Is the Chicago Police Department Overfunded?
The 2020 Edition.

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ABSTRACT

With the resurgence of the Black Lives Matter movement in the Summer of 2020, many United States citizens are outraged at the disproportionate arrests and murders of black people by police officers. The murders of black Americans like George Floyd and Breonna Taylor have us questioning if the police departments across the United States need to be reevaluated. Whether that is keeping police accountable with civilian councils, reallocating money to de-escalation training, or even outlawing choke holds during arrests, the Black Lives Matter movement has pushed for drastic change in the legislations and accountability of police departments in the United States.

In this exploratory data analysis, we will examine the Chicago Police Department (CPD), which has historically been one of the three most populated cities in the United States with one of the highest crime rates. Using linear and exponential regression, we predicted how much crime rates will decrease based on the annual CPD budget. With both regression models, we concluded that the 2020 CPD budget was overfunded by 43-56 million dollars with the exponential model, or 65-81 million dollars with the linear model. A surplus in the CPD Budget this large could have easily doubled (or even tripled) the 2020 budget allocated to affordable housing and homelessness, violence prevention, and mental health services combined; all of which have shown to create long lasting change in decreasing crime in a community.

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SECTION I: INTRODUCTION

I.I Project Background

Data Source Inspiration
I came across a Politico article written by Taylor Miller Thomas and Beatrice Jin, in which they visually represented how homicide rates and police budgets have historically changed, coming to the conclusion that dramatic growth of funding police departments in the United States has outpaced the decrease in crime rates for those respective cities. With the amount spent on each police department, they don't have much to show for the decrease in crime rates.
(Jin, B., Thomas, T)

My Take on the Data
It got me thinking, I would like to do similar research but not just on homicide rates. Violent crime encompasses 4 different types of crimes, of which homicide contributes a relatively small percentage. I believe looking at violent crime as a whole (as well as property crime which is far more frequent) may be an insightful twist on this original analysis.

I know that the police budgets in major cities like Chicago make up the majority of each city's budget. With so many duties for the police to deal with, it may be beneficial to examine how their budget has been impacting crime rates and if more of the city budget should be allocated to non-police resources. These resources include the budget for education, homelessness, social services, and healthcare which may affect unemployment rates, literacy rates, homelessness rates, mental health rates, mortality rates, and poverty rates.

Goals
- Show how change in CPD budget (adjusted for inflation) affects change in violent/property crime per capita from 1995-2019
- Use different regression models to determine a best fit model, and how the current 2020 CPD budget compares to this model

Hypothesis and Outcome

A police budget that increases at a rate quicker than the rate that crime decreases could indicate that the police budget is too high and not allocated efficiently. Ideally the police budget (adjusted due to inflation) should be increasing at the same rate as violent/property crime rates decreasing.

The goal of this project is to see if police are overfunded and if resources should be allocated to other resources such as housing, education, and mental health resources.

I hypothesize that The City of Chicago Budget is increasing exponentially while the rate of crime is not declining at the same rate (slower). This would support the hypothesis that the Chicago Police Department is overfunded, and that other resources should be looked into.

I.II Data Introduction

Chicago Crime Rates (*Crime in the U.S., Annual Reports*)

I will take a look at crime data from the Chicago which historically has ranked within the top 3 U.S. cities with the largest population and highest crime rates. Population data and property crime data ranges from 1995-2019 in the FBI database. Violent crime data for Chicago was incorrectly reported in the FBI database, so I used Chicago Police Department Annual Reports for this information.

The data includes the categories of violent crime and property crime. Violent crime encompasses murder and nonnegligent manslaughter, rape, robbery, and aggravated assault (of which, robbery and assault make up the majority). Property crime encompasses burglary, larceny-theft, motor vehicle theft, and arson (of which, larceny-theft makes up the majority).

Data was curated to only include population, violent crime rates, and property crime rates in Chicago from 1995-2019. Crime data was taken from different tables/reports and combined into 1 csv file to import to a Jupyter Notebook.

