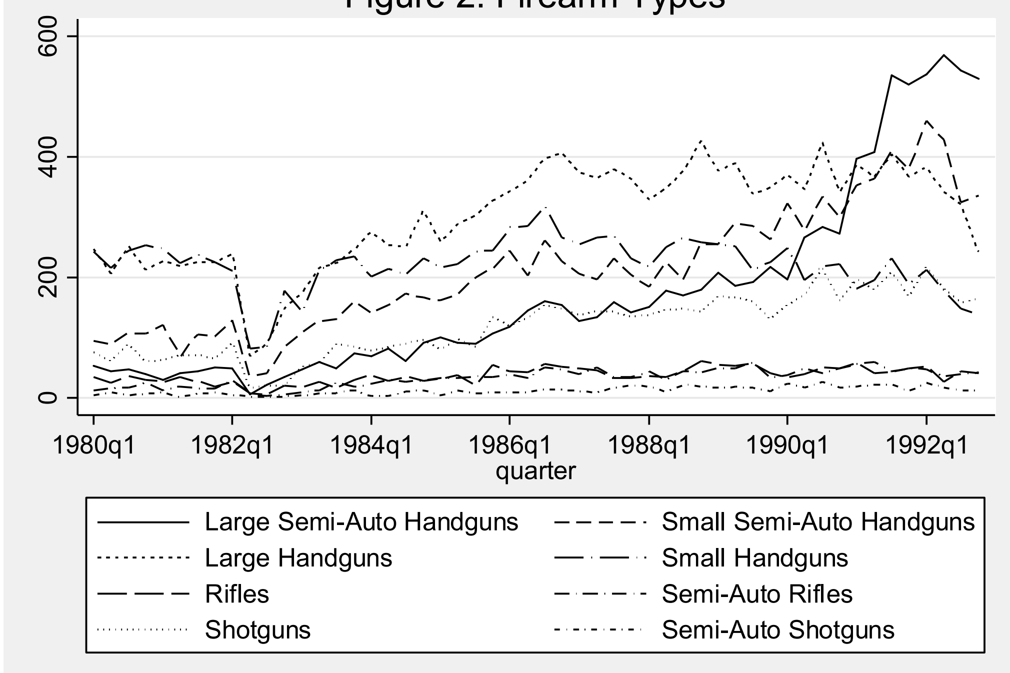


Figure 2: Firearm Types



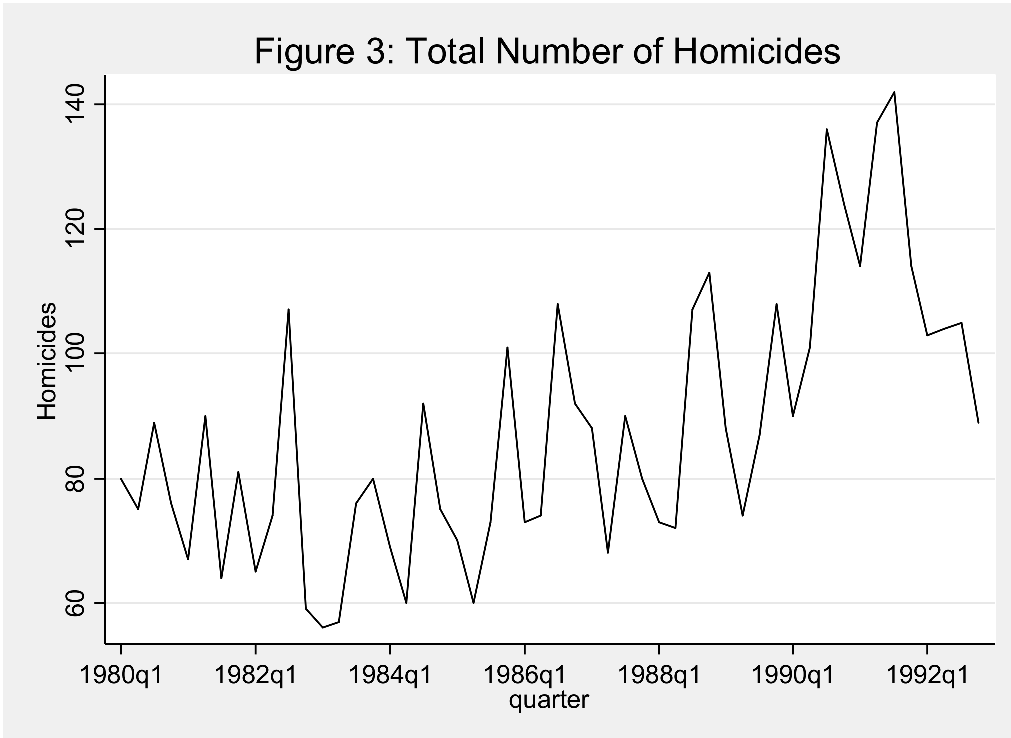


Figure 3: Total Number of Homicides
Homicides
140
120
100
80
60
1980q1
1982q1
1984q1
1986q1
1988q1
1990q1
1992q1
quarter

