

Economic Impact on Crime in Chicago

CSPB 4502

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1 Abstract

This study aimed to investigate the relationship between rates of different types of crime within the city of Chicago and several economic variables. Understanding questions related to if economic variables had an impact on the rates of different types of crime would allow for government agencies to try and better resolve issues related to crime. The study analyzed the correlation of the overall crime rate, property crime rate, violent crime rate, and drug-related crime rate against Chicago annual GDP and Chicago monthly unemployment rate.

Violent crime rates were shown to have no correlation with unemployment rates, and overall crime rates were shown to have insignificant or very weak positive correlation with unemployment rates. Property crime rates and drug-related crime rates were shown to have the strongest correlation with monthly unemployment but the relationship was classified as weak to moderate.

All types of crime were shown to have strong negative correlation values when compared with annual GDP. As GDP for the city of Chicago decreased the annual crime rates increased. Property crimes and drug-related crimes were again shown to be the crime types with the strongest correlation values.

2 Introduction

“All big cities have a violence problem. Chicago's is different,” although Chicago doesn't lead the nation in homicide rate and is actually lower than many other major cities such as St. Louis and Detroit, it is infamous for its reputation of violent crime. However when looking closer at the individual neighborhoods of the city the reason for this reputation becomes

clear. Communities in the west and south side of Chicago such as Garfield park have been disproportionately affected to where their per-capita murder rates are higher than the most violent cities in the world. Research done by the Chicago PD found that only 5 of the most violent police districts make up 42% of Chicago homicides. Compared to NYC where the 10 most violent districts make up 32%, it is clear to see that the violence in Chicago is much more concentrated. In part what makes the situation in Chicago appear so much more concentrated is the juxtaposition of the safer neighborhoods so close to the violent ones. The safest neighborhoods have crime rates roughly 70% less than the Chicago average.[1]

The proposed study aimed to look at the effect economic conditions have on the crime rate within the city of Chicago. The study looked to evaluate the relationship of the overall crime rate, as well as various types of crime such as the property crime rate, violent crime rate, and drug-related crime rates in Chicago versus the unemployment rate and the GDP of the Chicago metropolitan area.

The main questions were: Do changes in the unemployment rate result in changes in the rate of crime for any of the types measured?

Do changes in the GDP result in changes in the rate of crime for any of the types measured?

Does location within the city of Chicago indicate larger or smaller changes in crime rates as a result of economic changes?

Identifying potential connections between economic factors and crime would allow for the city of Chicago to create criminal justice and economic policies to try and mitigate identified types of crime with economic

reform. Any observed relationships could then be studied throughout the US to see if the same relationships exist and can be used to try and alleviate crime rates within other geographic areas.

3 Literature Survey

3.1 An Analysis of the Suspect: The Impact of Economic Conditions on Crime

Study looked at four macroeconomic variables, GDP per capita, unemployment rate, inflation rate, and interest rate and their effect on various crime rates (violent, property, and total). The study concentrates on data related to US economic and crime data from 1961 to 2019. The overall results show that US GDP did not have an effect on any type of crime rate within the US, and the unemployment rate did not have a statistically significant impact on violent crimes. The aggregate economic variables did show that economic conditions contribute to the crime rate. Property crime was shown to be the crime most influenced by economic conditions.[2]

3.2 The Impact of Economic Activity on Criminal Behavior: Evidence from the Fracking Boom

The study looked at the impact on crime rates in areas of North Dakota undergoing economic change as a result of the fracking industry. During the initial phase of area development resulting from the fracking industry crime rates were shown to decrease, but while economic promise had increased in the area economic conditions had not improved during this phase. During the follow-on phase associated with improving economic conditions, crime rates were shown to increase. The author offers the idea that the increase in job opportunity within the areas from the fracking industry results in an influx of people migrating to the fracking areas, and a large proportion of these individuals are young men who are statistically more likely to conduct crime. [3]

4 Data Set

4.1 Chicago Crimes: 2001 to Present

Dataset contains over 7 million data points with 22 attributes. Tracks reported in crime in the Chicago metropolitan area. Reports on crime type, location, date, crime code, and various description fields of the crime event. Data Source: City of Chicago

<https://data.cityofchicago.org/browse?category=Public%20Safety>

4.2 Chicago Unemployment Rate

Dataset contains the monthly unemployment rate for the city of Chicago since 2001. Data Source: Bureau of Labor Statistics

