

# America's Warzone: Modeling Armed Robberies in Chicago

**Reuben K. McCreanor\***  
reuben.mccreanor@duke.edu

**Anna K. Yanchenko\***  
anna.yanchenko@duke.edu

**Lei Qian\***  
lei.qian@duke.edu

**Megan S. Robertson\***  
megan.robertson@duke.edu

## 1 Introduction

The city of Chicago is frequently listed as one of the most dangerous and crime-ridden cities in the US. President Donald Trump frequently discusses the high-rate of crime in Chicago. According to the Chicago Tribune, there were 4,367 shooting victims in Chicago in 2016. In the same year there were also 785 homicides.[2] However, other reports conclude that Chicago should not be called the crime capital of America, as Chicago's violence rate is lower than cities like St. Louis and Detroit. [1] The goal of this project was to examine crime in Chicago, specifically armed robberies, from 2012-2016.

## 2 Data

The crime data used for this project came from the City of Chicago's website.<sup>1</sup> The data contained every reported crime in Chicago from 2001 to the present (Figure 1). In addition to the type of crime reported (battery, assault, etc.), there was information on the location and time of the crime. The data set was reduced to only consider armed robberies.

ID	Case Number	Date	Block	IUCR	Primary Type	Description	Location Description
10918167	JA231660	04/19/2017 11:58:00 PM	002XX N SACRAMENTO BLVD	041A	BATTERY	AGGRAVATED: HANDGUN	STREET
10921561	JA235113	04/19/2017 11:55:00 PM	006XX S CLARK ST	0281	CRIM SEXUAL ASSAULT	NON-AGGRAVATED	APARTMENT
10918133	JA231652	04/19/2017 11:51:00 PM	015XX W THOME AVE	031A	ROBBERY	ARMED: HANDGUN	STREET
10918777	JA232089	04/19/2017 11:45:00 PM	052XX W BELMONT AVE	0910	MOTOR VEHICLE THEFT	AUTOMOBILE	STREET
10918201	JA231633	04/19/2017 11:45:00 PM	116XX S ASHLAND AVE	1020	ARSON	BY FIRE	RESIDENCE
10921151	JA232118	04/19/2017 11:40:00 PM	070XX S CLYDE AVE	0486	BATTERY	DOMESTIC BATTERY SIMPLE	APARTMENT
10918154	JA231651	04/19/2017 11:37:00 PM	110XX S NORMAL AVE	031A	ROBBERY	ARMED: HANDGUN	SIDEWALK
10918105	JA231645	04/19/2017 11:35:00 PM	034XX W OHIO ST	0560	ASSAULT	SIMPLE	RESIDENCE
10918173	JA231643	04/19/2017 11:34:00 PM	011XX W BRYN MAWR AVE	0520	ASSAULT	AGGRAVATED KNIFE/CUTTING INSTR	RESTAURANT
10918164	JA231644	04/19/2017 11:30:00 PM	012XX W MARQUETTE RD	0487	BATTERY	AGGRAVATED DOMESTIC BATTERY: OTHER DANG	RESIDENCE
10918168	JA231662	04/19/2017 11:30:00 PM	029XX N KENOSHA AVE	0610	BURGLARY	FORCIBLE ENTRY	RESIDENCE
10918182	JA231695	04/19/2017 11:30:00 PM	005XX W 60TH PL	0910	MOTOR VEHICLE THEFT	AUTOMOBILE	STREET
10918205	JA231732	04/19/2017 11:30:00 PM	072XX S CAMPBELL AVE	0486	BATTERY	DOMESTIC BATTERY SIMPLE	RESIDENCE
10918203	JA231708	04/19/2017 11:30:00 PM	054XX W POTOMAC AVE	0420	BATTERY	AGGRAVATED KNIFE/CUTTING INSTR	APARTMENT
10918131	JA231630	04/19/2017 11:26:00 PM	074XX S STATE ST	0860	THEFT	RETAIL THEFT	GAS STATION
10918137	JA231637	04/19/2017 11:25:00 PM	072XX S COTTAGE GROVE A	0480	BATTERY	SIMPLE	CTA BUS

Figure 1: The city of Chicago website provides a data set containing information on crimes committed in the city from 2001 to present day.