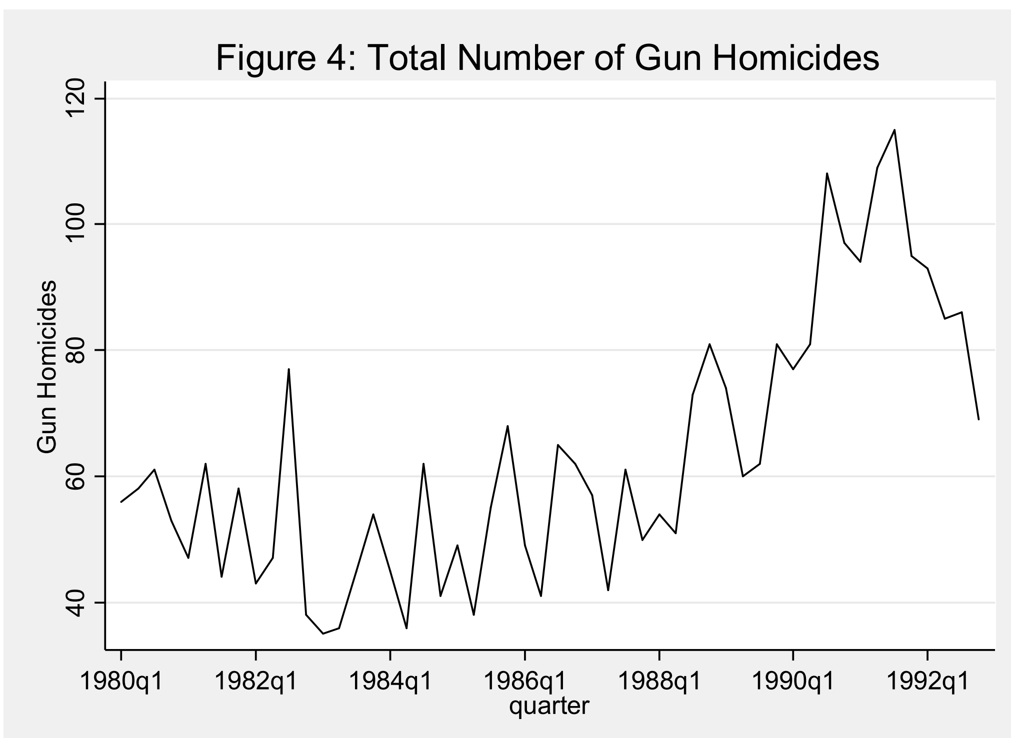


Figure 4: Total Number of Gun Homicides
Gun Homicides
120
100
80
60
40
1980q1
1982q1
1984q1
1986q1
1988q1
1990q1
1992q1
quarter