City of Chicago Budget (*City Budgets*)

I will take a look at the City of Chicago Budget to see how it has changed over the years (Corporate Fund > Total Revenue; Department of Police / Chicago Police Department > Appropriation Total). The Corporate Fund is the City's general operating fund and is the largest fund in the city budget, supporting basic City operations and services, such as public safety, public health, and tree trimming. The majority of this Fund is resourced via taxpayer money.

The Chicago Police Department is funded via the Corporate Fund and other grants. The majority of the Corporate Fund goes towards public safety > CPD > The Bureau of Patrol, which is responsible for general field operations, the protection of life and property, the apprehension of criminals, and the enforcement of laws.

Data was curated to only include Corporate Fund and CPD Budget from 1995-2020. Each year's data was taken from its corresponding budget ordinance and combined into 1 csv file to import to a Jupyter Notebook.

Population
For the 'crime' dataset, the population would be all years where crime was reported in the City of Chicago. For the 'budget' dataset, the population would be all years where a budget was proposed in the City of Chicago

Sample Size
For the 'crime' dataset, the sample size is n=24: Years 1995-2019
For the 'budget' dataset, the sample size is n=25: Years 1995-2020

I.III Data Dictionary

Data from each point was taken from a different annual report and curated to a single csv file for analysis. Sampling weights that must be added are inflation values for the years 1995-2020 in order to standardize the value of currency across each year. And per capita values for both crime and budget are added to take into account the change in population each year.

The 8 original variables from these reports are as follows:

Original Crime Data

Variable	Type	Definition
Year	integer	The year in which crime data was recorded
Population	integer	The population of citizens that live in the City of Chicago
Violent Crime Total	integer	The number of violent crime offences in the City of Chicago (encompasses murder and nonnegligent manslaughter, rape, robbery, and aggravated assault)
Property Crime Total	integer	The number of property crime offences i the City of Chicago (encompasses burglary, larceny-theft, motor vehicle theft, and arson (of which, larceny-theft makes up the majority)

From these 4 variables in the Original Crime Data, 2 calculated variables were created:

Variable	Type	Definition
Violent Crime PC	float	Violent crime per capita - 100,000 (Violent Crime divided by Population)
Property Crime PC	float	Property crime per capita - 100,000 (Property Crime divided by Population)

Original Budget Data

Variable	Type	Definition
Year	integer	The year in which a City of Chicago budget was proposed
Corporate Fund	integer	The total allowance of money in the Corporate Fund
Police Budget	integer	The total allowance of money from the Corporate Fund allocated to CPD

From these 3 variables in the Original Budget Data, 5 calculated variables were created:

Variable	Type	Definition
Corporate Fund Total	float	The Corporate Fund adjusted for inflation
Police Budget Total	float	The Police Budget adjusted for inflation
Corporate Fund PC	float	The Corporate Fund adjusted for inflation and per capita - 100,000
Police Budget PC	float	The Police Budget adjusted for inflation and per capita - 100,000
Percent CPD	float	The percentage of the Corporate Fund allocated to Police spending

I.IV Data Cleaning

There are no missing values in the 'budget' dataset. There is one missing value in the 'crime' dataset where violent crime was not reported. The missing value will not affect the analysis, and the value for property crime that year will be used so, there is no need to delete the data point. Because the dataset was hand-curated and each row was taken from a different table/report, there are no duplicate values, and all columns will be utilized in either the analysis or the creation of additional columns (referenced in the data dictionary).

Of the 5 original numeric columns (excluding Year) and 2 datasets, there is only 1 outlier (Year: 1995, Violent Crime: 73014). Although this value is identified as an outlier, it is the earliest year of data with the largest Violent Crime value. It is only 6,000 off from the next value which relatively is not far off. We will not be removing this value because it provides a solid baseline of what violent crime looked like in 1995.

**SECTION II: ANALYSIS OF CRIME IN CHICAGO**

Section II Overview
In this section we will analyze how violent crime and property crime have changed from 1995 to 2020. When analyzing the crime counts, we will pay attention to which years have significant increases or decreases and why. When analyzing percent change in crime, we will pay attention to significant large and small percentage changes and why.