\*Department of Statistical Science, Duke University

<sup>1</sup>Crimes 2001 to present, <https://data.cityofchicago.org/Public-Safety/Crimes-2001-to-present/ijzp-q8t2/data>

### 3 Time Series Analysis

The city of Chicago is divided into regions known as sides (Figure 2), where each side is comprised of several neighborhoods. There is a lot of variation in the population (Figure 3) and the number of armed robberies per capita (Figure 4) for these sides. Additionally, some sides are more residential, while others are more commercial.

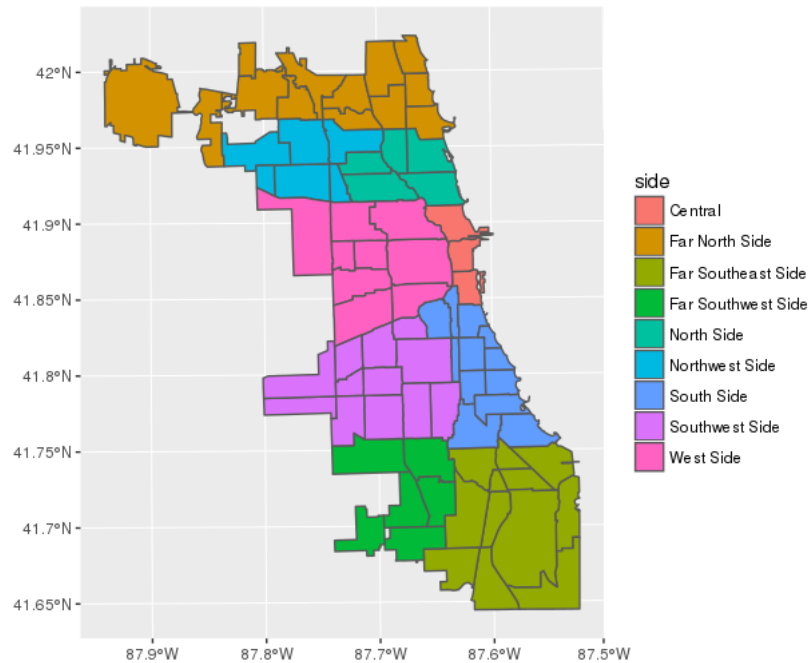


Figure 2: The “sides” of Chicago. The borders correspond to the boundaries of the community areas colored by the side.

ARIMA models were fit to predict the counts of monthly armed robberies in each side of the city between 2003 and 2016. In order to determine the type of model, the ACF and PACF plots were examined for the data for each of the sides. For example, if there was structure in the PACF plot beyond one lag, moving average terms were added. The model residuals were also examined to ensure that there was no remaining structure in the residuals. The PACF and ACF plots for the data from the South Side are displayed below. The ACF plot showed evidence of seasonality at lag 12 (i.e. yearly trends). After lag 1, there was no large values for the PACF, so no moving average terms were included in the model.