Figure 5: Gun vs. Non-Gun Homicides

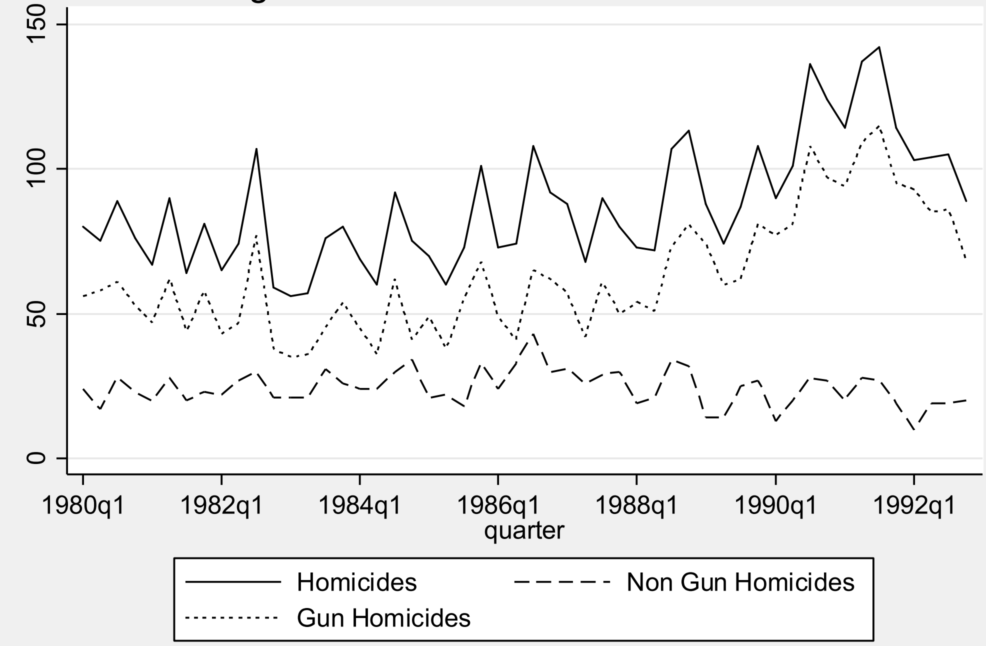


Figure 6: Total Number of Gun Aggravated Assaults

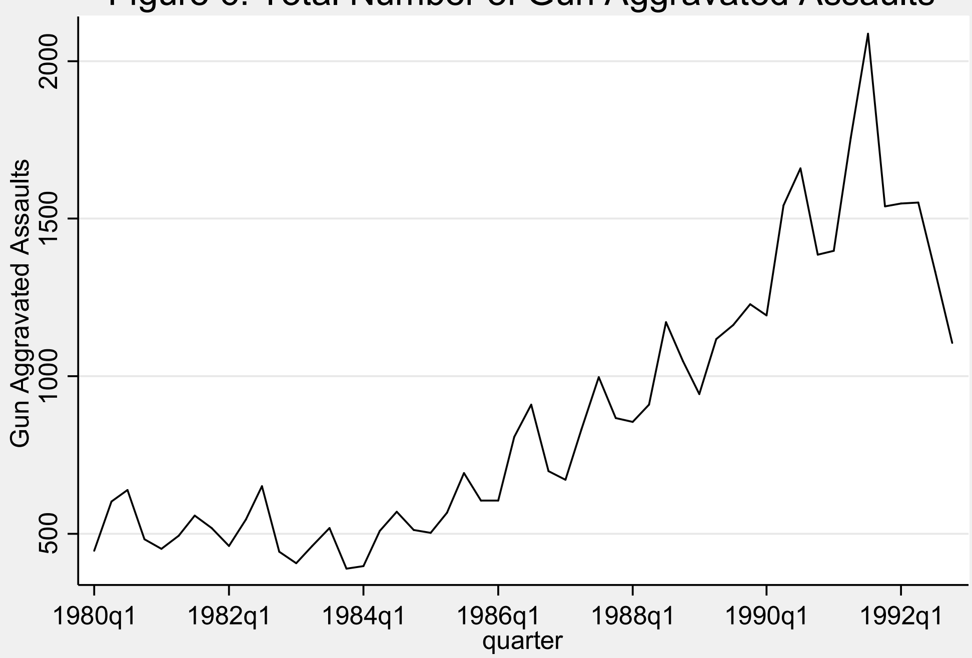


Table 1: Summary Statistics

	Mean	Standard Deviation	Minimum	Maximum
Gun Homicides	63.07692	20.55967	35	115
Gun Aggravated Assaults	872.5962	427.8129	389	2089
Total Guns	1115.212	400.1603	234	1938
Large Semi-Auto Handguns	174.7115	158.6468	7	568
Small Semi-Auto Handguns	212.0577	102.5188	37	460
Large Handguns	302.0385	83.93834	70	426
Small Handguns	221.6923	44.58943	82	318
Semi-Auto Rifles	33.82692	14.491	4	61
Rifles	37.69231	13.03771	6	62
Shotguns	120.3269	51.09918	18	218
Semi-Auto Shotguns	12.86538	6.692193	2	28
Observations		52		

Table 2: Firearm Correlations

	Large Semi-Auto Handguns	Small Semi-Auto Handguns	Large Handguns	Small Handguns	Semi-Auto Rifles	Rifles	Shotguns	Semi-Auto Shotguns
Large Semi-Auto Handguns	1							
Small Semi-Auto Handguns	0.913***	1						
Large Handguns	0.546***	0.771***	1					
Small Handguns	-0.184	0.0894	0.584***	1				
Semi-Auto Rifles	0.638***	0.802***	0.846***	0.313*	1			
Rifles	0.477***	0.651***	0.826***	0.464***	0.805***	1		
Shotguns	0.804***	0.929***	0.888***	0.262	0.882***	0.778***	1	
Semi-Auto Shotguns	0.614***	0.781***	0.778***	0.249	0.720***	0.588***	0.845***	1

Correlation coefficient with *, **, *** implies significance at the 10%, 5%, and 1% level respectively.

Table 3: Dickey-Fuller Test Results

Variable	DF Test Statistic	
	Levels	First differences
Gun Homicides	-2.606*	-9.937***
Gun Aggravated Assaults	-1.491	-7.114***
Total Guns	-1.179	-8.819***
Large Semi-Auto Handguns	1.017	-8.202***
Small Semi-Auto Handguns	-1.278	-10.492***
Large Handguns	-1.822	-9.056***
Small Handguns	-2.618*	-8.332***
Rifles	-3.237**	-10.838***
Semi-Auto Rifles	-2.520	-11.059***
Shotguns	-1.721	-11.859***
Semi-Auto Shotguns	-3.585**	-12.738***

Dickey-Fuller test statistic with *, **, *** implies significance at the 10%, 5%, and 1% level.

TABLE 4

Granger Causality Tests: Gun Homicides

	F-statistic	
	Cause Gun Homicides	**Gun Homicides Cause**
Total Guns	0.6621	3.2875**
Large Semi-Auto Handguns	0.1212	1.0688
Small Semi-Auto Handguns	0.4819	2.5989*
Large Handguns	1.7616	3.4748*
Small Handguns	2.0827	4.65**
Rifles	0.9367	3.2474**
Semi-Auto Rifles	3.0000*	0.2805
Shotguns	0.6179	2.3309*
Semi-Auto Shotguns	1.3054	0.4357

F-statistics with *, **, *** implies significance at the 10%, 5%, and 1% level. Levels of significance depends on the degrees of freedom due to the number of lags used in each VAR.

Table 5a: VAR Gun Homicides Models

	(1)		(2)		(3)	
	Gun Homicides	Total Guns	Gun Homicides	Large Semi-Auto Handguns	Gun Homicides	Small Semi-Auto Handguns
LD.Gun Homicides	-0.5208***	2.9587**	-0.5627***	0.3248	-0.5273***	0.6186
	(-3.62)	(2.13)	(-3.87)	(1.03)	(-3.65)	(1.67)
L2D.Gun Homicides	-0.4407***	0.1701	-0.4385***	0.4821	-0.4488***	0.2841
	(-2.88)	(0.11)	(-2.86)	(1.45)	(-2.94)	(0.73)
L3D.Gun Homicides	-0.2369	3.1870**	-0.2131	0.5017	-0.2114	0.9316**
	(-1.64)	(2.29)	(-1.46)	(1.59)	(-1.48)	(2.53)
L4D.Gun Homicides						
L5D.Gun Homicides						
LD.Total Guns	-0.0052	-0.1272				
	(-0.37)	(-0.95)				
L2D.Total Guns	0.0162	0.0420				
	(1.11)	(0.30)				
L3D.Total Guns	-0.0028	-0.2817*				
	(-0.19)	(-2.00)				
LD.Large Semi-Auto Handguns			0.0288	-0.2392*		
			(0.45)	(-1.74)		
L2D.Large Semi-Auto Handguns			-0.0170	0.2611*		
			(-0.27)	(1.94)		
L3D.Large Semi-Auto Handguns			-0.0223	0.2903**		
			(-0.35)	(2.11)		
LD.Small Semi-Auto Handguns					-0.0029	-0.3947***
					(-0.06)	(-2.92)
L2D.Small Semi-Auto Handguns					0.0307	-0.1422