Hypothesis and Assumptions
We hypothesize that in recent years, the percent change in crime is not as effective, given the large increase in police budget.

II.I Violent Crime
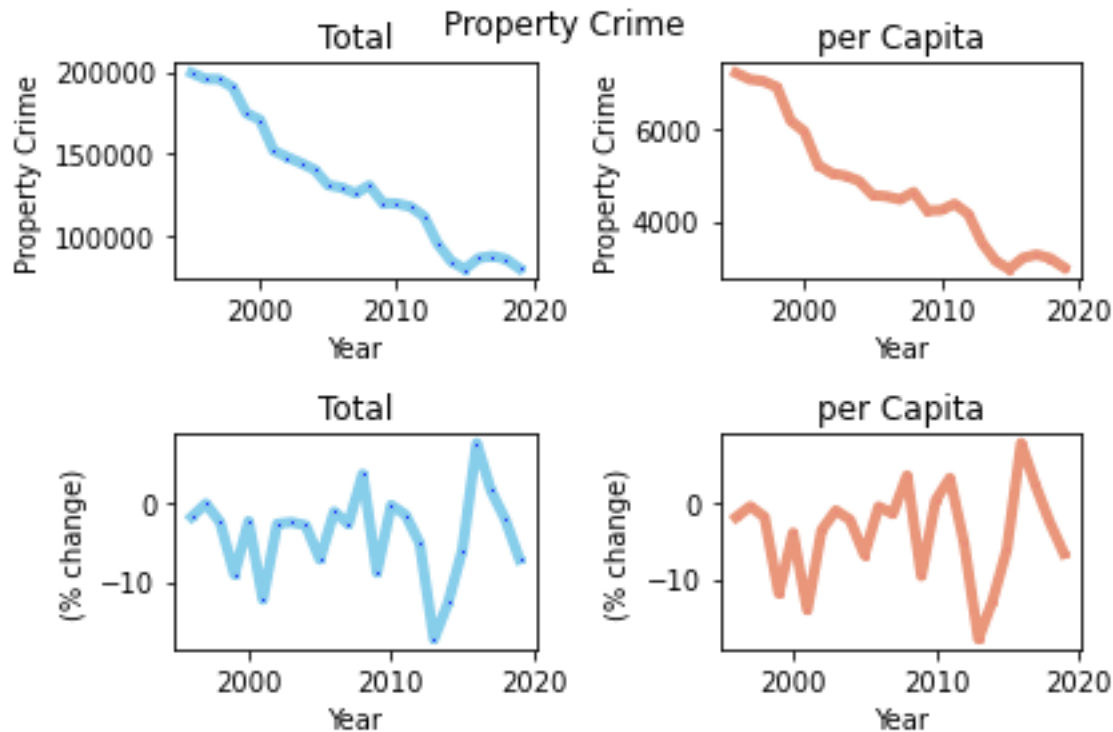
Violent Crime Graph
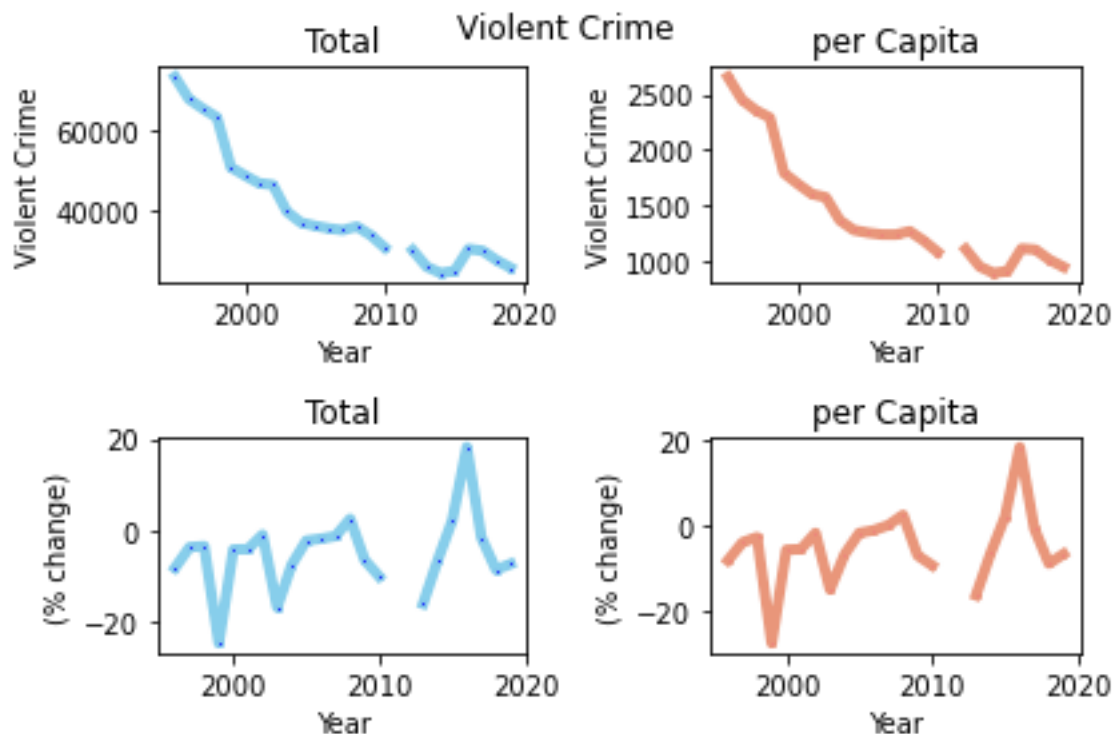
Analysis
From the Violent Crime counts in the top row, it looks like the total amount of violent crime has a decreasing trend throughout the years, both for Total Count and per Capita. In the percent change graphs on the bottom, there looks to be significant decreases of violent crime in 1999 and 2003 and a significant increase of violent crime in 2016. Overall, the median percent change per capita of violent crime from 1995 to 2020 is -5.77%.