<https://data.bls.gov/pdq/SurveyOutputServlet>

4.3 GDP of the Chicago Metro Area

Tracks yearly GDP of the Chicago metro area (adjusted to 2012 dollars) since 2001. Data Source: Bureau of Labor Statistics

<https://www.statista.com/statistics/183827/gdp-of-the-chicago-metro-area/>

5 Main Techniques Applied

5.1 Data Cleaning

Any data points containing NAN or Null values within 'Primary Type' attribute were removed from the dataset. Additionally, any data points containing Null or NAN values within the 'Location' attribute were removed. A large portion of the analysis would revolve use of the 'Primary Type' and 'Location' attribute, so in order to mitigate effects of incomplete data these points were removed.

5.2 Data Integration

Three datasets were linked together for analysis. The datasets were linked together utilizing date timestamps within all three datasets.

The unemployment rate data was linked to Chicago crime data via a month-year format, while the GDP data was linked to the Chicago crime data set strictly via a year format.

5.3 Data Reduction

First, the data was reduced in size in order to help facilitate management of the dataset and account for outlier time periods. Reducing the dataset timeline from 2001 through 2023 to 2006 through 2019 reduced the data points from over seven million to roughly 4 million data points. Additionally, omitting data starting in 2020 omitted the brief periods of intense economic turmoil caused by the Covid-19 pandemic that potentially could skew analysis of the data.

Second, a number of data attributes were removed from the Chicago crime data set that are either considered not pertinent for analysis of the data, or redundant. For example, police beat, case number, and FBI code were removed from the dataset due to not providing meaningful information for this analysis. Data attributes such as grid location were removed because location data has been captured by the latitude/longitude attribute.

Third, a small subset of data points were removed as location outliers due to the spatial data for these objects mapping to locations roughly 50 miles outside of Chicago.

Fourth, to try and analyze different classifications of crimes such as property crimes vs violent crimes we used a form of numerosity reduction. Individual crimes were placed into different crime buckets (Property Crime, Violent Crime, etc) based on the data object's 'Primary Type' attribute.

Finally, if a crime type bucket showed higher correlation values with an economic variable the buckets was clustered based on location using the k-

means method to further analyze the relationship while taking into account location.

5.4 Data Transformation

First, the date timestamp within the crime dataset were formatted dd-mm-yyyy HH:MM. While this level of detail may be beneficial for analysis of crime patterns related to days of the week or time of day; the focus was too narrow for the analysis proposed within this paper. In order to link the unemployment rate dataset with the Chicago crime data set the date was transformed into mm-yyyy. For linking the crime data set with the GDP dataset the data was further aggregated to the yyyy format.

5.5 Data Analysis

Initially the crime rates for the different buckets of crime and the overall crime rate were assessed for some form of correlation. To do this we used Pearson's Correlation Coefficient formula depicted in figure 1.

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Figure 1

Following the identification of any correlation values between crime types and economic variables that seemed potential interesting we assessed correlation values following the clustering of crimes based on location.

Our proposal is similar in nature to the referenced studies in the Literature Survey. The study will look at similar economic factors like GDP and unemployment rate to the study referenced in 2.1. Similar to the study referenced in 2.2 this proposal will analyze a smaller geographic area. Limiting the

scope of the analysis may allow for a better fitting of the correlation between crime rate and these economic factors by potentially reducing the number of confounding factors.

7 Key Results

7.1 Overview

In order to better understand the datasets, the basics cycles and trends, and decide on a plan of analysis we plotted basic line graphs of the overall crime rate, monthly unemployment rate, and the GDP versus time.

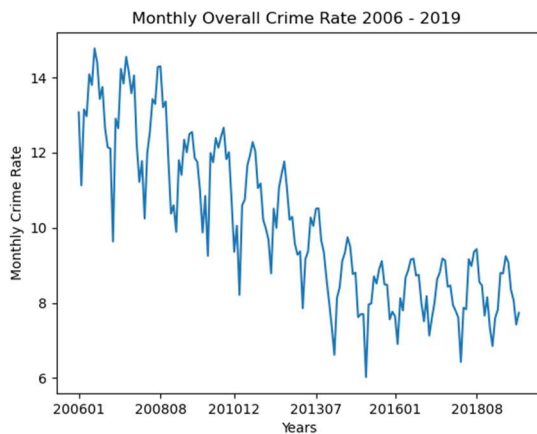


Figure 2

Figure 2 depict the monthly overall crime rate from 2006 through 2019. Overall crime is seen to generally be lowering from 2006 through 2019, but within an individual year there appears to be cyclic trends of rising and falling crime rates.

