
Guns, Crime, and Complexity: A Public Policy Analysis of Gun Control and Crime

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This study probes if the 1982 Chicago Gun Ordinance made any significant impact on violent crimes such as homicide and aggravated assault committed with firearms. The study uses Auto Regressive Moving Average time-series analysis, along with a control group time-series analysis for the U.S. national level data.

The results indicate that gun control has an abrupt but temporary statistically negative impact only on homicide rates for the first year. The sequence graphs depict similarities between the treatment group and control group. This indicates that the intervention year's significant negative effect on homicide rate is probably due to some other factors.

Keywords: Public policy, complexity, gun control, crime, problem definition

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As a complex and ill-structured problem, crime is a major challenge for governments in and outside of the United States. The deadliest campus-shooting rampage in American history at Virginia Tech on April 16, 2007, nearly eight years after Columbine High School shootings, has revived the gun-control debate. While the debate is critical for peace and security of most nations around the world, there is also a risk of addressing the wrong problem that can lead to the suppression of symptoms rather than reducing or controlling crime.

Complexity is a key characteristic of many, if not most, natural and social systems (Dunn, 1994; Axelrod and Cohen 1999; Kiel 1998; Marion 1999; Morgan 1997; Comfort 1999). Complex systems present dynamic and nonlinear characteristics in which outcome is not a simple function of input (Steven Levy in Marion 1999, P.45). Results cannot be predicted from what one knows about the individual components. Instead, it flows from the aggregate behavior of these individual units (Marion 1999). Like social systems, many social problems are ill structured and complex in which different actors perceive the same issue in very different terms (Dunn 1994; Mitroff and Sagasti 1973; Mitroff *et al.* 1982). This poses an important threat, solving the wrong problem or making type III error.¹ An important reason for failing problem definitions lies at the distinction between first and second order problems in which the former influences the latter under dynamic conditions. Avoiding type III error requires policy makers to transform the second order problems into first order problems to be able to apply standard methods of policy analysis (Dunn 1994).

Can number of guns held in a city or country by the public be a linear function of crime, or assuming such a correlation can lead us to a type III error? In addressing this question, the study analyzes the impact of the 1982 gun ordinance on violent crime rates in the city of Chicago by using annual data between 1973 and 1999. We obtained data from the U.S. Department of Justice, Bureau of Statistics, FBI uniform crime reports, and the Chicago Police Department for the city of Chicago and employ Auto Regressive Moving Average (ARIMA) (Box and Jenkins, 1976) along with a quasi-experimental research design.

Crime as a Complex and Ill-Structured Public Policy Problem

Many people tend to believe that if more people have guns, there will be more violent crime. Can crime, as a complex public policy problem be a linear function of gun control? The FBI's crime reports indicate that 65.6 percent of the 15,517 murders, 40.9 percent of all robberies, and 18.1 percent of all aggravated assaults reported to the police were committed with firearms in the U.S. in 2000.² Second amendment of U.S. Constitution states "a well regulated Militia, being necessary to the security of a Free State, the right of the people to keep and bear Arms, shall not be infringed" (United States House of Representatives, 2006). However, over the last 40 years, federal gun control ordinances have made "gun ownership" more difficult than ever. 1968, 1972, 1986, 1990, and 1994 Acts brought restraints in gun ownership in various ways. In addition, many states and cities have implemented different regulations to control guns in order to solve crime problems.³

Throughout the U.S. history, there have been hot debates about the issue of “gun control” and “violent crime.” Some argue that gun availability increases levels of gun violence (Newman and Zimring 1969; Cook 1979; 1983; McDowall 1991; Stolzenberg and D’Alessio 2000; Duggan 2001). They claimed that a greater availability of firearms would lead to more crime. One of the most prominent researches about the issue of gun control and crime relationship was Deutsch and Alt (1976)’s study in which they analyzed the effect of Massachusetts’s gun control law on gun related-crime in the city of Boston. The authors found that the gun control law was successful and decreased the armed robbery and aggravated assault while not affecting the homicide rate. However; Cook and Campbell (1979) analyzed the same issue three years later and found that the conclusion of Deutsch and Alt was suspicious. If they had identified the correct model by following the steps of ARIMA model, as Box and Jenkins (1976) offered, they would have found that the impact of gun control on armed robbery was not statistically significant.

