Crime, House Values and Covid-19 in Chicago

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1. Introduction

Historically, crime rates are significantly higher in big cities than in smaller ones or rural areas (Glaeser and Sacerdote (1999)). This is a phenomenon that numerous sociologists, criminologists and economists have tried to explain and investigate the determinants of this pattern. An increasing number of crimes in a particular area affects social welfare in different ways. It affects the quality of life, the economic growth of a society, and individuals' choices regarding housing and traveling. Thus, this is a complex issue that concerns not only researchers but also policymakers who are interested in ameliorating crime statistics and community areas' protection.

Recent advances in the data availability and quality have made urban crime research quite appealing and fruitful. More and more papers exploit Big Data era and state-of-the-art algorithms in order to analyze and understand complex patterns of crime in big cities (for example see Zhao and Tang (2018)). These new data sources allow us to have variables at high frequency and more granular levels. These aspects could potentially help us predict crimes and find temporal crime hotspots (Almanie, Mirza, and Lor (2015)).

Having these in mind, we explore a rich dataset that allows us to investigate crime data from Chicago for the years 2001-2021, exploring two different aspects of this particular city. Firstly, we explore the trends and the relationship between crime data and housing prices for different community areas (neighborhoods) across the Chicago area. Previous academic literature on this topic has shown results across the spectrum. We want to obtain additional insights using the Chicago data, especially insights on how the housing market in each community area reacts to changes in criminal activities.

The second aspect we are studying is the relationship between crime data and Covid-19 cases for the city of Chicago. One very popular concern regarding lockdowns and stay-at-home orders was that these measures will increase domestic violence, homicides, and gender-based violence. This concern has been publicly raised by media [1] and global organizations, such as United Nations [2]. The latter one defined the rise of gender-based violence during this period as a 'shadow pandemic'. Taking into account the increasing interest and the limited existing evidence, currently living in the Covid-19 era, we are investigating the relationship between coronavirus cases and Chicago crime data, using data from the beginning of the pandemic until more than a year forward. Hence, having access to such data allows us to have a clear picture regarding the aforementioned concerns. Overall, we conclude that while there was not a significant change in the number of total crimes during the covid-19 period, we find a sizeable reduction on the number of total crimes when compared to the levels before the covid-19 era. However, we didn't find any meaningful difference in homicides crime and

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[1] https://www.nbcnews.com/news/us-news/police-see-rise-domestic-violence-calls-amid
-coronavirus-lockdown-n1176151
[2] https://news.un.org/en/story/2020/11/1078812

domestic-related crimes between the two periods.

2. Literature Review

Multiple studies have analyzed the question of the impact of crimes on housing prices. While the large majority of such studies do not approach the question causally, they lay the ground for observational analysis and provides interesting insights into how neighborhoods 'values change in response to crime rates. Unsurprisingly, most of these studies document a negative effect of crime and house values.

Rizzo (1979) is one of the first studies to use a hedonic price model where they instrument crimes with multiple instruments such as the share of the population aged 15 to 24, the ratio of men to women, the median number of years of schooling, the unemployment rate, the population density, the proportion of the population on welfare, and the labor force participation rate. The model is applied using housing and rent values in 71 neighbourhood communities in the city of Chicago. While, OLS regressions documents negative effects of crime on rents and house values, IV estimates are much larger in magnitude, almost twice as large for rents for example. Another similar study published in the Journal of Urban Studies by Naroff, Hellman, and Skinner (1980) uses data on Boston census tracts and estimate a simultaneous equations model with both the median house value and the total crime rate as dependent variables. In this setting, population density and housing quality variables serve as instruments. They find that a 1 percent increase in the total crime rate is associated with a 1.67 percent decrease in housing values.

One paper that documents a positive relationship between crime and housing values is Case and Mayer (1996). The authors analyze house price data in the Boston area over the 1982-1994 period. The paper looks at multiple determinants of housing prices such as the accessibility to the city, supply shocks, demographics, and amenities such as the crime rates and local public school quality. While the paper acknowledges the simultaneous relationship between crime and housing values, they find a positive association between crime rates and house values in the housing boom while remaining stagnant during the bust. It is worth to point that analyzing crime rates as a causal predictor of home values was not the main focus of the paper, but rather offering a picture of which amenities matter for neighborhood values over the housing cycle.

The economics of crime was first formulated by Becker (1968). The theory states that the supply of criminal offenses depend, among other factors, on the income opportunities from other activities. This implies that negative income shocks from economic downturn may affect crime rates by altering the costs and benefits of committing a crime.

Covid-19 presents a very interesting angle to further study the impact of negative economic shocks on crime. Because the virus is very contagious, governments around the world have

enacted lockdowns to slow the spread of the virus. These lockdowns have led to significant economic downturns all over the world which resulted in significant job losses and increased unemployment.

The evidence in the United States seem to suggest that overall crimes decreased during the pandemic (Boman and Gallupe (2020); Bhuiyan (2020)). However, not all types of crimes experience a reduction in the pandemic. Boman and Gallupe (2020) find that the evidence the number of homicides remain unchanged and the number of intimate partner batteries incidents are increasing in the United States. In Chicago, Bullinger, Carr, and Packham (2020) find that while there is an increase in domestic-violence related calls to the police, the number of domestic-related crimes and arrests experience significant reductions due to stay at home orders.

3. Data

This project draws heavily on Chicago crime data as extracted from the Chicago Police Department's CLEAR (Citizen Law Enforcement Analysis and Reporting) system [3]. This dataset includes daily crime incidents that occurred in Chicago from 2001 to 2021 (the last reported date is 04-23-2021). The main variables that we use are the date of the incidents, the type of crime, their location (district and zip code level), whether an arrest was made, and whether the incident was domestically related as defined by the Illinois Domestic Violence Act [4]. Overall, the dataset includes 7,315,580 observations.

The second source of data we use is the housing price data from Zillow [5]. The dataset represents a smoothed, seasonally adjusted measure of typical home value across region and housing type. It reflects the typical value for homes in the 35th to 65th percentile range.

Finally, we exploit Covid-19 cases data as provided by City of Chicago [6]. This dataset includes weekly positive cases by ZIP code. The time range is from 01-03-2020 to 04-25-2021.

4. Crime and Housing Prices

As an overview, Figure 1 lists the top 15 most common types of crime in Chicago from 2001 to 2021.