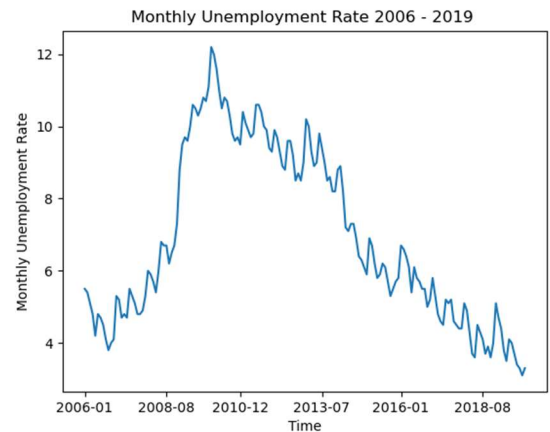


Figure 3

Figure 3 depicts the monthly unemployment rate from 2006 through 2019. The unemployment rate suffered from a large increase starting in 2008, where rates did not lower to pre-2008 levels until roughly 2013. This spike is likely the result of the financial crisis which began in 2007/2008 and the economic downturn created by the recession. The unemployment rate also appears to follow some of cyclic changes. In the following sections we will determine if these unemployment rate and crime rate cycles match one another.

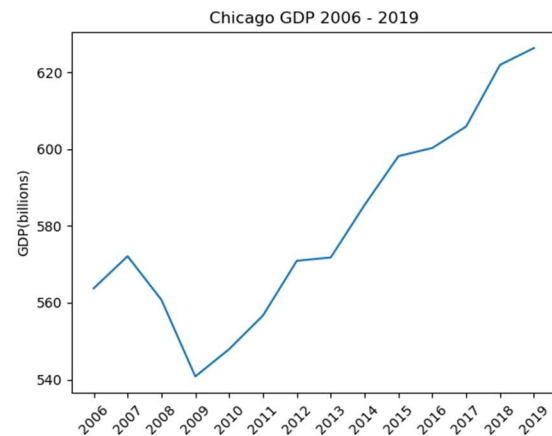


Figure 4

Figure 4 depicts the GDP of the city of Chicago from 2006 to 2019. Similar to the unemployment rate GDP experienced a large change following the 2007/2008 financial crisis with a large decrease in GDP occurring during this time. Following the economic crisis, GDP generally increased from 2009 through 2019. The

annual trend of the crime rate appears to decrease from 2006 to 2019. In the following sections we will analyze if GDP increase and crime rate decreases occur at the same time.

7.2 Correlation

In order to better understand the data and in attempt to find economic variables, or specific crime types which appeared to have some form of relationships we ran correlations between the sets of variables to try and find areas to focus the future forms of testing on. We decided to use the pearson correlation value for this assessment due to the lack of categorical variables present in the data to run a test such as a chi-squared test. We produced scatter plots and correlation tests on Total Crime, Property Crime, Violent Crime, and Drug Crimes vs the Monthly Unemployment Rate

7.2.1 Monthly Crime Rate vs Monthly Unemployment Rate

The monthly crime rate was defined as the total number of crimes that occurred within a month divided by the current Chicago population multiplied by 1000 to achieve a monthly crime rate per 1000 residents. The monthly unemployment rate was calculated as the percentage of the Chicago workforce that was looking for work but unemployed divided by the entire Chicago labor force. Following the data transformation to the dataset the time period from January 2006 – December 2019 was evaluated.

7.2.1.1 Monthly Overall Crime Rate vs Unemployment Rate

The overall crime rate was aggregated using all types of crime listed in the City of Chicago dataset. The scatter plot referenced in figure 5 plots the crime rate and unemployment rate linked by the corresponding year and month in which both occurred. The scatter plot displays a weak or insignificant positive relationship between unemployment rate and the total crime rate.