Statistic #1: "Violent crime typically decreases by about 5.77% each year."

II.II Property Crime

Property Crime Graph

Analysis

From the Property Crime counts in the top, it looks like the total amount of violent crime has a decreasing trend throughout the years, both for Total Count and per Capita. In the percent change graphs on the bottom, there looks to be significant decreases of property crime in 2001 and 2013 and a significant increase of property crime in 2016. Overall, the median percent change per capita of violent crime from 1995 to 2020 is -2.44%

Statistic #2: "Property crime typically decreases by about 2.44% each year."

Section II Takeaways

  From 1995-2019, crime has a few increases but typically decreases. Both violent crime and property crime had an abnormal percent increase in 2016. Both violent crime and property crime have had a decreasing trend with a median decrease of 5.77% in property crime and a median decrease of 2.44% in property crime. Overall, we conclude that crime rates have historically decreased.

# SECTION III: ANALYSIS OF CITY OF CHICAGO BUDGET

Section III Overview
In this section we will analyze what percentage of the Corporate Fund goes to funding the Chicago Police Department (CPD) and how the city budget has changed over time by taking into account population and inflation from 1995 to 2020. We will pay attention to any overall trends in the city budget as well as any significant increases or decreases.

Hypothesis and Assumptions
We hypothesize that in recent years, the police budget has increased significantly with respect to the historical changes in Chicago's budget.