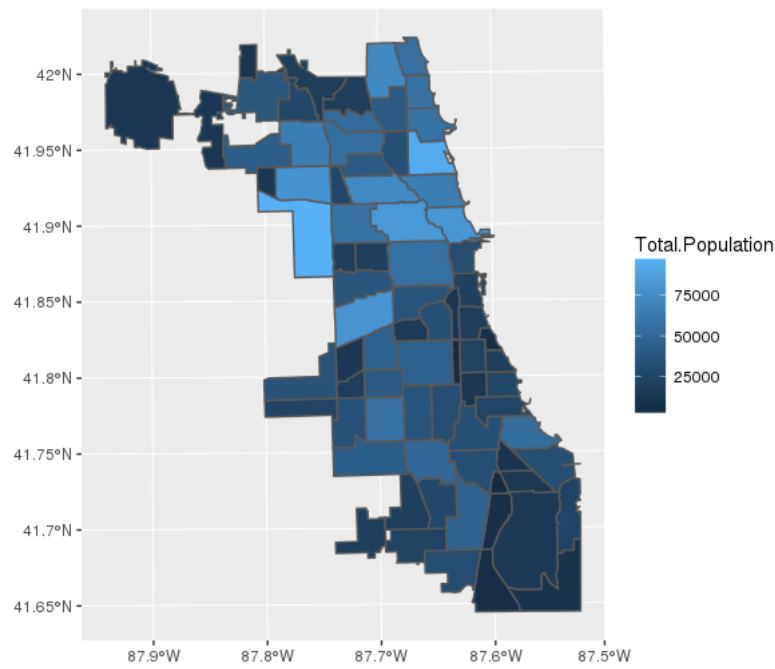


Figure 3: The population distribution of the “sides” of Chicago. The borders correspond to the boundaries of the community areas colored by the side.

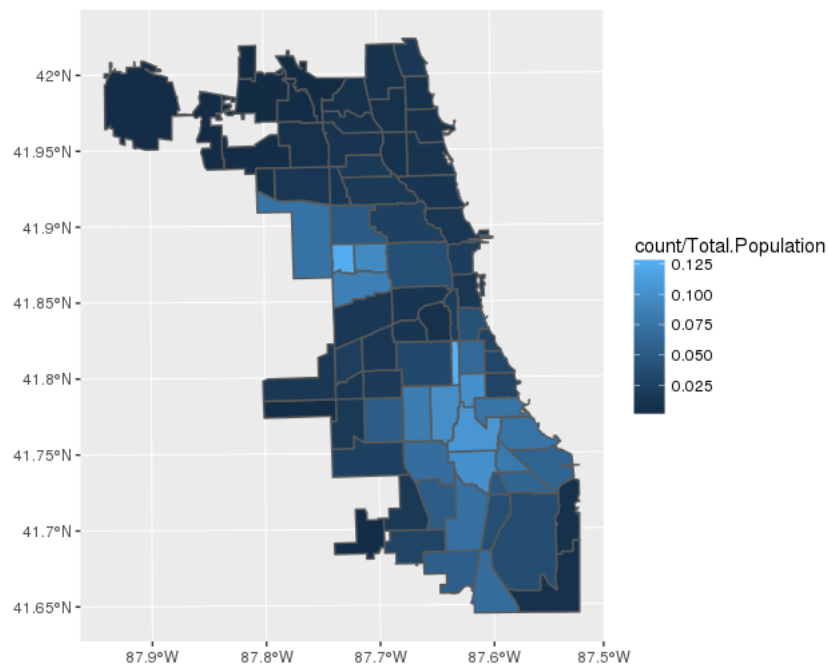
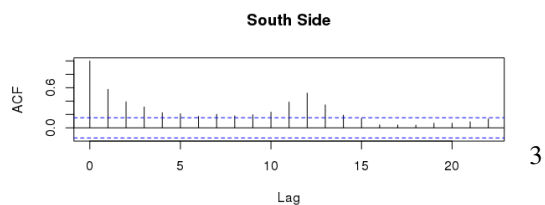


Figure 4: The number of armed robberies per capita for the “sides” of Chicago between 2003 and 2016. The borders correspond to the boundaries of the community areas colored by the side.



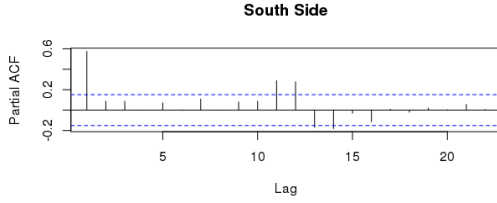


Figure 6: PACF plot for the number of monthly armed robberies in the South Side of Chicago between 2003 and 2016.

Based on the ACF [Figure 7](#) and PACF [Figure 3](#) plots, an AR(4) model was fit with a seasonal component with period twelve. The residuals plot for this model did not display any remaining structure in the data and the coefficients are in [Table 1](#).