					(0.45)	(-0.82)
L3D.Small Semi-Auto Handguns					-0.0410	-0.2492
					(-0.64)	(-1.52)
Constant	0.8150	19.8642	1.1505	6.0620	1.1320	8.2439
	(0.43)	(1.08)	(0.53)	(1.30)	(0.55)	(1.57)
Observations	48		48		48	

Dependent variables are listed under each numbered (#) VAR equation. Independent variables are listed along the left-hand side. Coefficients with *, **, *** implies significance at the 10%, 5%, and 1% level.

Table 5b: VAR Gun Homicides Models (cont.)

	(4)		(5)		(6)	
	Gun Homicides	**Large Handguns**	**Gun Homicides**	**Small Handguns**	**Gun Homicides**	**Rifles**
LD.Gun Homicides	-0.3487**	0.7297*	-0.3747***	0.6909**	-0.5067***	0.2457**
	(-2.64)	(1.86)	(-2.84)	(2.16)	(-3.54)	(2.39)
L2D.Gun Homicides					-0.4141**	0.2411**
					(-2.66)	(2.16)
L3D.Gun Homicides					-0.2267	0.2707**
					(-1.56)	(2.60)
L4D.Gun Homicides						
L5D.Gun Homicides						
LD.Large Handguns	-0.0605	-0.3056**				
	(-1.33)	(-2.26)				
LD.Small Handguns			-0.0789	-0.1564		
			(-1.44)	(-1.18)		
LD.Rifles					-0.1799	-0.5366***
					(-0.96)	(-4.01)
L2D.Rifles					0.1472	-0.2368
					(0.71)	(-1.59)
L3D.Rifles					-0.0317	0.1420
					(-0.16)	(1.01)
Constant	0.5188	0.7144	0.2965	-2.2887	1.0431	-0.2199
	(0.28)	(0.13)	(0.16)	(-0.50)	(0.58)	(-0.17)
Observations	50		50		48	

Dependent variables are listed under each numbered (#) VAR equation. Independent variables are listed along the left-hand side. Coefficients with *, **, *** implies significance at the 10%, 5%, and 1% level.

Table 5c: VAR Gun Homicides Models (cont.)

	(7)		(8)		(9)	
	Gun Homicides	**Semi-Auto Rifles**	**Gun Homicides**	**Shotguns**	**Gun Homicides**	**Semi-Auto Shotguns**
LD.Gun Homicides	-0.4721***	-0.0191	-0.5414***	0.2142	-0.6041***	0.0294
	(-3.60)	(-0.22)	(-3.76)	(0.96)	(-4.12)	(0.58)
L2D.Gun Homicides	-0.2790**	0.0504	-0.4516***	0.1082	-0.4320**	-0.0456
	(-2.12)	(0.59)	(-3.01)	(0.47)	(-2.58)	(-0.79)
L3D.Gun Homicides			-0.2008	0.5583**	-0.1825	-0.0157
			(-1.39)	(2.51)	(-1.01)	(-0.25)
L4D.Gun Homicides					0.0061	-0.0099
					(0.03)	(-0.16)
L5D.Gun Homicides					0.1420	-0.0222
					(0.92)	(-0.41)
LD.Semi-Auto Rifles	0.2765	-0.5608***				
	(1.31)	(-4.05)				
L2D.Semi-Auto Rifles	0.5164**	-0.2708*				
	(2.44)	(-1.95)				
LD.Shotguns			0.0223	-0.4207***		
			(0.26)	(-3.23)		
L2D.Shotguns			0.1184	-0.1062		
			(1.23)	(-0.72)		
L3D.Shotguns			0.0191	-0.3342**		
			(0.21)	(-2.40)		
LD.Semi-Auto Shotguns					0.3057	-0.9009***
					(0.75)	(-6.38)
L2D.Semi-Auto Shotguns					0.6822	-0.7733***
					(1.19)	(-3.92)
L3D.Semi-Auto Shotguns					1.0109	-0.6155***
					(1.61)	(-2.85)

L4D.Semi-Auto Shotguns					1.4345**	-0.2853
					(2.49)	(-1.44)
L5D.Semi-Auto Shotguns					0.8713*	-0.3259**
					(1.96)	(-2.12)
Constant	0.2365	0.8761	0.6395	3.4230	-0.1062	0.9493
	(0.14)	(0.77)	(0.34)	(1.19)	(-0.06)	(1.47)
Observations	49		48		46	

Dependent variables are listed under each numbered (#) VAR equation. Independent variables are listed along the left-hand side. Coefficients with *, **, *** implies significance at the 10%, 5%, and 1% level.