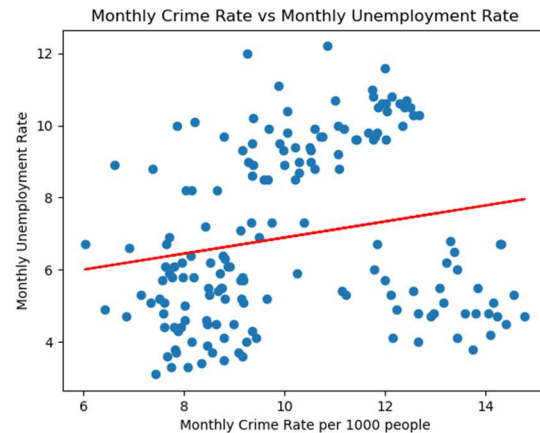


Figure 5

This insignificant relationship is confirmed via the correlation value between the two rates which resulted in a value of 0.195276.

7.2.1.2 Monthly Property Crime Rate vs Unemployment Rate

Property crimes were defined as any crimes that fell into one of the following five categories of theft, auto theft, robbery, burglary, or deceptive practice. Figure 6 depicts a stronger relationship between property crime than the relationship between total crime and the unemployment rate.



Figure 6

Although the relationship between property crime and unemployment rate is stronger the pearson correlation value is only 0.271569

7.2.1.3 Monthly Violent Crime Rate vs Unemployment Rate

Violent crimes were defined as any crimes that fell into one of five type categories. The five violent crime categories were assault, battery, homicide, domestic violence, or robbery. The correlation value of the two rates was 0.069969 indicating no relationship between unemployment rate and the violent crime rate within Chicago. This lack of a relationship is evident in figure 7 with a near flat correlation line and a fairly random dispersal of points.

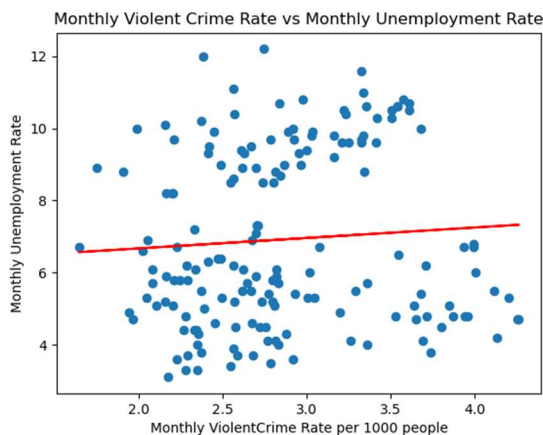


Figure 7

7.2.1.4 Monthly Drug Crime Rate vs Unemployment Rate

Drug crimes were any crimes receiving a primary type classification of narcotics or narcotics related offense.

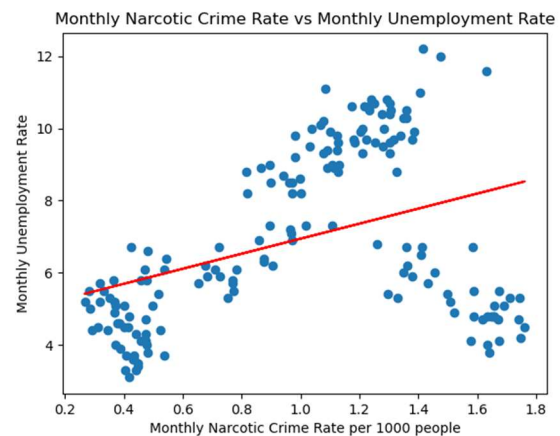


Figure 8

Figure 8 and the correlation value of narcotic crimes showed the strongest positive correlation between any crime type and the unemployment rate with a value of 0.384.

Overall, the monthly unemployment rate and monthly crime rate for overall crime and the several sub-types of crime did not show any extremely strong positive or negative correlations. The two sub-types with the strongest correlations were property crimes and drug-related crimes, showing weak positive correlations. These two crime types will be further analyzed in section 7.3 to see if attributes such as location within Chicago coupled with the crime rates and unemployment potentially result in more significant values.

7.2.2 Annual Crime Rate vs Annual GDP

GDP was recorded for the city of Chicago on an annual basis. The data was recorded in billions of dollars and inflation adjusted for all values to be represented in 2012 dollars. The annual crime rate was calculated as the aggregate of crimes that occurred within a year divided by the population of Chicago multiplied by 1000 to return an annual rate of crime per 1000 residents.