Stolzenberg and D’Alessio (2000) conducted a pooled cross-sectional time series analysis by using four years of country level data from South Carolina. Different from the other researches, the authors gathered the data for only illegal gun availability and asserted that there is a strong positive relationship between the illegal gun availability and violent crime. McDowall (1991) examined the relationship between levels of firearm density and homicide rates in Detroit from 1951 to 1986. His time series analysis indicates that there is a strong positive relationship between firearm density and Detroit’s homicide rate. Duggan (2001), in his article, “More Guns, More Crime,” stood against the famous book written by Lott (2000), *More Guns, Less Crime*. Using state and county level data, Duggan (2001) found that there is a strong positive relationship between gun ownership and violent crime.

Despite all these arguments, some social scientists remained unconvinced that there is a strong positive relationship between gun ownership and violent crime (Lott 1998; 2000; Lott and Mustard 1997; Bronars and Lott 1998; Kleck 1991; Kleck and Patterson 1993; Kleck and De Lone 1993). Therefore, they claim that there is a negative association between concealed handgun laws and crime rates. They argue that stricter regulations do not decrease violent crime, in contrary; these regulations harm the law-abiding citizens who have the right to protect themselves.

One of the most comprehensive studies in this subject is Lott’s (2000) research, which challenged the widespread idea about the relationship between these two variables. He collected crime data of 3054 counties from 1977 to 1992 and performed cross sectional time series analysis along with regression analysis. By supporting this analysis with surveys and interviews, Lott claimed that gun ownership had a negative relationship with violent crime. Increases in gun ownership decreased the violent crime throughout the years. Lott argues that the ownership of guns by citizens actually acts as deterrent to crime.

Kleck (1979; 1991) and his associates (Kleck and Patterson 1993) found controversial evidences when they examined the relationship between gun ownership and violent crime. In his earlier research, Kleck (1979) found a significant positive relationship between level of gun manufacturing and murder rate. He found that increased gun manufacturing resulted in higher rates of homicide. However,

afterward, Kleck (1991) and Kleck and Patterson (1993) argued that increasing gun ownership may reduce crime rate by claiming that since guns are frequently used in self-defense, they act as an effective deterrent to criminal activity. In another research, Kleck and De Lone (1993) found that people who use a gun to defend themselves are more likely to prevent injury and completion of the crime.

Regardless of these hot debates and all regulations, gun ownership has been increased and violent crime is still one of the biggest problems that particularly metropolitan cities have to deal with. Moreover, violence has expanded to school campuses. The deadliest campus-shooting rampage in American history at Virginia Tech recently killed 32 people, nearly eight years after Columbine High School shootings.

The fundamental problem of the gun control policies is its linear approach in which “crime” is generally isolated from other social problems. Instead, crime is a complex policy problem that requires understanding interacting agents of subsystems that contribute to it.⁴

Complex social problems are ill-structured and not easily explained. Public policies must be based upon multiple criteria from which the society has been affected. Multiple stakeholders play crucial roles in society from policy formulation to policy evaluation on larger policy issues. Dunn (1994) explicitly clarifies that “the way people classify a problem determines the way they will explain and attempt to resolve it ...” While different actors perceive the same issue in very different terms supported by different data (Dunn, 1994; Mitroff and Sagasti, 1973; Mitroff *et al.* 1982), this poses an important threat, solving the wrong problem or making a type III error. An important reason for failing problem definitions lies at the distinction between first and second order problems in which the former influences the latter (Dunn, 1994). Therefore, it should be the aim of the policy makers to transform the second order problems into first order problems in structuring public policy problems before applying standard methods of policy analysis.

Based on the analysis of the impact of the 1982 gun ordinance on violent crime rates in the city of Chicago, this study argues that the policies that will focus on only the means causing crime will not help us to solve the problem.

The Policy Intervention: The 1982 Chicago Gun Ordinance

Chicago, as one of the biggest metropolitans in the U.S., has been suffering from violent crimes. Along with general trend in the U.S., in 1968, the state of Illinois passed a gun-control law and Chicago imposed a handgun registration requirement. By acknowledging the law was not effective in the early 1980s, the city passed another ordinance, which is still one of the most restrictive gun control measures in the U.S.