TABLE 6

Granger Causality Tests: Gun Aggravated Assaults

	F-statistic	
	Cause Gun Assaults	**Gun Assaults Cause**
Total Guns	1.3247	0.5396
Large Semi-Auto Handguns	4.2871***	2.2708*
Small Semi-Auto Handguns	2.0096	3.1904**
Large Handguns	1.503	1.6369
Small Handguns	0.2435	0.4011
Rifles	0.739	2.7216*
Semi-Auto Rifles	2.5510**	2.1369*
Shotguns	1.5129	1.0014
Semi-Auto Shotguns	1.1797	0.7258

F-statistics with *, **, *** implies significance at the 10%, 5%, and 1% level. Levels of significance depends on the degrees of freedom due to the number of lags used in each VAR.

Table 7a: VAR Gun Aggravated Assaults Models

	(1)		(2)		(3)	
	Gun Assaults	Total Guns	Gun Assaults	Large Semi-Auto Handguns	Gun Assaults	Small Semi-Auto Handguns
LD.Gun Aggravated Assaults	-0.0498	0.1270	-0.1539	0.0057	0.0019	0.0909**
	(-0.40)	(1.04)	(-0.97)	(0.15)	(0.01)	(2.53)
L2D.Gun Aggravated Assaults	-0.5924***	0.0098	-0.3744**	0.0683	-0.3537**	0.0244
	(-4.77)	(0.08)	(-2.20)	(1.68)	(-2.40)	(0.63)
L3D.Gun Aggravated Assaults			0.2502	0.0970**	0.1142	0.1263***
			(1.35)	(2.19)	(0.81)	(3.43)
L4D.Gun Aggravated Assaults			0.5430***	0.1108***	0.4065**	0.0044
			(3.33)	(2.84)	(2.70)	(0.11)
L5D.Gun Aggravated Assaults			0.2895	0.1222**		
			(1.39)	(2.45)		
LD.Total Guns	-0.0516	-0.2261				
	(-0.35)	(-1.55)				
L2D.Total Guns	0.2187	0.1289				
	(1.45)	(0.87)				
LD.Large Semi-Auto Handguns			0.0805	-0.2035		
			(0.12)	(-1.32)		
L2D.Large Semi-Auto Handguns			1.0262	0.2167		
			(1.53)	(1.36)		
L3D.Large Semi-Auto Handguns			-1.9308***	0.0806		
			(-2.90)	(0.51)		
L4D.Large Semi-Auto Handguns			-1.7130**	-0.3070*		
			(-2.37)	(-1.78)		
L5D.Large Semi-Auto Handguns			-0.9385	0.0416		
			(-1.31)	(0.24)		
LD.Small Semi-Auto Handguns					-0.3188	-0.4875***
					(-0.56)	(-3.29)

L2D.Small Semi-Auto Handguns					-0.3592	-0.1822
					(-0.55)	(-1.06)
L3D.Small Semi-Auto Handguns					-0.8574	-0.1844
					(-1.28)	(-1.06)
L4D.Small Semi-Auto Handguns					0.9530	0.1774
					(1.47)	(1.05)
Constant	20.1044	13.8153	33.9181	1.9997	13.8574	3.6901
	(1.01)	(0.71)	(1.59)	(0.39)	(0.65)	(0.66)
Observations	49		46		47	

Dependent variables are listed under each numbered (#) VAR equation. Independent variables are listed along the left-hand side. Coefficients with *, **, *** implies significance at the 10%, 5%, and 1% level.

Table 7b: VAR Gun Aggravated Assaults Models (cont.)

	(4)		(5)		(6)	
	Gun Assaults	**Large Handguns**	**Gun Assaults**	**Small Handguns**	**Gun Assaults**	**Rifles**
LD.Gun Aggravated Assaults	-0.0408	0.0658*	-0.0755	0.0266	-0.0789	0.0031
	(-0.33)	(1.81)	(-0.60)	(0.88)	(-0.62)	(0.36)
L2D.Gun Aggravated Assaults	-0.5690***	0.0040	-0.5587***	-0.0023	-0.5323***	0.0200**
	(-4.58)	(0.11)	(-4.42)	(-0.08)	(-4.22)	(2.33)
L3D.Gun Aggravated Assaults						
L4D.Gun Aggravated Assaults						
L5D.Gun Aggravated Assaults						
LD.Large Handguns	-0.2937	-0.2712*				
	(-0.59)	(-1.84)				
L2D.Large Handguns	0.6818	0.1256				
	(1.37)	(0.85)				
LD.Small Handguns			-0.3216	-0.2112		
			(-0.55)	(-1.49)		
L2D.Small Handguns			0.1934	-0.1592		
			(0.33)	(-1.12)		
LD.Rifles					-0.1394	-0.5144***
					(-0.07)	(-3.74)
L2D.Rifles					2.1643	-0.1885
					(1.06)	(-1.36)
Constant	22.3412	-0.8851	23.0763	-3.0446	23.1713	-0.2512
	(1.15)	(-0.15)	(1.16)	(-0.63)	(1.18)	(-0.19)
Observations	49		49		49	

Table 7c: VAR Gun Aggravated Assaults Models (cont.)