# III.I Percent CPD

Corporate Fund Allocation to CPD Graph
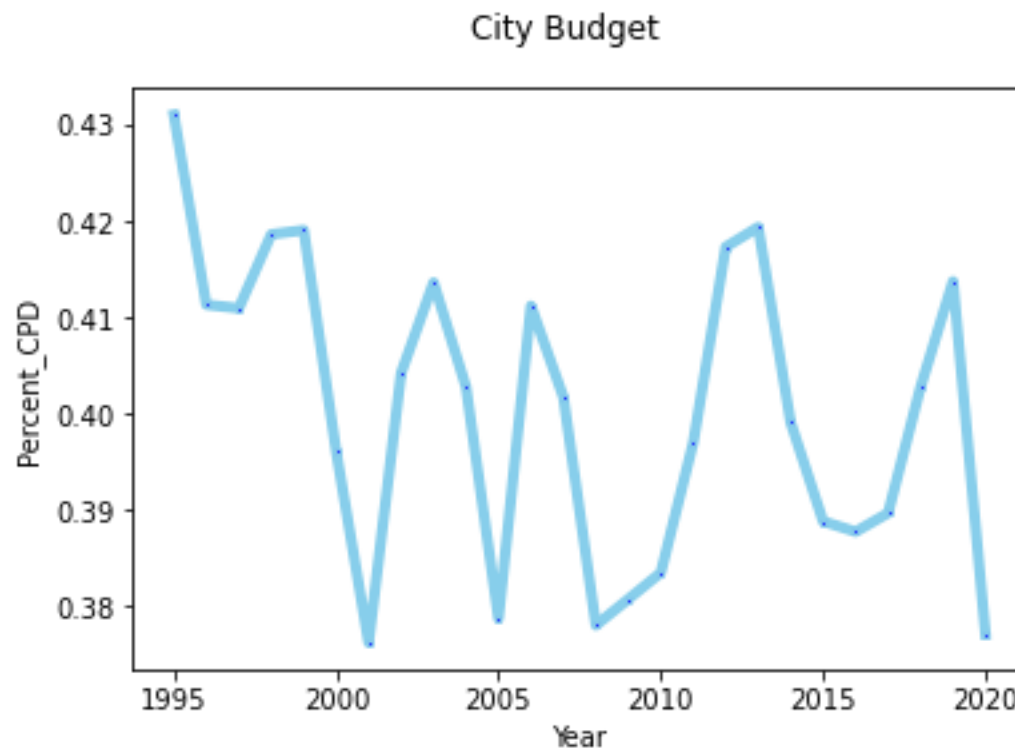
Analysis
The CPD budget consumes anywhere from 37.62% to 43.10% of the Corporate Fund in the Chicago Budget, taking up the largest percentage of the tax-payers money. The percentage seems to fluctuate between years with a median percentage of 40.22%.

Statistic #3: "The CPD Budget typically consumes about 40.22% of the Corporate Fund."

III.II Corporate Fund and Police Budget

Corporate Fund and Police Budget Graph
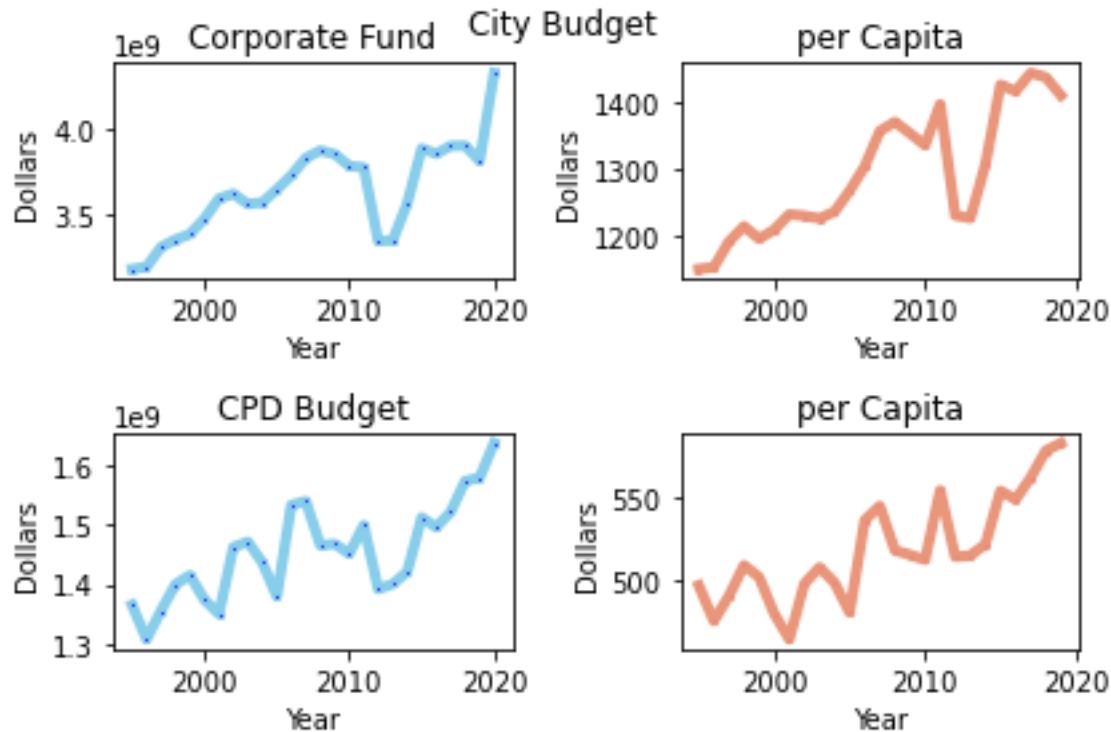
Analysis