The Chicago City Council passed an ordinance on March 19, 1982 and the ordinance became effective on April 10, 1982. In the ordinance, Chapter 11.1 of the Municipal Code of the City of Chicago, registration of firearms was re-codified and re-modified in 1990 and 2003 (Municipal Code 8-20).⁵ This ordinance regulates the sale, possession, and registration of firearms and ammunition.

The ordinance requires that all firearms must be registered with the Chicago police before entering the city. According to this ordinance some firearms are unregistrable. With this regulation, handgun ownership is banned in the city. There are some exceptions to this rule (sections 8-20-050):

- (1) Those validly registered to a current owner in the City of Chicago prior to the effective date of this Chapter.
- (2) Those owned by Peace Officers who are residents of the City of Chicago.
- (3) Those owned by security personnel.
- (4) Those owned by private detective agencies licensed under the present law.

The 1982 ordinance also required that owners of firearms must re-register their registerable guns every two years (in 1994, the re-modified ordinance required annual re-registration). The ordinance required that all registered guns must be re-registered within six months. The ordinance allowed the inheritance of handguns.

Several years after the implementation, the 1982 gun control law seemed very effective. Starting from early 1980s, the violent crimes, especially homicide began to decline. This decline in homicide was explained by the ordinance, which had banned the handgun ownership. However; a close look at crime trends in a relatively long-time period reveals that the effect of this policy is doubtful. In late 1980s, the number of homicide in the city started to increase gradually. In 1992, the number of murders in the city had passed the level in which it had been before gun control.

Research Design, Concepts and Methodology

Research Methodology

In order to solve complex, interdependent policy problems, use of multiple methodologies and techniques is required since values, judgments, and preferences cannot be separated from policy analysis of crime. Campbell and his colleagues (2002) illustrate a unique approach, quasi experimentation, an alternative way of experimentations in social life, to overcome these difficulties and show the better interpretations of the policies. The essence of quasi-experimenting tradition is “eliminative induction that involves a search for evidence for either corroborating a rival hypothesis, and thus weakening or eliminating the originally favored hypothesis, or failing to corroborate the rival hypothesis that is then eliminated” (Dunn 1998).

The study uses ARIMA (Box and Jenkins, 1976), Auto Regression Integrated Moving Average model along with quasi-experimental design. The research design and ARIMA (Box and Jenkins, 1976) model let us deal with the problem of “threats to validity”⁶ as well as the problems that occur between series and their interactions, and the policy intervention itself. Therefore, the study has employed interrupted time-series analysis to probe whether there is a positive or a negative causal relationship between 1982 Chicago gun ordinance and violent crimes in Chicago. Our study treats time series as interconnected series not independent variables itself for each year. Therefore, the interaction between the consecutive years of series is an

important assessment of the series. Interrupted-time series design can be presented as follows:

Pre-test Measures *1982 Chicago gun ordinance* *Post-test measures*

In this research design, history, instrumentation, selection bias and testing are the major rival hypotheses, which can hide the real effects of intervention. Interrupted time-series analysis with control group helps eliminate the rival explanations. Therefore, there are two formulations, the first one is applied to the treatment group (Chicago), while the second is applied to control group (the U.S.). The new design looks as:

(1) *Pre-test Measures* *1982 Chicago gun ordinance* *Post-test measures- Chicago*

(2) *Pre-test Measures* *~1982 Chicago gun ordinance* *Post-test measures- U.S.*

The 1982 Gun Ordinance, the policy intervention, is the independent variable. There are two dependent variables, murder and aggravated assault, which are used to analyze the research questions. The Chicago Police Department⁷ gives index definitions of these crimes as follows:

Murder: The willful killing of a person. Index murder also includes voluntary manslaughter, which is the death of a person caused by gross negligence of any individual other than the victim.

Aggravated assault: The intentional causing of, or attempt to cause, serious bodily harm, or the threat of serious bodily injury or death. This category includes aggravated assault, aggravated battery, and attempted murder. In Illinois, “assault” is a threat while “battery” is an actual attack. “Aggravated” means that serious bodily harm, or the threat of serious bodily harm, is involved.