7.2.2.1 Annual Total Crime Rate vs Annual GDP

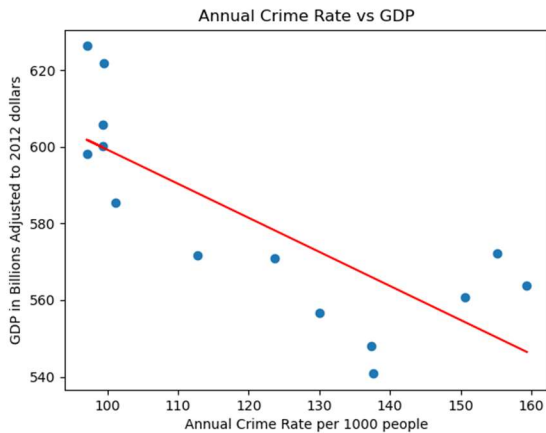


Figure 9

Figure 9 depicts the annual crime rate vs GDP and shows a fairly strong negative correlation. This visual representation is confirmed when calculating the Pearson's correlation value between the two categories which resulted in a value of -0.779583

7.2.2.2 Annual Property Crime Rate vs Annual GDP

Similar to the annual crime rate, figure 10 shows the annual property crime rate vs GDP, and once again showed strong negative correlation. The Pearson correlation was stronger than total crime with a value of -0.820799

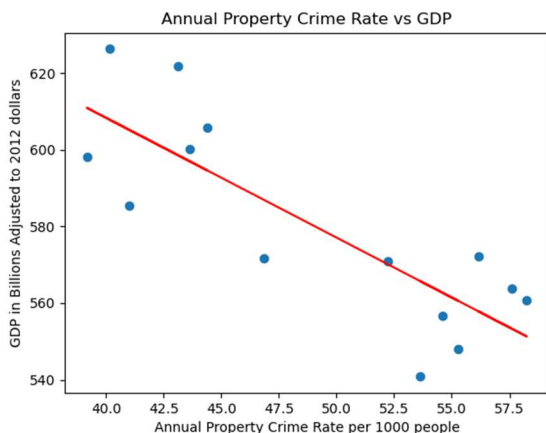


Figure 10

7.2.2.1 Annual Violent Crime Rate vs Annual GDP

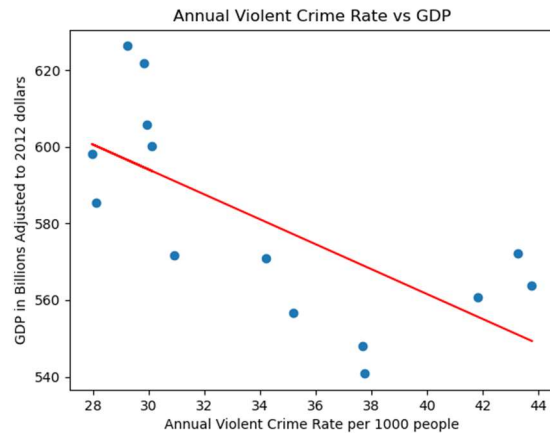


Figure 11

Annual violent crime rate and GDP showed a negative correlation with a value of -0.6933, but of the different crime types measured against GDP violent crimes showed the weakest correlation. This weaker correlation mirrors the results of unemployment rate and violent crimes, which also showed the weakest correlation values of all the crime types.

7.2.2.1 Annual Drug Crime Rate vs Annual GDP

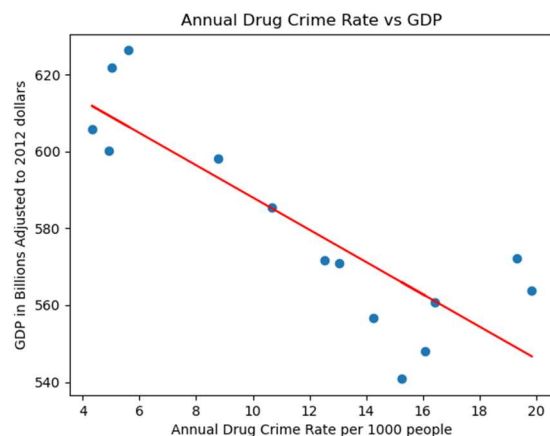


Figure 12

Drug-related crimes showed a strong negative correlation with GDP, showing a Pearson's correlation value of -0.84765, exhibiting the same relationship as all crime types previously measured against GDP. Drug-related crimes had the strongest

correlation value with both GDP and the unemployment rate.