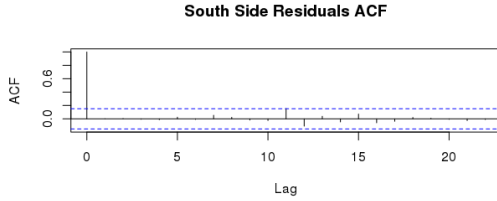


Figure 7: ACF plot of the residuals of an AR(4) model with a period twelve seasonal component fit to the monthly count of armed robberies for the South Side.

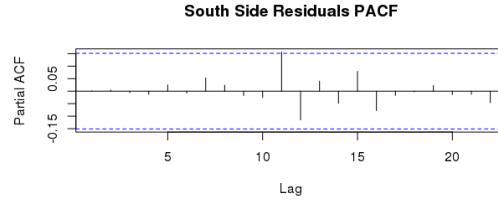


Figure 8: PACF plot of the residuals of an AR(4) model with a period twelve seasonal component fit to the monthly count of armed robberies for the South Side.

	ar1	ar2	ar3	ar4	sar1
Coefficient	0.3850	0.1328	0.0825	0.0167	0.4784
Standard Error	0.0793	0.0832	0.0824	0.0771	0.0708

Table 1: Summary of model fit for the AR(4) with period 12 seasonal component fit to the monthly count of armed robberies for the South Side.

The coefficient estimates for all of the different sides were very similar. While some sides displayed evidence of higher order autoregressive structure or the addition of moving average terms, as compared to the South Side, all sides had a clear period 12 seasonal component, indicating strong yearly trends for all sides of the city. The coefficient estimates were positive for the autoregressive terms, indicating that there was a positive correlation between the amount of monthly armed robberies over time. Plots of the various model fits can be found in [subsection 5.1](#). It is interesting that although the sides of Chicago are quite diverse in terms of population and demographics, as well as the number of monthly armed robberies, the temporal trends for all of the sides are very similar. Although the count of the monthly armed robberies differs by side of the city, the overall temporal trend is the same across Chicago and has a strong yearly, autoregressive trend.