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[3] https://data.cityofchicago.org/Public-Safety/Crimes-2001-to-present-Dashboard/5cd6-ry5g

[4] https://www.ilga.gov/legislation/ilcs/ilcs5.asp?ActID=2100&ChapterID=59

[5] https://www.zillow.com/research/data/

[6] https://data.cityofchicago.org/Health-Human-Services/COVID-19-Cases-Tests-and-Deaths-by-ZIP-Code/yhhz-zm2v
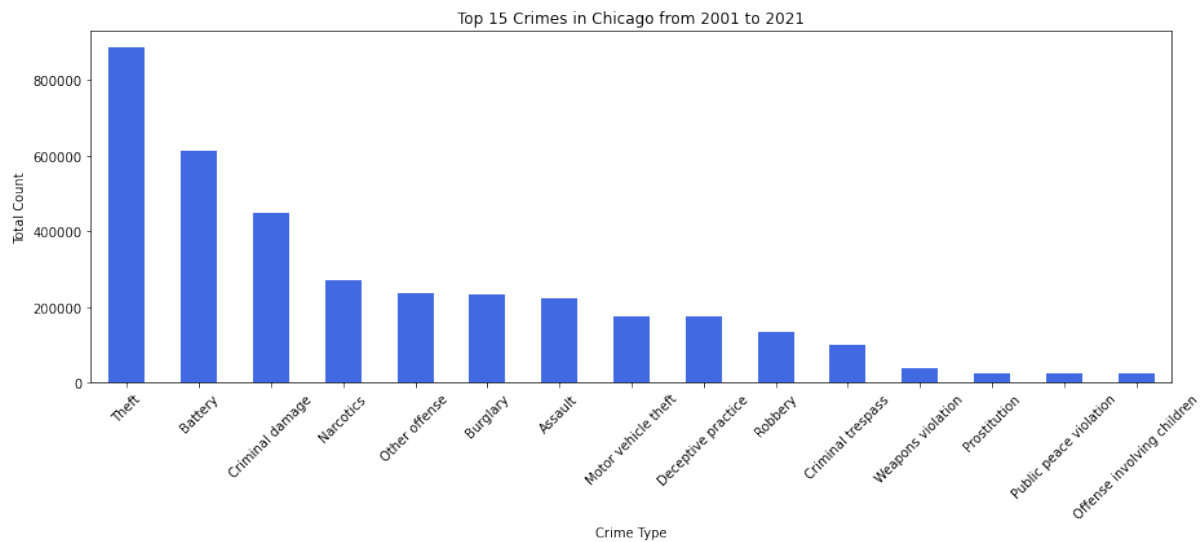
Figure 1: Top 15 Crimes in Chicago (2001-2021)

Upon careful inspection of the dataset, there seem to be some under-counting issues for the year 2001 and 2002. In addition, there are community areas with missing records. To maintain the integrity of our analysis, we will focus on 52 community areas (neighborhoods) in Chicago throughout 2003 to 2021.

Most of the community areas exhibit a downward sloping trend for crime count and crime rate. One interesting observation is the sharp drop in crime for the Loop area during the year 2020. It could be due to the lockdown reducing the number of people traveling to the site for work. We also observe areas such as Chicago Lawn, Humboldt Park, Logan Square, Near West Side, South Shore, and West Town where monthly crime count dropped from over $1,000$ to below 500 [7]. Highlighting these areas on the map, as shown in Figure 2, we observe a cluster in the central and northern part of Chicago that successfully reduced overall criminal activities. It could be interesting to investigate further the reasons behind this success, such as gentrification or improved policing strategy.

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[7] See Appendix Figure 13 for the crime count and crime rate trends in each community area.
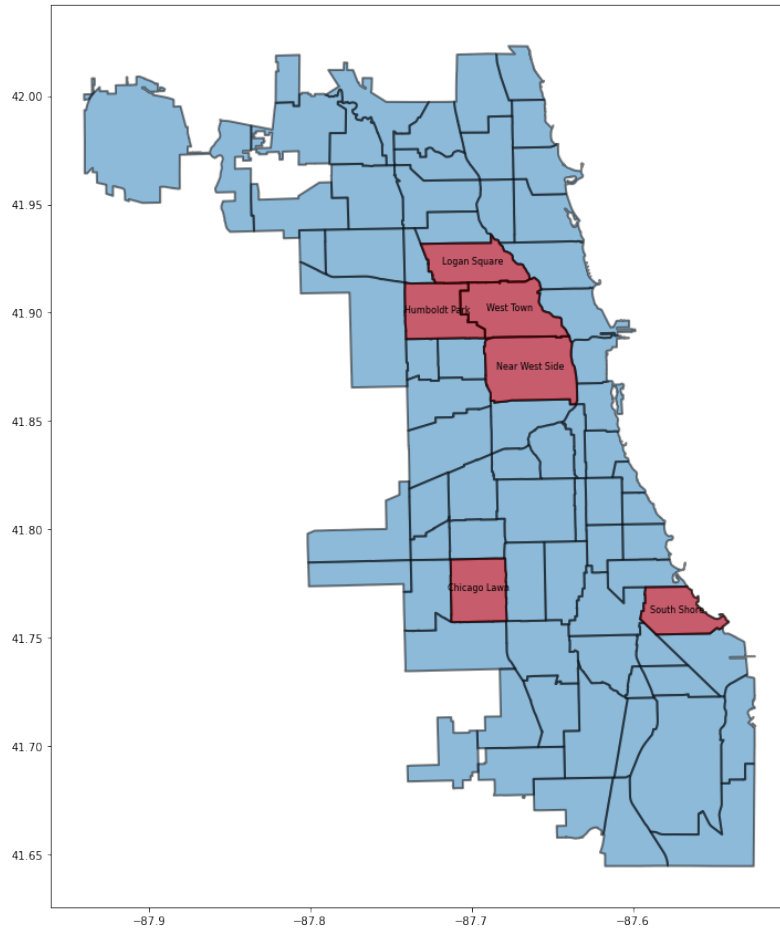
Figure 2: Community Areas with Significant Crime Reduction

When it comes to housing price trends over the past two decades, most community areas exhibit a similar pattern: upward movement before the financial crisis, downward during the recession, and upward again during recent years [8]. To find out the relationship between crime rate and housing price, we calculate the correlation between monthly crime rate and housing price for each community area. We also consider crime rate from one month and two months ago to accommodate for potential delayed reaction of the housing market to crime. Our result shows that the correlations between monthly housing price and the crime rate of the same month, of the previous month, or of two months ago are similar for most areas. Moreover, the correlations differ significantly among community areas. Contrary to conventional wisdom, some areas have strong positive correlations between crime and housing price. We suspect that the housing prices in those areas could be more sensitive to non-crime factors. To find out more about the common characteristics for community areas that exhibit similar price-crime rate correlations, we create a scatter plot for the correlation values and the median housing prices. See Figure 3.