Data Sources

We needed “crime-with firearms” data in order to analyze the exact effect of the policy in order to see whether the policy had an impact on the gun related crimes. We were able to collect “gun-related murder” and “gun-related aggravated assault” data for the city of Chicago and the U.S.

The annually compiled data from 1973 to 1997 for murders and from 1973 to 1999 for aggravated assaults were used. The study has collected crime data of Chicago from different sources. The main source for Chicago data was the Chicago Police Department while we employed Bureau of Justice Department Statistics⁸ and the FBI uniform crime reports⁹ for violent crime data at the national level. We used these different data in order to compare the trends of crime between Chicago and the U.S.

Research Questions and Hypothesis

The issue addressed in this paper is whether there are significant impacts of the 1982 gun ordinance on the violent crimes in the city of Chicago. Did the policy accomplish its expected objective, the “deterrence” of “gun-related crimes”? In order

to answer this broad question, we need to analyze several sub-questions:

- Did the gun control law have a measurable impact on gun-related homicide in the City of Chicago?
- Did the gun control law have a measurable impact on gun-related aggravated assault in the City of Chicago?

The broad hypothesis of the study is that the 1982 Chicago gun ordinance did not reach its objectives and decrease the violent crime rate. There was not any linear relationship between gun control law and crime in the city of Chicago. In this respect, the ordinance did not have a negative effect on homicide and aggravated assault incidents.

ARIMA: A Time-Series Analysis

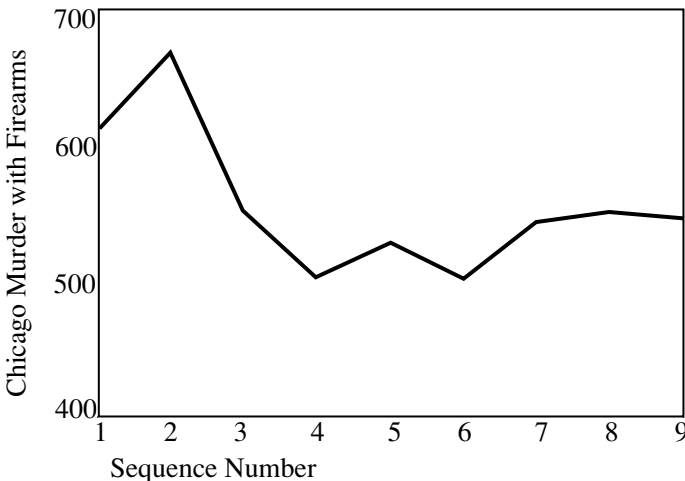
Box and Jenkins (1976) describe three steps to perform ARIMA analysis: Identification, Estimation and Diagnosis. Therefore, we follow these steps for each dependent variable in the analysis.

Homicide

Identification

In this stage, there are difficulties in identifying the model since we have only nine observations before intervention. Some researchers do not see a problem to examine the whole series in order to identify the model. However, this is not right, since mainly the intervention changes the trend in the rest of the series (Cook and Campbell 1979). In this case, the whole trend does not seem to change (Figure 1).

Figure 1: Chicago Murder Sequence Plot from 1973 to 1999



After looking at the sequence graph and both the ACF and PACF plots, we decided to change the model and use ARIMA (1,0,0).

Estimation

The tentative model, ARIMA (1,0,0), gives us estimated coefficient (ϕ) of Autoregressive model.

$$\text{Homicide (t)} = .46736 \text{ Homicide (t-1)} + \text{disturbances (t)}.$$

From this model, we interpret that current homicide value is explained by the preceding value and the unexplained part—the disturbance term. According to the estimated result, an increase in preceding homicide value will increase the next homicide value about 47 percent.

Diagnosis

ACF and PACF of the error series are not significant. There is one spike at fourth-order correlation, but it does seem significant. The important thing is that first or second order correlation should not be significant. In the model, they are not exceeding 95 percent confidence level. Therefore, the results indicate that our model is usable.