## 4 Spatial Models

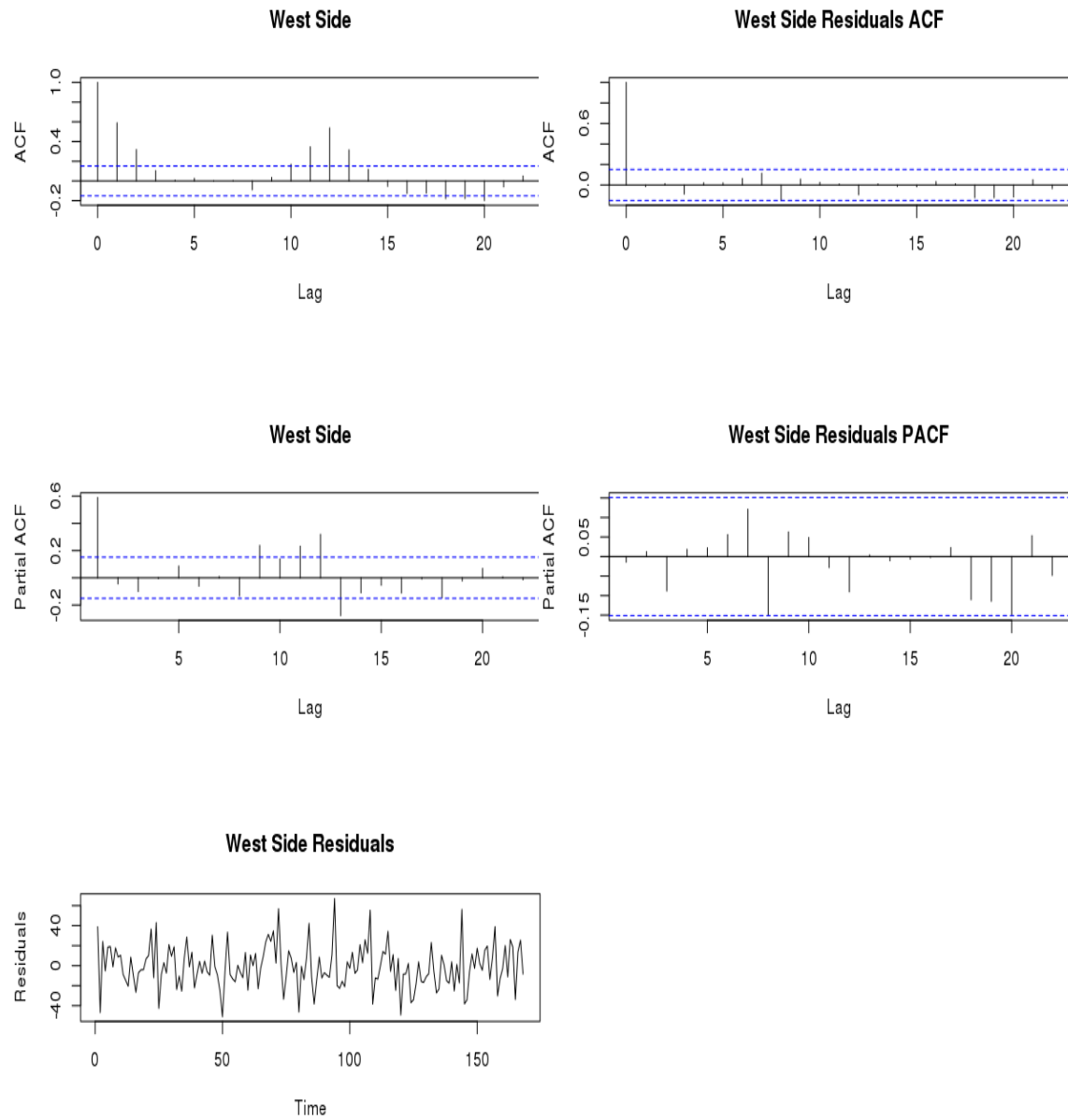
## References

- [1] Papachristos, Andrew V., "48 Years of Crime in Chicago: An Analysis of of Serious Crime Trends from 1965-2013,[http://isps.yale.edu/sites/default/files/publication/2013/12/48yearsofcrime\\_final\\_ispsworkingpaper023.pdf](http://isps.yale.edu/sites/default/files/publication/2013/12/48yearsofcrime_final_ispsworkingpaper023.pdf), December 2013.
- [2] Pearson, Rick, "Trump Again Assails Chicago gun violence in speech to Congress", *Chicago Tribune*, <http://www.chicagotribune.com/news/local/politics/ct-donald-trump-congress-speech-chicago-met-20170228-story.html>, March 2017.