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[8] See Appendix Figure 15 for the housing price and crime rate trends in each community area.
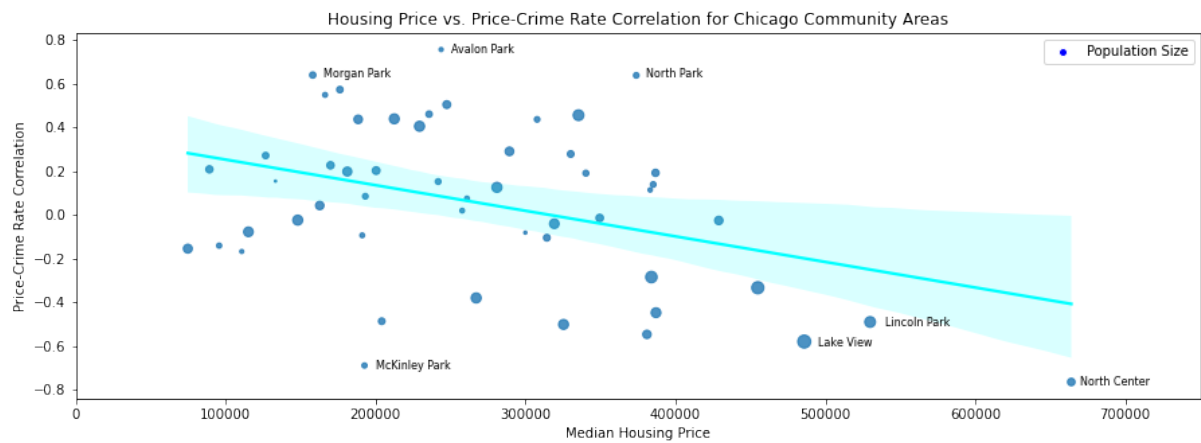
Figure 3: Median Housing Price and Price-Crime Rate Correlation for Chicago Community Areas

Overall, the correlation becomes more negative as the median housing price increases. Our intuition is that as the community area gets richer, other amenities such as parks and schools also get better. Given those amenities, the housing market becomes more sensitive to factors like crime rate. Similar to Maslow's Hierarchy of Needs, if basic infrastructures are lacking, the level of criminal activities might not be housing market participants' primary concern. In addition, the population size of each community area does not seem to have a noticeable impact on the price-correlation relationship.
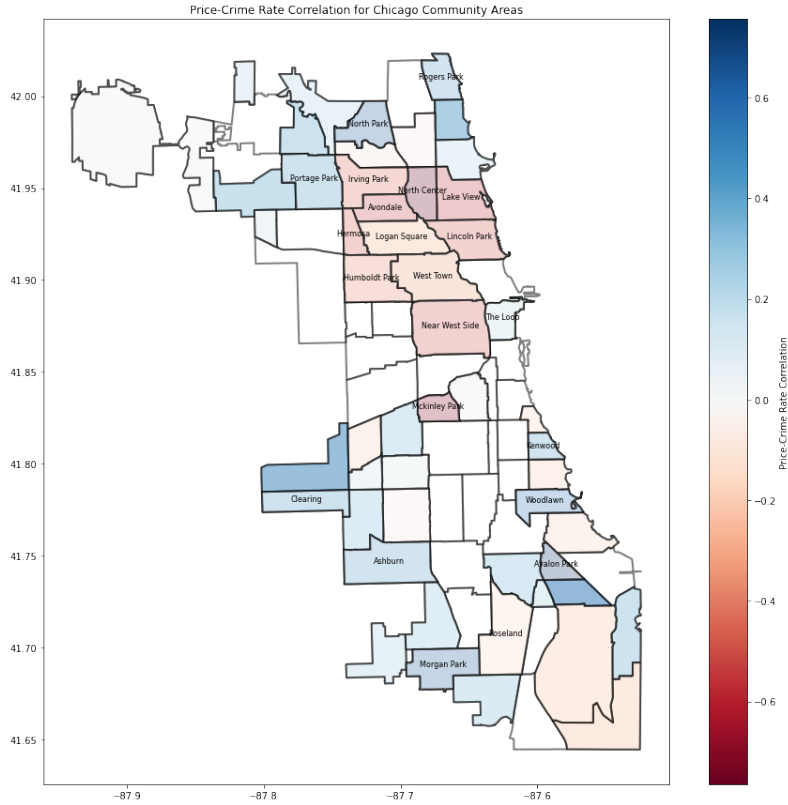
Figure 4: Price-Crime Correlation for Chicago Community Areas

Plotting the result on the map in Figure 4, we observe a familiar cluster in the northern part of Chicago where the correlation between the crime rate and the housing price is strongly negative. Many community areas in this region have high median housing price. On the one hand, this observation supports our conjecture that the housing markets in affluent areas are more sensitive to crime rate changes due to other factors that affect housing prices, such as parks and schools are already of a high standard. On the other hand, our early result shows that community areas in this cluster successfully reduced crime count and crime rate during the past two decades. The negative correlation between price and crime rate is destined to be stronger for these areas due to the drastic decrease in crime. In a nutshell, we need additional evidence to establish a causal link between an area's economic condition and its housing market's sensitivity to crime changes.

5. Regression analysis

In this section, we conduct a basic prediction exercise where we use a linear regression algorithm to predict average house prices for neighborhoods in Chicago. In this exercise, we use the log of crimes count, along with population (in log) [9] as predictors for log house values at the community area level. Before conducting such analysis, we analyze how different types

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[9] We also use community area population from the Census in 2010 as one of our features.

of crime correlates with prices. Looking at the correlation between house prices and all crime counts, we find a really small coefficient of -0.04. Given this small number, we rank all different types of crimes according to their correlation with housing values and look specifically at the top five crime types. These are weapon violations (-0.47), homicides (-0.45), offenses involving children (-0.38), narcotics (-0.3) and arsons (-0.29). We therefore focus on weapon violations and use it as the main feature of our linear regression model. The label used here is the average house price at the community area level. A summary of the final dataset in presented in Table 1.