Intervention Analysis

After these steps, the study includes the intervention into ARIMA model. First of all, the effect of policy intervention is checked only for the first year on which the policy was implemented. According to Table 1, the coefficient of policy intervention is statistically significant at 5 percent significant level ($p=0.018$), when we take one tailed t-test.¹⁰

As Cook and Campbell describe (1979), the intervention can have different effects such as abrupt-constant, gradual-constant or abrupt-temporary. In order to find out the characteristics of change, the study has used step functions. It has created several dummy variables to see the effect of policy intervention for different years. The data indicate that the policy intervention has abrupt but temporary changes. After 1982, the policy does not have a significant negative effect. In 1989, it has a significant positive effect that means gun-control policy increases the number of homicides.

Table 1
Intervention Analysis for Chicago Murder

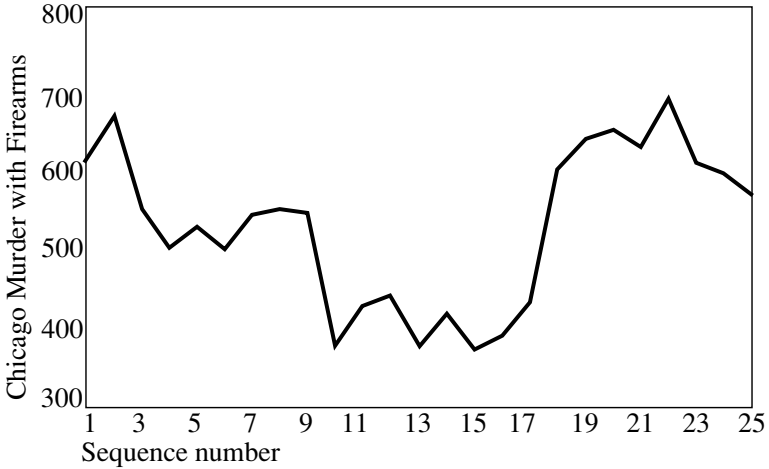
	B	SEB	T-RATIO	APPROX. PROB.
ARI	.84635	.098146	8.6233612	.00000002
POLICY	-143.37346	56.109016	-2.5552660	.01804270
CONSTANT	634.51427	70.806479	8.9612459	.00000000

Aggravated Assault

Identification

From the sequence graph, ACF and PACF results, the ARIMA model for aggravated assault is the first order autoregressive model.

Figure 2
Chicago Aggravated Assault Sequence Plot from 1973 to 1999



Like homicide graphs, and plots, ACF and PCF plots of aggravated assault indicate roughly stationary series. Therefore, we use the ARIMA (1,0,0).

Estimation

The tentative model for ARIMA (1,0,0) is as follows:

$$\text{Aggravated}(t) = .81657 \text{ Aggravated}(t-1) + \text{disturbances}(t).$$

From this model, we interpret that current aggravated assault number value is explained by preceding value of robbery and disturbances. An increase in preceding aggravated assault value will increase the next aggravated value about 82 percent.

Diagnosis

ACF and PACF of the error series are difficult to decide whether they are white noise or not. The spikes both at the second and third lags bothered us. However, Box-Ljung probability function does not indicate any significant spike. Therefore, we decide to keep our model as it is.

Table 2
Intervention Analysis for Chicago Aggravated Assault

	B	SEB	T-RATIO	APPROX. PROB.
ARI	.93753	.05672	16.530316	.00000000
POLICY	282.01609	1533.36535	.183920	.85576113
CONSTANT	7611.20145	3404.74215	2.235471	.03585717

Intervention Analysis

From the analysis of variance table, we can definitely say that the gun-control policy did not affect the number of aggravated assaults (Table 2). In fact, it has a positive though insignificant relationship with aggravated assault, which means after the policy intervention, the number of this type of crime starts to increase.

Step function analysis also supports this result. The policy was effective in the year of 1984 and 1986; however, this was a significant positive effect that the policy, the 1982 Gun Ordinance, did not aim to achieve.