	(7)		(8)		(9)	
	Gun Assaults	Semi-Auto Rifles	Gun Assaults	Shotguns	Gun Assaults	Semi-Auto Shotguns
LD.Gun Aggravated Assaults	-0.1028	0.0021	-0.0159	0.0152	-0.0458	0.0064
	(-0.75)	(0.25)	(-0.11)	(0.65)	(-0.32)	(1.27)
L2D.Gun Aggravated Assaults	-0.3498**	0.0007	-0.3662**	-0.0031	-0.2429	0.0040
	(-2.41)	(0.08)	(-2.47)	(-0.13)	(-1.62)	(0.76)
L3D.Gun Aggravated Assaults	-0.0517	-0.0136	0.1006	0.0432*	0.0719	0.0067
	(-0.30)	(-1.31)	(0.71)	(1.84)	(0.50)	(1.32)
L4D.Gun Aggravated Assaults	0.3642**	0.0029	0.3199**	-0.0052	0.4140***	-0.0006
	(2.50)	(0.33)	(2.13)	(-0.21)	(2.82)	(-0.11)
L5D.Gun Aggravated Assaults	-0.0520	-0.0329**				
	(-0.25)	(-2.65)				
LD.Semi-Auto Rifles	4.7737**	-0.4463***				
	(2.17)	(-3.34)				
L2D.Semi-Auto Rifles	1.6956	-0.2382				
	(0.70)	(-1.62)				
L3D.Semi-Auto Rifles	4.3259*	-0.0570				
	(1.73)	(-0.37)				
L4D.Semi-Auto Rifles	4.7783*	-0.3270**				
	(1.90)	(-2.14)				
L5D.Semi-Auto Rifles	5.8092**	-0.3408**				
	(2.66)	(-2.56)				
LD.Shotguns			-0.1897	-0.4558***		
			(-0.21)	(-3.01)		
L2D.Shotguns			-0.2628	-0.0949		
			(-0.27)	(-0.60)		
L3D.Shotguns			-0.6763	-0.3220*		
			(-0.69)	(-2.01)		

L4D.Shotguns			1.6034	0.0582		
			(1.66)	(0.37)		
LD.Semi-Auto Shotguns					-4.9309	-0.9570***
					(-1.15)	(-6.32)
L2D.Semi-Auto Shotguns					-4.9940	-0.7268***
					(-0.88)	(-3.63)
L3D.Semi-Auto Shotguns					0.4498	-0.4214**
					(0.08)	(-2.05)
L4D.Semi-Auto Shotguns					5.3894	-0.0132
					(1.17)	(-0.08)
Constant	5.7599	2.6252*	11.7838	3.2754	9.1801	0.2017
	(0.26)	(1.96)	(0.59)	(1.00)	(0.47)	(0.29)
Observations	46		47		47	

Dependent variables are listed under each numbered (#) VAR equation. Independent variables are listed along the left-hand side. Coefficients with *, **, *** implies significance at the 10%, 5%, and 1% level.

TABLE 8

Granger Causality Tests: Gun Homicides with Seasonal Effects

	F-statistic	
	Cause Gun Homicides	**Gun Homicides Cause**
Total Guns	0.4904	6.8453***
Large Semi-Auto Handguns	*Excluded*	
Small Semi-Auto Handguns	0.0245	1.4547
Large Handguns	0.3699	3.7867*
Small Handguns	1.909	5.2551**
Rifles	0.7235	5.1034***
Semi-Auto Rifles	3.3141**	0.0793
Shotguns	0.0267	1.0607
Semi-Auto Shotguns	1.4379	0.6194

Note: Seasonal dummy variables are included in VAR as exogenous. F-statistics with *, **, *** implies significance at the 10%, 5%, and 1% level. Levels of significance depends on the degrees of freedom due to the number of lags used in each VAR. Some firearm measures are excluded from granger causality tests due to AIC selecting a model with 0 lags.

Table 9a: VAR Gun Homicides Models with Seasonal Effects

	(1)		(2)		(3)	
	Gun Homicides	Total Guns	Gun Homicides	Large Semi-Auto Handguns	Gun Homicides	Small Semi-Auto Handguns
LD.Gun Homicides	-0.4488***	3.4626**			-0.3823***	0.4630
	(-3.03)	(2.37)			(-2.90)	(1.21)
L2D.Gun Homicides	-0.1797	0.4993				
	(-1.09)	(0.31)				
L3D.Gun Homicides	0.0402	5.4087***				
	(0.26)	(3.58)				
L4D.Gun Homicides						
L5D.Gun Homicides						
LD.Total Guns	0.0017	-0.0194				
	(0.14)	(-0.15)				
L2D.Total Guns	0.0162	-0.0342				
	(1.21)	(-0.26)				
L3D.Total Guns	0.0039	-0.2019				
	(0.30)	(-1.54)				
LD.Large Semi-Auto Handguns						
LD.Small Semi-Auto Handguns					0.0071	-0.3406**
					(0.16)	(-2.60)
q2	-0.7584	-125.7411**			2.1786	-23.1836*
	(-0.13)	(-2.22)			(0.46)	(-1.69)
q3	16.9756***	39.4732			18.8775***	-9.8669
	(3.07)	(0.72)			(4.12)	(-0.74)
q4	6.9754	-66.3375			6.3643	-21.6867
	(1.26)	(-1.22)			(1.24)	(-1.46)

Constant	-5.6581	53.8983		-6.6688*	19.9770**
	(-1.45)	(1.40)		(-2.00)	(2.06)
Observations	48			50	

Dependent variables are listed under each numbered (#) VAR equation. Independent variables are listed along the left-hand side. Coefficients with *, **, *** implies significance at the 10%, 5%, and 1% level.

Table 9b: VAR Gun Homicides Models with Seasonal Effects (cont.)