Furthermore, we separate the dataset into randomly selected training and testing samples. The training sample represents 80 percent of the original data and the testing sample represents 20 percent of the data. Since the final data contain 52 data points (one for each community area), our testing sample only contains 11 observations. We perform a linear regression model on the training sample and report the results in Table 2. The table shows that, a 1 percent increase in the number of violation offenses reduces house values by 28 percent, which is abnormally high. The adjusted R-squared is also moderately low and has a value of 0.50. This suggests a relatively poor fit. The next step in our analysis is to use our model to predict house values on our testing sample. Using the model on the testing sample yields a similar adjusted R-squared of 0.51. Results are shown in Table 3

Another metric that we can use to gauge the quality of our prediction is the RMSE (Root Mean Square Error). The RMSE calculated on the testing sample is 0.28. One advantage of this metric is that it has the useful property of being in the same units as our response variable. Considering that the RMSE is about 2 percent of the average house value in the dataset, the model seem to be fairly good. However, this might just be an artifact of the selected sample. To remedy this, we finally performed k-folds cross validation using 6 splits. This exercise also revealed how the original results are biased by the selected sample selected. However, the model can be greatly improved in many aspects. The poor quality of the model is potentially due to having only a few features that are not sufficiently correlated with our response variable. Furthermore, the model might be mispecified in terms of its functional form. If the relationship between crime and house values in Chicago is non-linear, then a model like the one we built is likely to produce bad out-of-sample predictions. In the future, we plan to build upon these limitations with better housing data, perhaps at a smaller geographic unit along with better features[10].

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[10] Different factors such as the income per capita, racial composition, school quality, the quality of health institutions are known to be good predictors of neighborhood values.

6. Crime during Covid-19 pandemic

The second aspect we are studying is the relationship between crime data and Covid-19 cases for the city of Chicago. One very popular In this section we analyze the Crime data during the Covid-19 era. During this period (from 01-3-2020 to 04-25-2021) there were reported 224,508 crime incidents. Figure 5 represents a treemap of the major crimes in Chicago during this period. Similarly, with the whole sample period, battery, theft and criminal damage crimes belong to the first three more common crimes in Chicago. One significant change comparing these two figures is the change of narcotics crime during the Covid-19 era. This type of crime is in the fourth position of the major crimes in Chicago, while for the Covid-19 era, it is in the eleventh position.

Major Crimes in Chicago during Covid-19 era

| BATTERY 44,959 | CRIMINAL DAMAGE 27,627 | ASSAULT 20,512 |

THEFT 40,672

DECEPTIVE PRACTICE 20,026 | MOTOR VEHICLE THEFT 11,314 | WEAPONS VIOLATION 10,009

BURGLARY 8869 | NARCOTICS 6368

OTHER OFFENSE 13,602 | CRIMINAL TRESPASS 3982

ROBBERY 8540 | SEX OFFENSE 969 | HOMICIDE 894
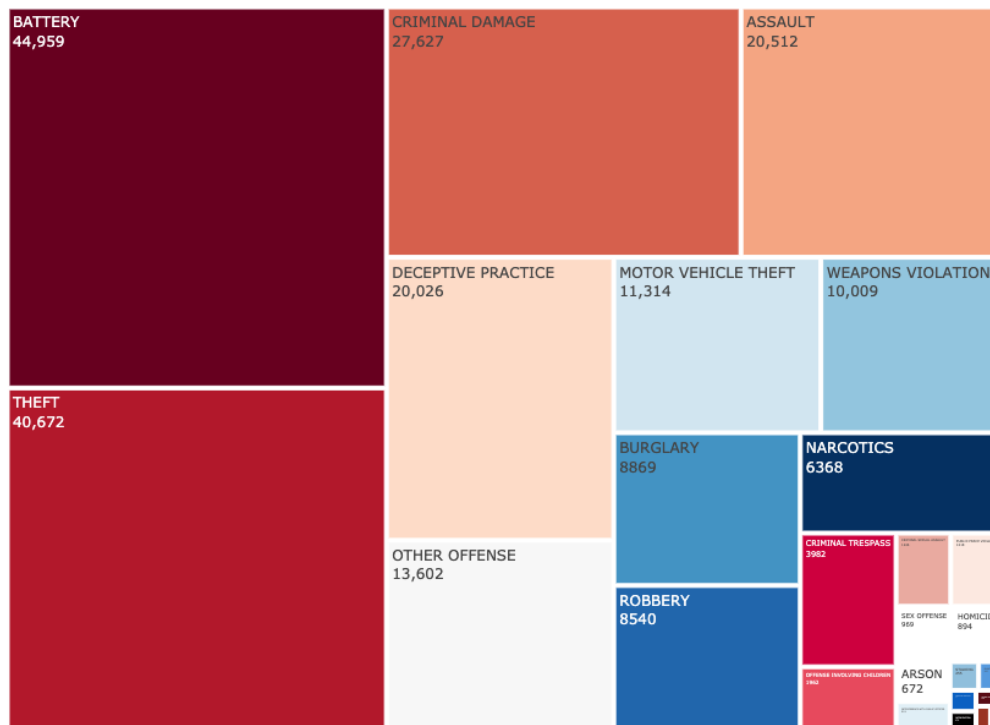
OFFENSE INVOLVING CHILDREN 1962 | ARSON 672

Figure 5: Treemap for the Major Crimes in Chicago during Covid-19 era

Next, we present the Crime trend in Chicago during the pandemic period. Figure 6 shows the volume of daily crimes in Chicago for Covid-19 era. The three vertical red lines represent three important dates for our period; the Stay-at-Home order in Illinois state, George Floyd's death, and the beginning of vaccinations in Chicago. As we can see, there is not a significant

fluctuation in the volume of crimes during this period. As expected, there is a peak in the volume of crime incidents, after George Floyd's death and the protests that followed in Chicago [11].
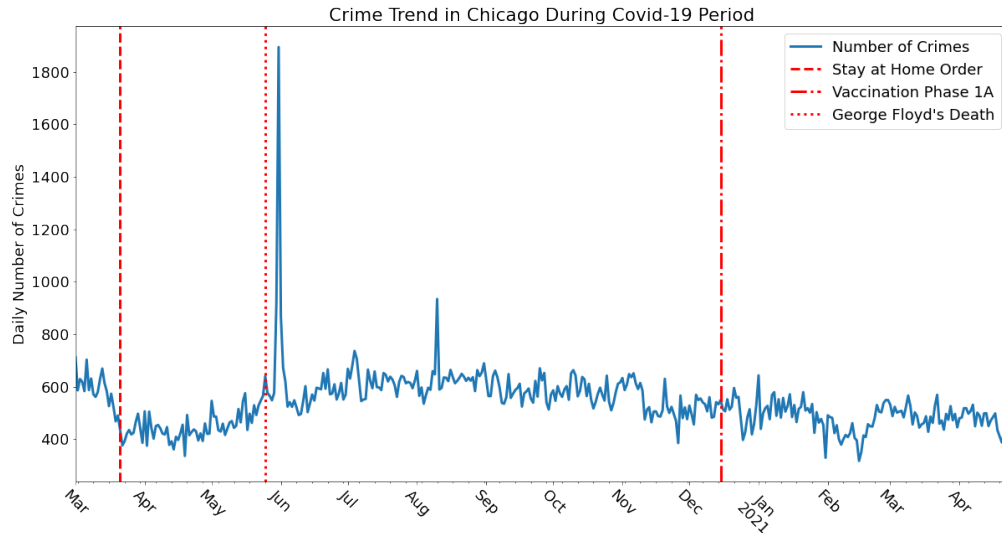