GPD and all crime types showed strong negative correlation values. As GDP went up the crime rates of all types decreased. The GDP values were only calculated on an annual basis, which required for the crime rate aggregation to occur on a yearly basis. This larger aggregation period resulted in less data points to analyze in comparison with the monthly unemployment rate analysis, but property and drug-related crimes were still the two crime types with the largest correlation values.

7.3 K Means Clustering

Property crimes and drug-related crimes were the crime types identified by the initial analysis with the strongest relationships with unemployment rate and GDP. To further investigate these relationships we used a K Means clustering method on the location attribute of the crime objects. Using the K Means algorithm we clustered the crime types into several geographic districts of the city of Chicago. Once the data had been clustered we re-analyzed the relationships to see if location had any influence on the relationships.

Total property and drug-related crimes per cluster were used in analysis with the unemployment rate following the use of K Means, as opposed to the rates of these crimes used in the previous section. This change was made because there were no reliable data for the population numbers of each specific cluster to calculate the rates.

The crimes were plotted onto a map of Chicago using the latitude and longitude values of the crime data objects, and then the objects were clustered into their respective groups.

7.3.1 Property Crime Clustering

Property crimes were clustered into three location groups, North (Cluster 3 Yellow), South (Cluster 2 Red), and Central (Cluster 1 Blue) Chicago. Reference figure 13 for the property crimes location clusters.

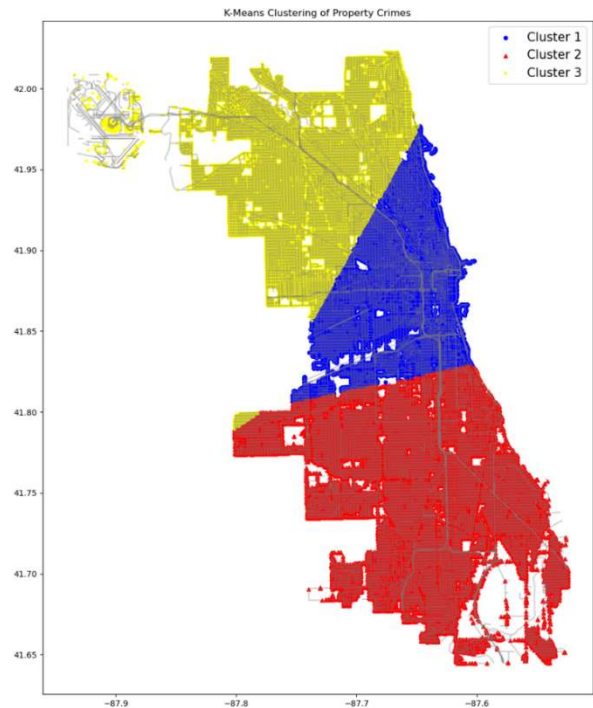


Figure 13

The total property crimes per cluster per month were measured against the monthly unemployment rate. The north (cluster 3) and south (cluster 2) clusters of Chicago showed similar correlation values with values of 0.348057 for the south and 0.349308 for the north portion of the city of Chicago. These correlation values are slightly higher than the one generated in section 7.2.1.2 of .27 which compared the monthly property crime rate vs the unemployment rate while not taking into account location. Further research is needed to understand the relationships, but north and south Chicago property crimes may be more impacted by the unemployment rate.

While the north and south clusters showed slightly stronger positive correlation value in regards to the unemployment rate and property crime, the central downtown cluster showed a very weak negative correlation value of -0.013135. When controlling for location the downtown area of Chicago showed no correlation between the unemployment rate and the number of monthly property crimes.

7.3.2 Drug-Related Crime Clustering

Drug-related crimes were clustered into four clusters. Northwest (cluster 2), northeast (cluster 3), central/downtown (cluster 1), and south (cluster 4) Chicago are marked on the figure below by the colors red, yellow, blue, and green respectively. Reference figure 14 for the drug-related crime clusters.