	(4)		(5)		(6)	
	Gun Homicides	Large Handguns	Gun Homicides	Small Handguns	Gun Homicides	Rifles
LD.Gun Homicides	-0.3854***	0.8628*	-0.4186***	0.8528**	-0.4033***	0.1156
	(-2.93)	(1.95)	(-3.17)	(2.29)	(-2.74)	(1.18)
L2D.Gun Homicides					-0.2146	0.1510
					(-1.27)	(1.34)
L3D.Gun Homicides					0.0005	0.2983**
					(0.00)	(2.47)
L4D.Gun Homicides					-0.1250	-0.2437*
					(-0.69)	(-2.02)
L5D.Gun Homicides					0.0468	-0.1927
					(0.26)	(-1.60)
LD.Large Handguns	-0.0247	-0.2557*				
	(-0.61)	(-1.87)				
LD.Small Handguns			-0.0662	-0.1139		
			(-1.38)	(-0.84)		
LD.Rifles					0.0783	-0.4597***
					(0.40)	(-3.56)
L2D.Rifles					0.2072	0.0114
					(1.00)	(0.08)
L3D.Rifles					-0.1164	0.1230
					(-0.60)	(0.96)
L4D.Rifles					-0.0584	-0.2317*
					(-0.30)	(-1.81)
L5D.Rifles					0.1279	-0.3685***

					(0.72)	(-3.09)
q2	2.2063	-15.9003	1.7974	-0.6370	-2.9810	-11.4282***
	(0.48)	(-1.02)	(0.39)	(-0.05)	(-0.53)	(-3.06)
q3	18.2712***	7.9895	18.2593***	13.0903	19.5158***	2.7741
	(3.95)	(0.51)	(4.06)	(1.04)	(3.07)	(0.66)
q4	6.7883	-14.0738	7.6528	-7.1897	4.7045	6.4822
	(1.33)	(-0.82)	(1.51)	(-0.50)	(0.76)	(1.57)
Constant	-6.5572*	5.9587	-6.8219**	-3.6871	-4.8858	0.8043
	(-1.97)	(0.53)	(-2.09)	(-0.40)	(-1.23)	(0.30)
Observations	50		50		46	

Dependent variables are listed under each numbered (#) VAR equation. Independent variables are listed along the left-hand side. Coefficients with *, **, *** implies significance at the 10%, 5%, and 1% level.

Table 9c: VAR Gun Homicides Models with Seasonal Effects (cont.)

	(7)		(8)		(9)	
	Gun Homicides	**Semi-Auto Rifles**	**Gun Homicides**	**Shotguns**	**Gun Homicides**	**Semi-Auto Shotguns**
LD.Gun Homicides	-0.4554***	0.0107	-0.3807***	0.2445	-0.4755***	0.0270
	(-3.35)	(0.10)	(-2.87)	(1.03)	(-3.29)	(0.48)
L2D.Gun Homicides	-0.1669	0.0405		-0.4243***	-0.2653	-0.0478
	(-1.23)	(0.39)		(-3.31)	(-1.64)	(-0.76)
L3D.Gun Homicides					0.0422	0.0277
					(0.25)	(0.42)
L4D.Gun Homicides					-0.1414	-0.0084
					(-0.87)	(-0.13)
L5D.Gun Homicides					0.1490	-0.0183
					(0.99)	(-0.31)
LD.Semi-Auto Rifles	0.3123*	-0.5478***				
	(1.70)	(-3.95)				
L2D.Semi-Auto Rifles	0.4547**	-0.2841**				
	(2.47)	(-2.04)				
LD.Shotguns			-0.0117	-0.4243***		
			(-0.16)	(-3.31)		
LD.Semi-Auto Shotguns					0.6862*	-0.8405***
					(1.89)	(-5.93)
L2D.Semi-Auto Shotguns					0.7092	-0.7411***
					(1.42)	(-3.79)
L3D.Semi-Auto Shotguns					1.0355*	-0.5499**
					(1.87)	(-2.54)
L4D.Semi-Auto Shotguns					0.9946*	-0.3029
					(1.94)	(-1.51)
L5D.Semi-Auto Shotguns					0.7111*	-0.3420**
					(1.82)	(-2.24)

q2	-1.2244	-1.3069	2.5895	-6.4105	-6.2403	-3.0870
	(-0.24)	(-0.35)	(0.52)	(-0.72)	(-1.13)	(-1.43)
q3	15.2682***	-0.4408	18.8719***	-1.2516	15.7510**	0.2480
	(3.09)	(-0.12)	(4.12)	(-0.15)	(2.59)	(0.10)
q4	4.9119	-2.6092	6.6698	-17.6713*	-1.4187	-0.7593
	(1.00)	(-0.70)	(1.28)	(-1.88)	(-0.23)	(-0.31)
Constant	-4.5709	1.9851	-6.7945*	9.0761	-2.5842	1.7557
	(-1.30)	(0.75)	(-2.00)	(1.49)	(-0.66)	(1.15)
Observations	49		50		46	

Dependent variables are listed under each numbered (#) VAR equation. Independent variables are listed along the left-hand side. Coefficients with *, **, *** implies significance at the 10%, 5%, and 1% level.

TABLE 10

Granger Causality Tests: Gun Aggravated Assaults with Seasonal Effects		
	F-statistic	
	Cause Gun Assaults	**Gun Assaults Cause**
Total Guns	*Excluded*	
Large Semi-Auto Handguns	4.4900***	1.3466
Small Semi-Auto Handguns	2.4175*	6.4255***
Large Handguns	*Excluded*	
Small Handguns	*Excluded*	
Rifles	0.0167	0.1565
Semi-Auto Rifles	4.4947***	0.7045
Shotguns	0.0371	0.2072
Semi-Auto Shotguns	0.773	0.0605

Note: Seasonal dummy variables are included in VAR as exogenous. F-statistics with *, **, *** implies significance at the 10%, 5%, and 1% level. Levels of significance depends on the degrees of freedom due to the number of lags used in each VAR. Some firearm measures are excluded from granger causality tests due to AIC selecting a model with 0 lags.