Control Group Analysis

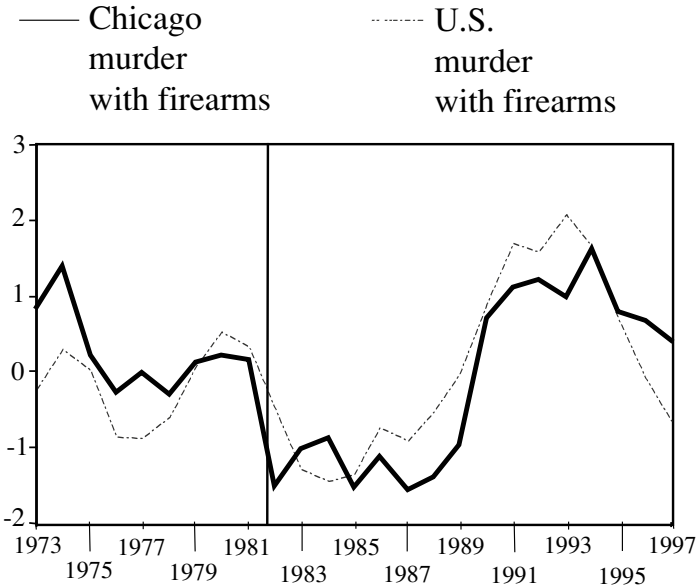
In this section, the study compares the U.S. national homicide data (control group) with the Chicago data (treatment group). So far, ARIMA analyses have depicted that the 1982 gun control policy has an abrupt and temporary effect on homicide incidents and decrease the homicide numbers in the year of policy intervention, while it does not have any negative effect for the following years. On the other hand, the 1982 gun ordinance does not have any significant negative impact on aggravated assault either. In fact, in some years (i.e. 1984, 1986) after the intervention, the policy has a highly statistically significant positive effect. These results indicate that the results can be more correctly interpreted if a control group interrupted time-series analysis is used.

Control Group Analysis for Murder

The sequence chart of Chicago murder data shows that decrease in murder rate starts falling before the implementation of the city's 1982 gun control (Figure 3). After several years of fluctuation, the number of murders in the city begins to climb steadily. In 1992, the tenth anniversary of the gun regulation, the number of murders in the city reached to the level that was higher than the level before the policy. This implies that there is a selection bias. If the policy was implemented in a different date, the result may have been different.

We can see the same sequence in national level data. As we can easily observe from Figure 3, the sequence of both cases looks very similar. Although there was not a federal gun control regulation at the time, there was a decrease in homicide numbers in the early '80s.

Figure 3
Comparison of Chicago Murder Rate
to the U.S. Murder Rate



Therefore, along with ARIMA (1,0,0) step analysis, the decrease in homicide rates in Chicago, in 1982, was not the direct result of the gun control law. We can argue that there is a decreasing pattern in homicide rate in the U.S. overall.

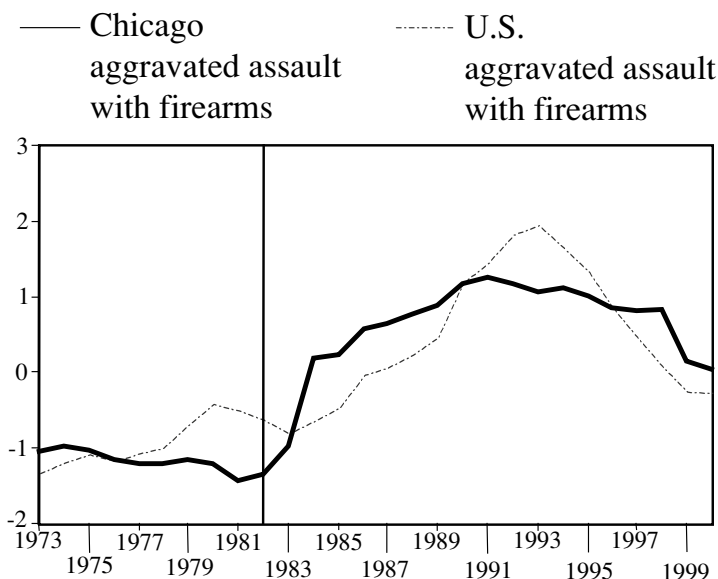
Control Group Analysis for Aggravated Assault

The results of ARIMA (1,0,0) analysis of aggravated assault displayed that 1982 gun control does not decrease the aggravated assault crime, for some years even positively affects it. The sequence graph of aggravated assault shows that after the implementation of gun control policy the crime rapidly increases in 1984 (Figure 4).