From the Corporate Fund amount on the top row, it looks like it has an increasing trend throughout the years, with a significant budget cut in 2012, and a significant budget raise in 2020. In the CPD Budget amount on the bottom row, it also has an increasing trend throughout the years. Overall, the median Corporate Budget per year was 3.63 billion dollars and the median Police Budget per year was 1.45 billion dollars.

Each has a record highs in Corporate Fund and CPD Budget in the past 3 years. All these data points are adjusted for inflation.

Statistic #4: "2020 has one of the highest budget increases to both Corporate Fund and CPD Budget ever recorded."

Section III Takeaways

From 1995-2019, the budget for the CPD typically consumes about 40.22% of the Corporate Fund (the largest fund for the City of Chicago Budget which is funded by tax payers). The budget has an increasing trend over the years with a significant decrease in 2012, and a significant increase in 2020.

SECTION IV: COMBINED ANALYSIS OF CRIME AND BUDGET

Section IV Overview
In this section we will analyze a correlation matrix between crime counts and police funding using each year as an individual data point. We graph these points and create a regression model, determine which model fits best for predicting crime rates from police budget, and see how far off the 2020 police budget is from the best model's prediction.

Hypothesis and Assumptions
We hypothesize that there is a negative correlation between crime and budget (as budget increases, crime will decrease). We also hypothesize a negative exponential or logarithmic graph where each increase in budget (x) results in a smaller decrease in crime (y). The marginal increase in police budget has a marginal decrease in value: decreasing crime rates.