Table 11a: VAR Gun Aggravated Assaults Models with Seasonal Effects

	(1) Gun Assaults	(1) Total Guns	(2) Gun Assaults	(2) Large Semi-Auto Handguns	(3) Gun Assaults	(3) Small Semi-Auto Handguns
LD.Gun Aggravated Assaults			0.0957	0.0769*	-0.0416	0.0697*
			(0.66)	(1.96)	(-0.29)	(1.80)
L2D.Gun Aggravated Assaults			-0.1490	-0.0126	-0.0710	-0.0074
			(-0.93)	(-0.29)	(-0.47)	(-0.18)
L3D.Gun Aggravated Assaults			0.3646**	0.0051	0.1720	0.1694***
			(2.23)	(0.11)	(1.11)	(4.00)
LD.Total Guns						
LD.Large Semi-Auto Handguns			-0.2923	-0.3120**		
			(-0.53)	(-2.07)		
L2D.Large Semi-Auto Handguns			0.2201	0.3371**		
			(0.40)	(2.27)		
L3D.Large Semi-Auto Handguns			-1.8145***	0.2954*		
			(-3.20)	(1.91)		
LD.Small Semi-Auto Handguns					0.1474	-0.3774***
					(0.31)	(-2.86)
L2D.Small Semi-Auto Handguns					-0.6938	-0.1853
					(-1.17)	(-1.15)
L3D.Small Semi-Auto Handguns					-1.4188**	-0.1848
					(-2.61)	(-1.24)
q2			132.9715**	-12.0810	177.8914***	-28.1380
			(2.17)	(-0.72)	(2.77)	(-1.60)
q3			185.5529**	-20.2419	190.6637**	21.3940
			(2.37)	(-0.95)	(2.39)	(0.98)
q4			-88.3681	-24.5316	-85.1023	-3.0551
			(-1.48)	(-1.51)	(-1.33)	(-0.17)

Constant		-32.4794	19.9959	-44.8011	6.8783
		(-0.71)	(1.59)	(-0.91)	(0.51)
Observations		48		48	

Dependent variables are listed under each numbered (#) VAR equation. Independent variables are listed along the left-hand side. Coefficients with *, **, *** implies significance at the 10%, 5%, and 1% level.

Table 11b: VAR Gun Aggravated Assaults Models with Seasonal Effects (cont.)

	(4)		(5)		(6)	
	Gun Assaults	Large Handguns	Gun Assaults	Small Handguns	Gun Assaults	Rifles
LD.Gun Aggravated Assaults					-0.0329	0.0049
					(-0.23)	(0.40)
L2D.Gun Aggravated Assaults						
L3D.Gun Aggravated Assaults						
LD.Large Handguns						
LD.Small Handguns						
LD.Rifles					-0.1942	-0.4298***
					(-0.13)	(-3.34)
q2					164.9085***	-6.5166
					(3.34)	(-1.54)
q3					128.0885**	-2.8639
					(2.08)	(-0.54)
q4					-131.9573**	0.8904
					(-2.29)	(0.18)
Constant					-27.8940	2.3683
					(-0.71)	(0.71)
Observations					50	

Dependent variables are listed under each numbered (#) VAR equation. Independent variables are listed along the left-hand side. Coefficients with *, **, *** implies significance at the 10%, 5%, and 1% level.

Table 11c: VAR Gun Aggravated Assaults Models with Seasonal Effects (cont.)

	(7)		(8)		(9)	
	Gun Assaults	Semi-Auto Rifles	Gun Assaults	Shotguns	Gun Assaults	Semi-Auto Shotguns
LD.Gun Aggravated Assaults	0.0196	-0.0088	-0.0222	0.0124	-0.0724	-0.0016
	(0.14)	(-0.84)	(-0.15)	(0.46)	(-0.49)	(-0.25)
L2D.Gun Aggravated Assaults						
L3D.Gun Aggravated Assaults						
LD.Semi-Auto Rifles	3.5880**	-0.4424***				
	(2.12)	(-3.43)				
LD.Shotguns			-0.1399	-0.4306***		
			(-0.19)	(-3.21)		
LD.Semi-Auto Shotguns					2.5398	-0.5110***
					(0.88)	(-4.08)
q2	143.1944***	-0.7624	167.3311***	-8.1610	167.0360***	-1.4362
	(2.96)	(-0.21)	(3.31)	(-0.87)	(3.41)	(-0.68)
q3	111.4977*	0.8635	127.3102**	-4.3911	142.3576**	2.5543
	(1.88)	(0.19)	(2.06)	(-0.38)	(2.27)	(0.94)
q4	-152.9109***	-0.7129	-131.6783**	-16.5256	-131.2814**	0.9936
	(-2.74)	(-0.17)	(-2.29)	(-1.56)	(-2.31)	(0.40)
Constant	-15.7517	1.0503	-28.3382	9.9521	-32.0326	-0.3879
	(-0.41)	(0.36)	(-0.72)	(1.37)	(-0.82)	(-0.23)
Observations	50		50		50	

Dependent variables are listed under each numbered (#) VAR equation. Independent variables are listed along the left-hand side.
Coefficients with *, **, *** implies significance at the 10%, 5%, and 1% level.

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