Figure 6

Furthermore, we present our findings exploring the trends for different types of crimes during this period. As aforementioned, the main concern about lockdowns and stay-at-home-orders was that we will experience an increase in domestic crimes and homicides. Regarding the first type of crime, Figure 7 shows that there was not a dramatical increase in the volume of these crimes. The red line represents the weekly moving average of this timeseries. There was a slight increase from March till July, but overall, this series seem to fluctuate around its mean. The same figure depicts the volume in the number of arrests. The number of arrests represent whether an arrest was made after the crime reporting. Again, the purple line represents the moving average on a seven-days window. According to this graph, number of arrests dramatically decreased after the stay-at-home order and till mid May. Arrests increased around the protests after George Floyd's death. Afterwards, there were small fluctuations around eighty arrests on average.

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[11] https://www.chicagotribune.com/news/breaking/ct-loop-protests-property-damage-20200530
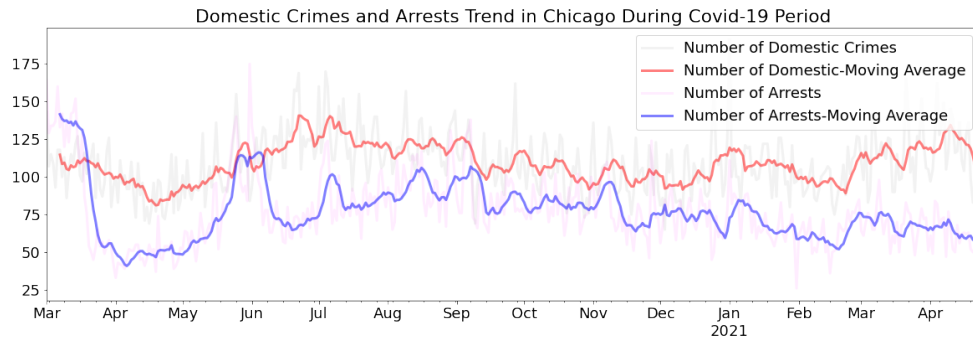-ncvxjtwglnfoddlyj4yuhd6lwm-story.html

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Figure 7

Regarding homicides, Figure 8 plots the volume and the seven-day moving average of the homicides series in Chicago. Again, we experience a peak in homicides after George Floyd's death, but overall there was not any other significant change in this particular time range. However, we need to mention that the external validity of these findings is questionable. Other big cities, might have experienced an increase in domestic crimes in general, or domestic crimes against women during this period, as the United Nations report [12].
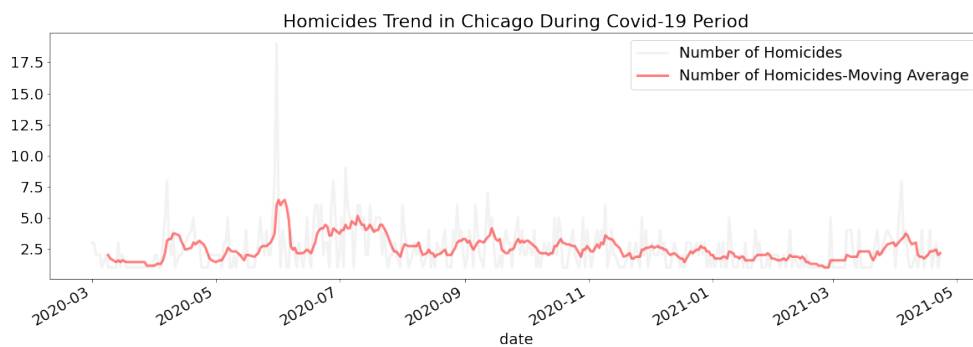

Figure 8

Next, we move to investigating geographical variation in crime and covid-19 incidents. The first heatmap on the left presents the geographical variation in crime rates in the Chicago area. It shows that zipcodes in the southern area and western area in Chicago have the largest number of crimes reported during the covid-19 period. Specifically, the most crime-prone community areas where the number of crimes exceeds 10,000 cases include community areas such as Auburn Gresham, Roseland, Pullman, and Garfield Park.

The heatmap on the right shows the variation in severity of covid-19 infections between zipcodes in Chicago. The western part of chicago seems to show the most severe covid-19 infections. These areas include Westlawn, Chicago Lawn, Belmon Cragin, Hermosa, Archer Heights, and Brighton Park. When comparing the two heatmap side-by-side, it seems to sug-

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[12] https://www.unodc.org/documents/data-and-analysis/covid/Violence_against_women_24Nov.pdf

gest that covid-19 infection numbers do not have a strong relationship with total crime incidents, which is confirmed by the results on table 4.

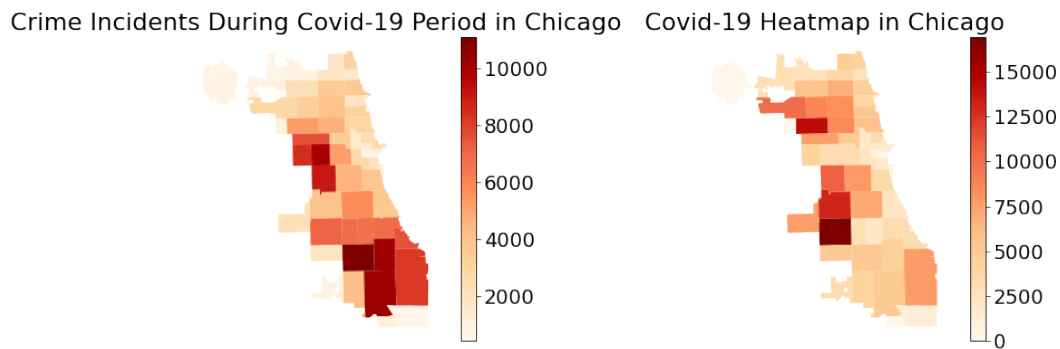Crime Incidents During Covid-19 Period in Chicago   Covid-19 Heatmap in Chicago

Figure 9: Heatmaps for Crime & Covid-19 infections in Chicago

To investigate the trend in crime further, we conduct comparison between pre and post covid-19 era in the number of total crimes, homicides crime, and domestic-related crime cases in Chicago. To do this, we compile all crime reports for 731 days between March 18th, 2019 to March 18th, 2021. On Figure 10, we observe that while there is a significant reduction in the number of crime briefly after the stay at home order on March 18th, 2020, the reduction quickly dissipated afterwards. However, the rolling-average number of total crime experienced an overall decline after the stay-at-home order in March 18th, 2020.