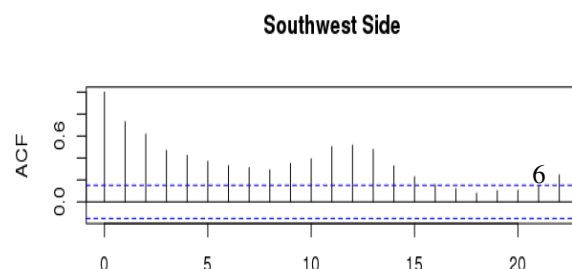
## 5 Appendix

### 5.1 Time Series Modeling Plots

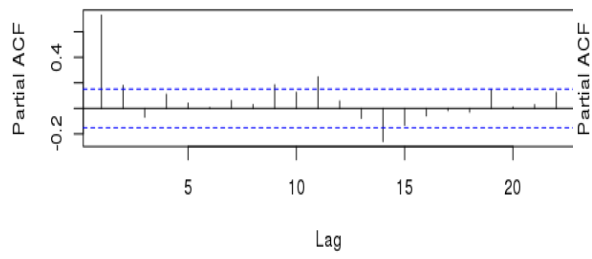
#### 5.1.1 West Side



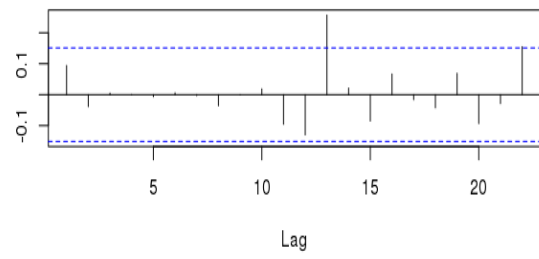
#### 5.1.2 Southwest Side



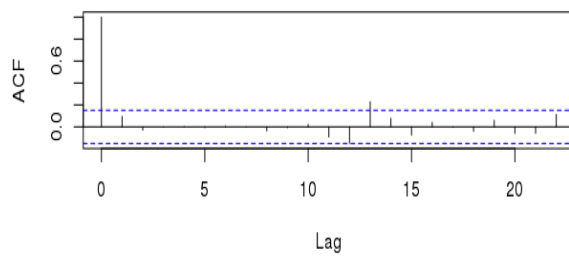
**Southwest Side**



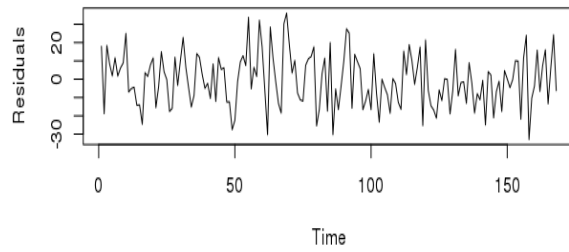
**Southwest Residuals PACF**



**Southwest Residuals ACF**

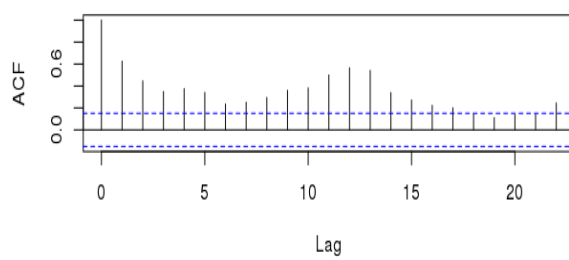


**Southwest Residuals**

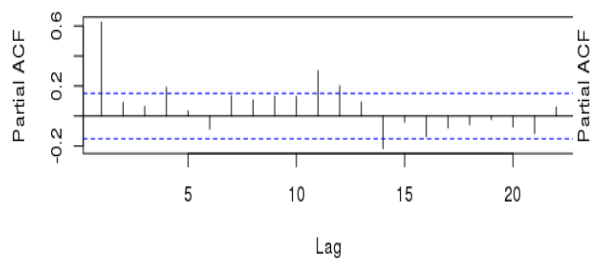


### 5.1.3 Southeast Side

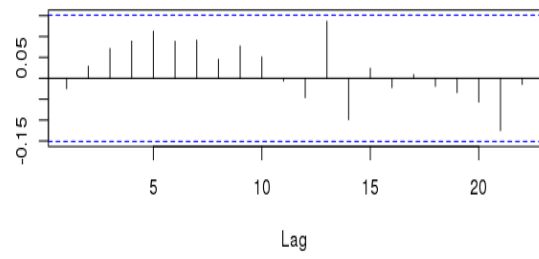
**Southeast Side**



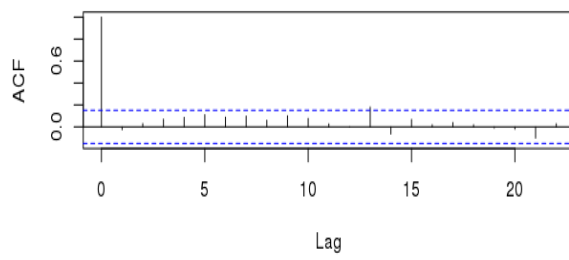
**Southeast Side**



**Southeast Residuals PACF**



**Southeast Residuals ACF**



**Southeast Residuals**