IV.I Correlation Matrix
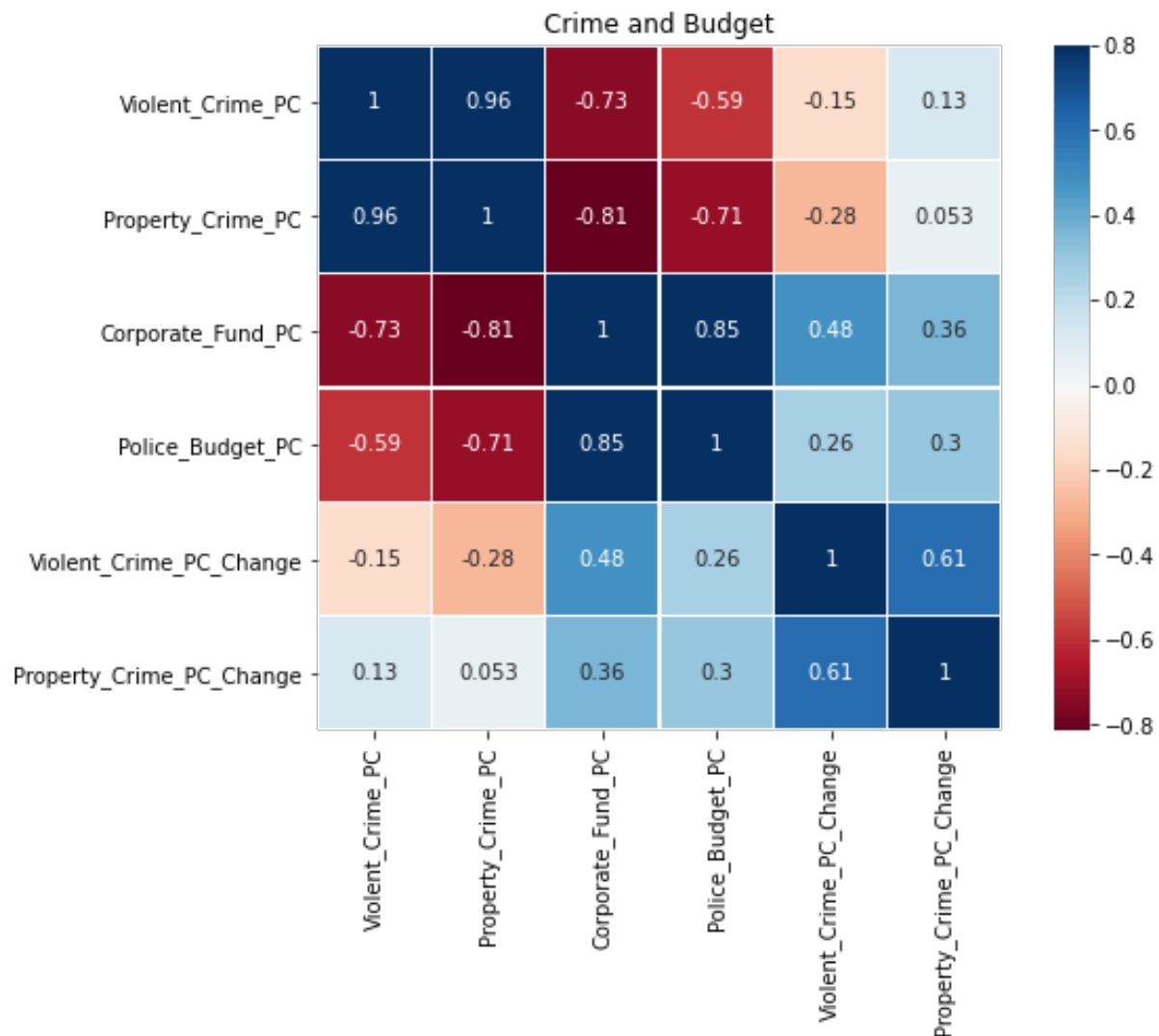
Analysis

There is a strong positive correlation (0.96) between violent crime and property crime. Although maybe not a causation, it would make sense that both would rise and fall together since they are both classified as crime.

There is a very strong negative correlation between Corporate Fund and Property Crime (-0.81). There is a strong negative correlation between Corporate Fund and Violent Crime (-0.73) and Police Budget and Property Crime (-0.71). There is a moderate negative correlation between Police Budget and Violent Crime (-0.59).

Overall, it appears that the Corporate Fund has a higher effect on decreasing crime than the Police Budget, especially on Property Crime. Whereas Police Budget has a weaker effect on decreasing crime, also with a favor in Property Crime. We may infer that the Corporate Fund may have a higher effect because it invests in other funds such as homelessness and mental health. It's interesting to see that budget also has a weaker effect on Violent Crime than Property Crime.

Statistic #4: "Corporate Fund has a stronger negative correlation with both violent crime rates and property crime rates than police budget (possibly due to investing in non-police crime-reducing resources)"

Statistic #5: "Police Budget has a -0.59 (moderate) correlation with decreasing violent crime and a -0.71 (strong) correlation with decreasing property crime."