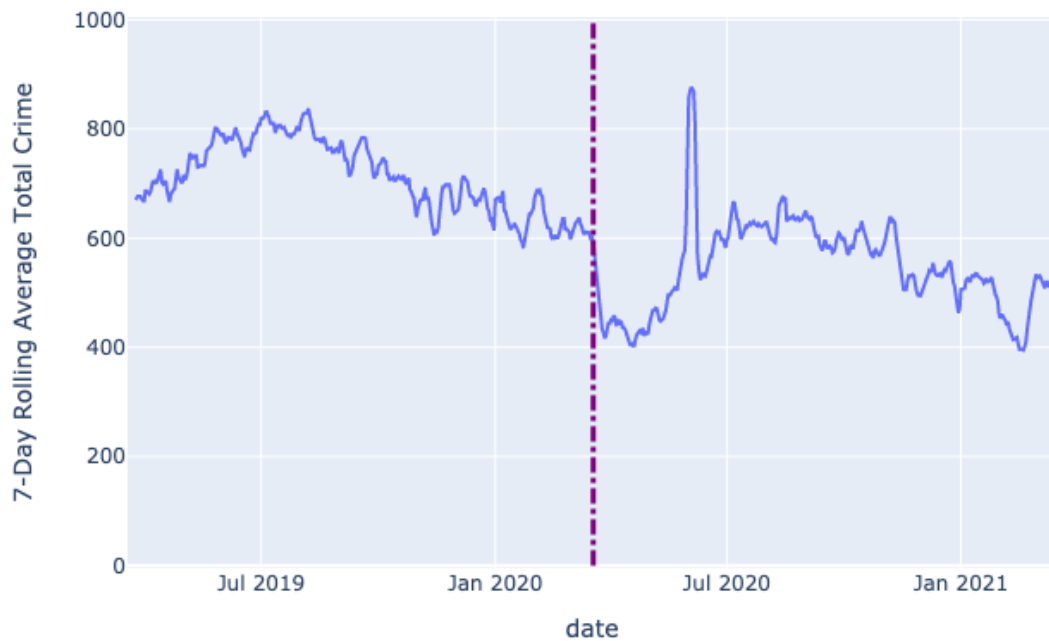Comparison of Total Number of Crime Pre and Post Covid-19 Era

Figure 10: Comparison of Crime Pre and Post Covid-19 Era in Chicago

Figure 11 shows the trend on domestic-related crime before and after the stay-at-home order. When looking at the trend, there is a brief reduction in domestic-related crime after the stay-at-home order. However, the number of domestic-related crime quickly bounces back to the level similar prior to the stay-at-home order.
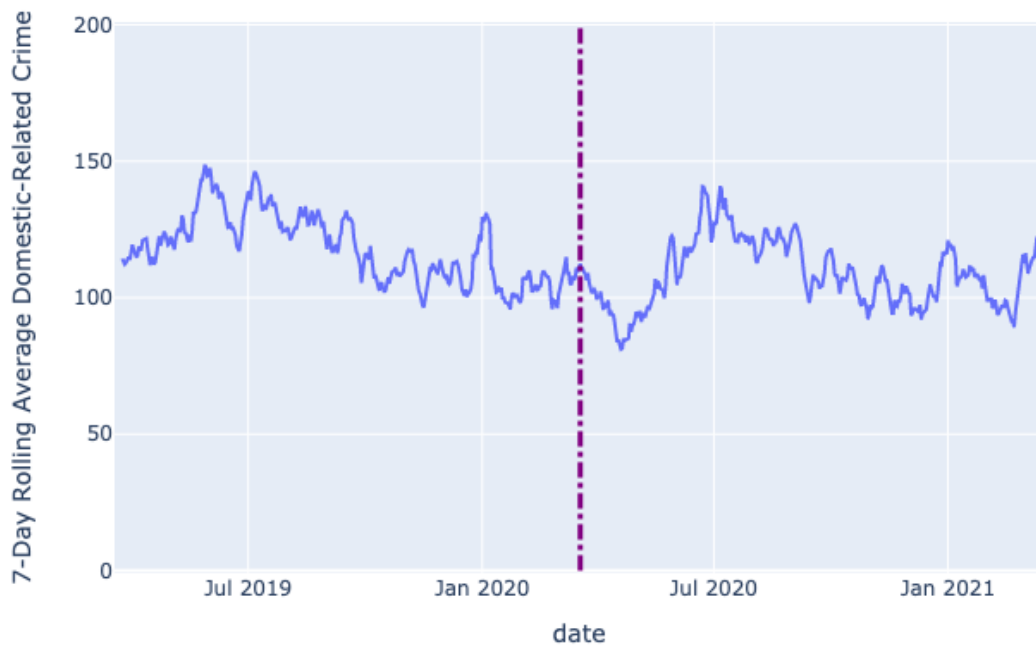
Figure 11: Comparison of Domestic Crime Pre and Post Covid-19 Era in Chicago

Figure 12 shows the trend on homicides-related crime before and after the stay-at-home order. In contrast to domestic-related crime there is a brief spike in the number of homicides crime after the stay-at-home order. However, similar to the previous cases, the spike of homicides crime quickly dissipates and goes back to the levels similar prior to the stay-at-home order. Overall, the number of homicide crimes post stay-at-home order seems to be similar to before the stay-at-home order.
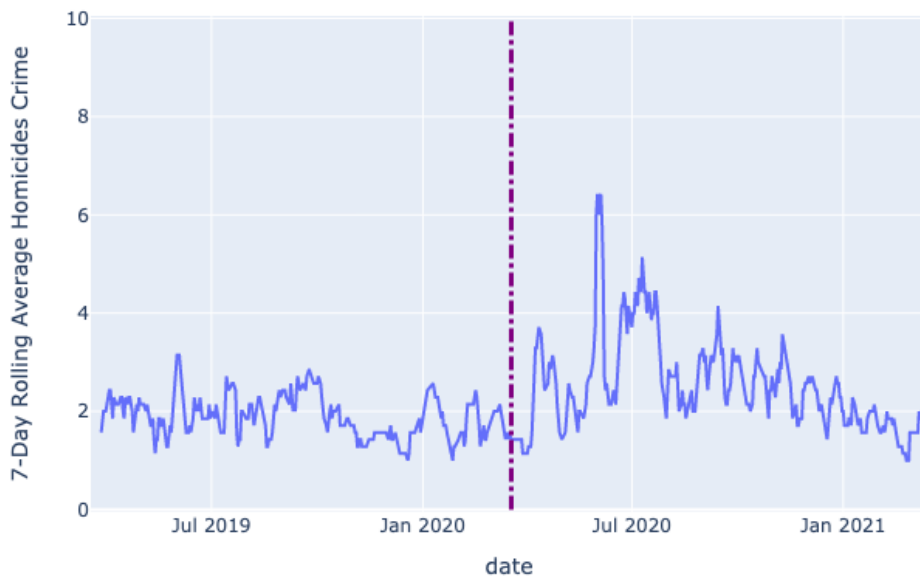
Figure 12: Comparison of Homicides Crime Pre and Post Covid-19 Era in Chicago