This can also be observed from comparison graphs. Before the intervention date, while aggravated assault was decreasing in Chicago, it was higher at the national level and started to increase in the late 1970s. After the intervention in 1982, the crime began to increase in Chicago, however, at federal level this happened in 1984. Therefore, we cannot observe any signs from both ARIMA (1,0,0) analysis and control group-interrupted time-series analysis that the 1982 gun control policy had a negative impact on and decreased the aggravated assault crime rate.

Despite all these facts, it is not safe to claim the 1982 gun control definitely increased aggravated assault numbers in Chicago. The 1984 FBI uniform crime reports states that aggravated assault numbers in Chicago are not comparable with previous numbers due to changes in reporting. We assume that the changes

Figure 4
Comparison of Chicago Aggravated Assault Rate
to the U.S. Aggravated Assault Rate



in reporting or definition of aggravated assault may have caused this sharp climb. Therefore, the positive effect of this policy is doubtful as well. However, this does not change the reality, which is gun control ordinance did not decrease aggravated assault level.

Conclusion

Our study indicates that the 1982 gun ordinance did not accomplish its expected objectives. Although, the ARIMA (1,0,0) analysis with policy intervention shows that the policy decreased the homicide rates, this was an abrupt and temporary influence. Our ARIMA (1,0,0) step analysis indicates that after this very first year, the policy was not statistically significant. Control group design also displays that the trend in homicide rates was dropping in the United States where there was not a policy intervention.

The policy did not also decrease the aggravated assault crime at all after the intervention. ARIMA (1,0,0) step analysis and sequence graphs shows that the policy did not decrease the aggravated assault rate, but increased it in some years. Even though, the analysis indicates the statistically significant positive effect, the unusual differences in this type of crime after 1984 implies that there were possibly

other significant changes which would increase the number of aggravated assaults. Examining other possible hypotheses might solve this ambiguity.

As we do not have the ability to control circumstances, it is difficult to meet all the conditions of defining casual relationship between gun control and crime. There are many uncontrollable variables, “threats to validity,” which prevent researchers from building such an experiment outside. These “rival hypotheses” can have better explanations of crime. Researchers have to test these “rival hypotheses” and if possible, they have to eliminate them. Factors such as, but not limited to, unemployment, racial issues, drug, enforcement, and education as interacting subsystems can have a role in the problem. Focusing on such first order problems that can impact crime will be a more appropriate public policy approach. Therefore, the policy makers must pay closer attention to critical factors and their interactions to see the leverage points for policy interventions. Restraining gun ownership, alone, has not addressed the problem of crime and it seems unlikely to achieve it in the future, unless a complex policy approach is adopted.

Footnotes

¹ In addition to generally known type I and type II errors in statistics, a type III error is an important concept in policy analysis. It can be defined as solving the wrong problem; choosing the wrong boundaries of the metaproblem, choosing the wrong worldview, ideology or myth to conceptualize a problem situation, and the wrong formal representation (model) of the substantive problem.

² FBI crime reports press release, <http://www.fbi.gov/pressrel/pressrel01/cius2000.htm>.

³ See State Laws and Published Ordinance, Bureau of Alcohol, Tobacco, Firearms and Explosives, <http://www.atf.gov/firearms/statelaws/25thedition/> for different states’ and cities’ gun ordinances.

⁴ Gumus (2004) studies crime issue in a different context. He uses many economic variables to identify determinant of urban crime. See Gumus (2004) for details.

⁵ See <http://www.atf.gov/firearms/statelaws/25thedition/illinois.pdf> for detailed explanations of Chicago municipal code of 8-20.

⁶ Shadish, Cook and Campbell (2002, p. 39) defines “threats to validity” as “specific reasons why we can be partly or completely wrong when we make inference about covariance, about causation, about constructs, or about whether the casual relationship holds over variation in persons, settings, treatments, and outcomes.”

⁷ <http://egov.cityofchicago.org/city/webportal/home.do>.

⁸ <http://www.ojp.usdoj.gov/bjs/glance/guncrime.htm>.

⁹ <http://www.fbi.gov/ucr/ucr.htm>.

¹⁰ We would expect that policy would have a negative impact on homicide rate, so our hypothesis is; coefficient of policy intervention <0.

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