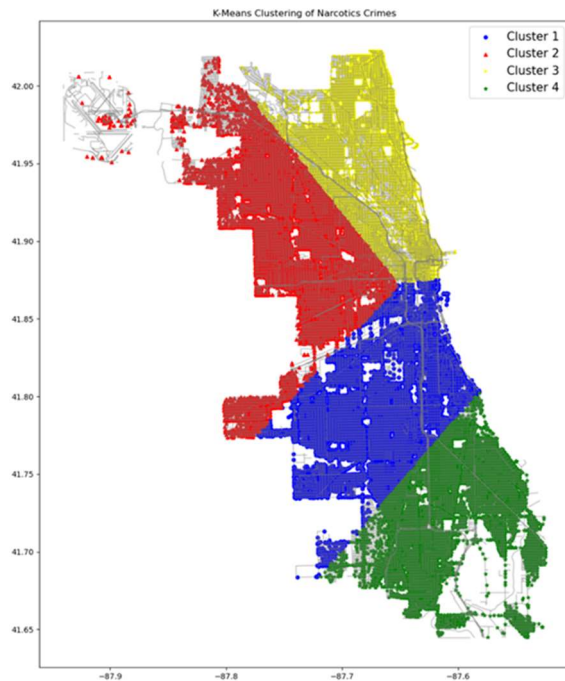


Figure 14

Unlike property crimes, controlling for location did not appear to have an effect on the correlation values between drug-related crimes and the unemployment rate. The northwest cluster had a value of 0.349732, northeast a value of 0.366465, downtown a value of 0.37759, and finally the southern cluster had a value of 0.357462. All values did not individually vary to a large degree, and additionally did not differ much from the value created in section 7.2.1.4 of .384. Initial analysis appears to indicate that location within Chicago does not have an impact on the number of drug related crimes when unemployment rates rise and fall.

7.4 Conclusions

Overall, GDP showed stronger relationships and correlation with all crime types than the monthly unemployment rate. The GDP data set was aggregated over a longer period of time which resulted in a

smaller number of data points than unemployment rate. Further study will need to be conducted to confirm the relationship between GDP and crime rates in Chicago.

The monthly unemployment rate showed weak correlation to the various crime rates measured within this study, with the two strongest correlation rates associated with property crimes and drug-related crimes. The previous studies referenced in section 3 Literature Survey have shown the unemployment rate to have strong positive correlation results with property crime rates. While this study does show property crimes to be one of the two most effected crime rates by the unemployment rate, the correlation was not nearly as strong as those found in the previous studies. Analysis considering location of the crime appeared to have an impact on property crimes within Chicago, but not drug-related crimes.

The studies referenced in section 3 use economic variables aggregated on an annual basis such as annual unemployment rate, in contrast to the monthly rate used in this study. A possible explanation for the differences in results is that economic conditions have a lagging effect on certain crime rates. An initial increase in the unemployment rate may not have an immediate effect on the rate of crime, but following a period of time the changes in unemployment rate may be seen in the crime rate. The GDP results within this study provide further evidence that aggregating economic change over longer periods may help in the assessment of their effects.

8 Applications

8.1 Current Use

Based off the results of this study, there are a number of programs the local Chicago government can look into enacting. These proposed programs fall into two general categories, aid/social programs, and enforcement programs.

8.1.1 Aid/Social Programs

The local government can look to increase allocation of funding to drug rehabilitation and prevention programs during years of falling city GDP and increasing unemployment rates due to the increases in drug-related offenses during these periods of time.

Additionally, the government can look to build more robust social programs to create a safety net for individuals most affected by downturns in Chicago's economic status. Social programs built to deal with the effects of economic downturns may help to mitigate some of the factors leading to the rises in property and drug-related crime rates during these time periods.

8.1.2 Enforcement Programs

Law enforcement agencies can use economic data to try and predict upcoming surges in property crimes and develop enforcement strategies to try and curb or prevent the surges related to economic downturns.

8.2 Future/Follow On Studies

Continue the study into potential lag effects of economic changes on crime rates mentioned above. GDP and annual unemployment rates referenced in the literature related to this study show stronger correlation values with economic variables gathered on an annual basis. Test if annual unemployment rates show similar trends. Test if monthly unemployment rates can be used to identify changes in crime rates following a lag in specified time (i.e. 1 month, 2 months, etc).

Due to the small size of the GDP dataset, continue to collect data and compare GDP to crime rates and see if correlations continue to remain strong with larger datasets.

Narrow the classification of crime types to smaller groupings to test for relationships. Smaller groupings of crime types such as auto thefts, as opposed to property crimes, may allow law enforcement agencies

to better create preventive strategies to combat surges in specific types of crimes.

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