7. Conclusion

To sum up, in this paper we are investigating Chicago's crime data exploring two aspects of this city; land value and Covid-19 period. With respect to crime and housing prices, previous research conducted on this topic hasn't reached a consensus. Our analysis reinforces this state of affair by showing how the correlations between the housing prices and crime vary by community area. We hypothesize that the economic condition in each area may affect how sensitive the housing price in that area is to changes in criminal activities. The intuition is that infrastructures and amenities have significant impact on housing prices. If they remain in a poor state, prices are trapped at a low level regardless of crime fluctuations. But given high-quality amenities such as good schools and parks, housing market participants will update criminal activities as their primary concern.

Regarding the second aspect, we investigated the relationship of different types of crime and the Covid-19 cases. Tracking down the changes of crime after the announcement of the stay-at-home order, we conclude that Chicago did not experience any significant change in homicides, domestic crimes and total crimes for the entire covid-19 period that we examined. When compared to the pre-pandemic era, we find a sizeable reduction in the overall number of total crimes after the stay-at-home order was enacted. However, the external validity of these findings is questionable.

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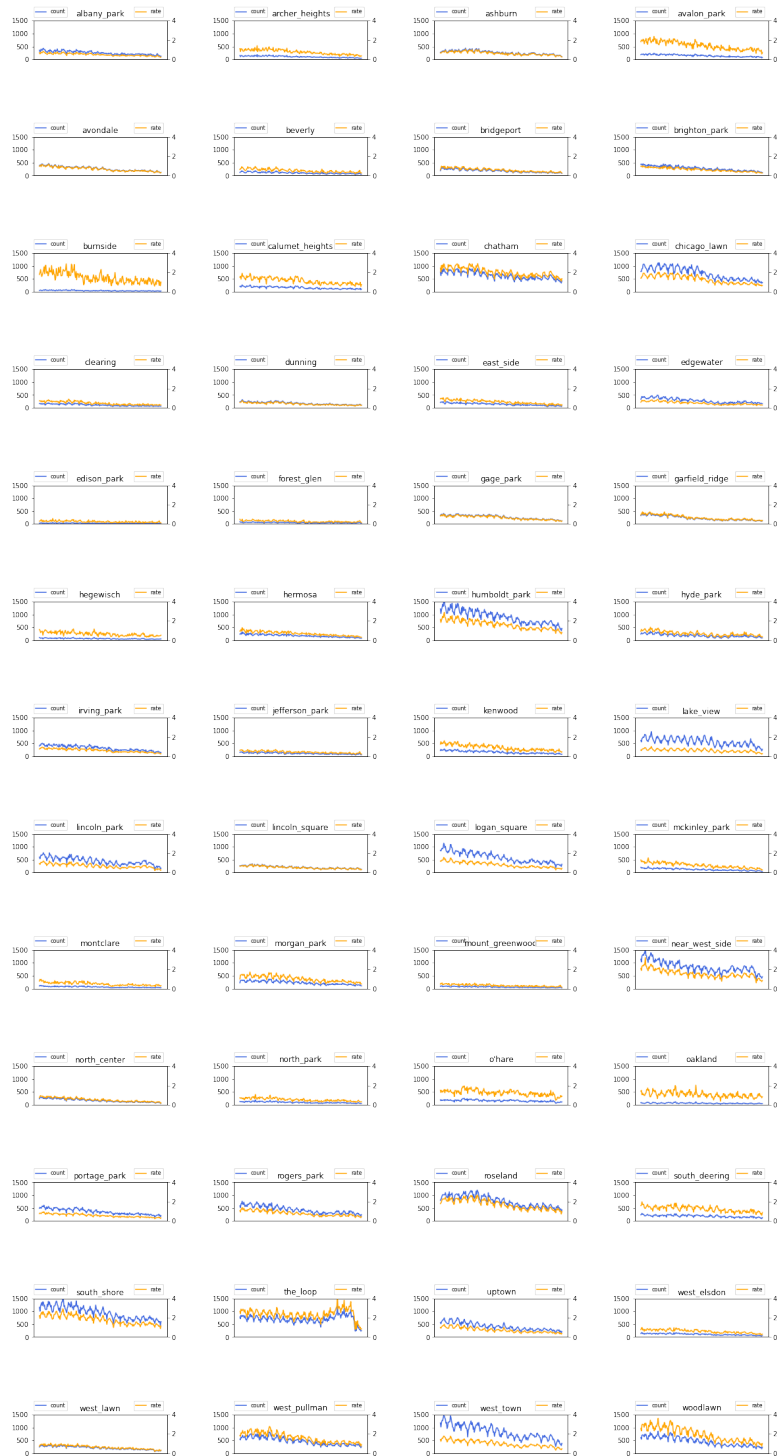
8. Appendix

Figure 13: Crime Count and Crime Rate for 52 Community Areas in Chicago (2003-2021)
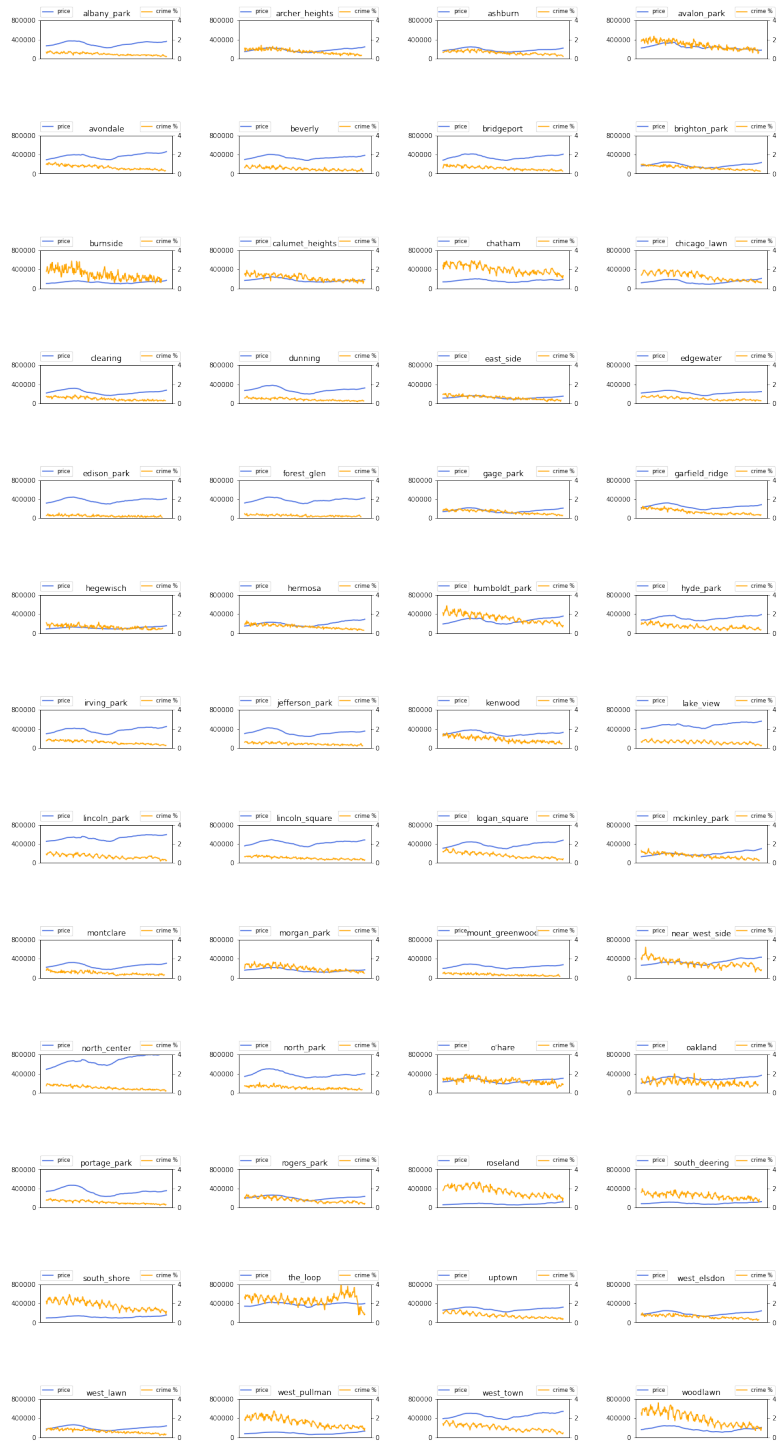
Figure 14: Housing Price and Crime Rate for 52 Community Areas in Chicago (2003-2021)
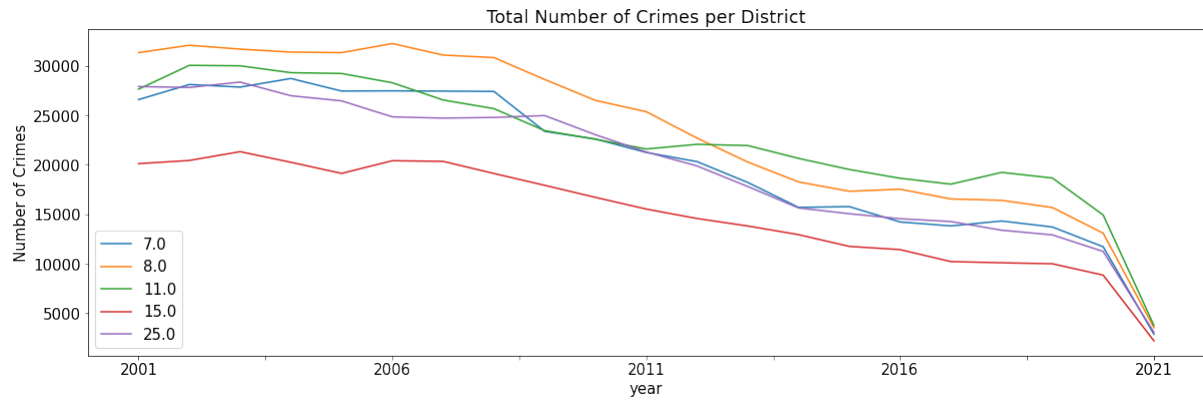
Figure 15: Crime trend for the five districts with the most crimes (2001-2021)

Table 1: Summary table of housing price and crime data

	weapon violations	price	population
N	52.0	52.0	52.0
mean	5.89	12.4	10.24
sd	1.21	0.48	0.70
min	2.08	11.26	7.98
p50	5.93	12.43	10.32
max	8.09	13.41	11.45

Table 2: Regression of Housing prices on Crime and Population (Training sample)

Dep. Variable:	price	R-squared:	0.526
Model:	OLS	Adj. R-squared:	0.501
Method:	Least Squares	F-statistic:	21.09
Date:	Thu, 13 May 2021	Prob (F-statistic):	6.89e-07
Time:	14:47:09	Log-Likelihood:	-13.408
No. Observations:	41	AIC:	32.82
Df Residuals:	38	BIC:	37.96
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P> |t|	[0.025	0.975]
weapons violation	-0.2833	0.048	-5.865	0.000	-0.381	-0.186
population	0.4177	0.082	5.080	0.000	0.251	0.584
const	9.8038	0.758	12.930	0.000	8.269	11.339

Table 3: Regression of Housing prices on Crime and Population (Testing sample)

Dep. Variable:	price	R-squared:	0.610
Model:	OLS	Adj. R-squared:	0.512
Method:	Least Squares	F-statistic:	6.248
Date:	Thu, 13 May 2021	Prob (F-statistic):	0.0232
Time:	14:48:12	Log-Likelihood:	0.061183
No. Observations:	11	AIC:	5.878
Df Residuals:	8	BIC:	7.071
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P> |t|	[0.025	0.975]
weapons violation	-0.4477	0.136	-3.303	0.011	-0.760	-0.135
population	0.6595	0.258	2.552	0.034	0.064	1.255
const	8.2491	2.478	3.330	0.010	2.536	13.962

Table 4: OLS Regression Covid-19 Cases and Crime Rates in Chicago

	(1)
VARIABLES	Log Total Crimes
Log Covid-19 Cases	-0.007
	(0.01)
Observations	3,283
Zipcode FE	Y

Note: Standard errors are in parentheses and clustered at the zipcode level. The observations are at the zipcode-week level. Zipcode Fixed Effects is included to take into account unobserved time invariant confounders.
***p<0.01, **p<0.05, * p<0.1.