IV.II Crime vs Budget

Crime vs Budget Graph
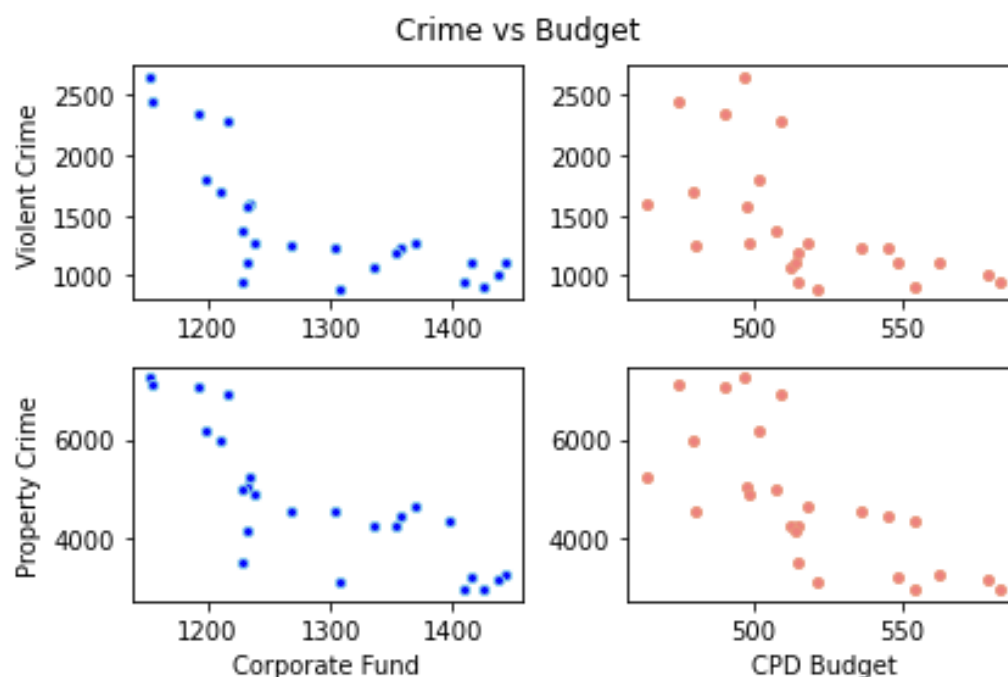
Analysis
It is clear that there is a negative correlation between crime and budget. To determine if the budget increase proportionally decreases crime, we will fit a linear regression. This hypothesis will hold true if the R^2 for linear regression is higher than that of an exponential or logarithmic regression.

IV.III Regression Model Analysis

Hypothesis
The R^2 of exponential and logarithmic models are greater than a linear regression, indicating that the increase in budget does not proportionally decrease crime: the value of police in decreasing crime decreases as their budget increases.

Table of R^2 for predicting Violent Crime PC from Police Budget PC

Model	Prediction	Violent Crime - R^2	Property Crime - R^2
Linear	crime = A + B*budget	0.3518	0.5068
Logarithmic	crime = A + B*log(budget)	0.3556	0.5063
Exponential	crime = A * e $^{B * budget}$	0.4124	0.5602

Analysis:
The exponential functions have higher R^2 values and are better at predicting crime rates by 6% for both violent and property crime. This supports our hypothesis that City Budget does not have a proportionate relationship between crime and budget. We conclude that an increase in police budget has less and less effect on the decrease in crime (also known as the law of diminishing returns. The first billion dollars spend on police will decrease crime more than the next billion.)

Statistic #6: "CPD Budget is better at predicting decrease in crime rates using an exponential model rather than a linear model. There is a disproportionate decrease in crime for each dollar spent on CPD (law of diminishing returns)."

Section IV Takeaways
　　　　Looking at the correlation matrix, Corporate Fund has a stronger negative correlation with both violent crime rates and property crime rates than the CPD budget. This may be due to the fact that the Corporate Fund also invests in crime-decreasing programs such as homelessness, violence prevention, and mental health resources.
　　　　Using a regression model to predict crime from budget, we conclude that an exponential model is the best fit. This rejects the idea of a linear model: that CPD Budget proportionally decrease crime for each dollar allocated to them. In conclusion, exponential model supports the law of diminishing returns: each dollar allocated to the CPD Budget has less of an effect in decreasing crime. This becomes more and more apparent over the years and solidified in a 6% difference in R^2 values between models.

SECTION V: APPROPRIATE BUDGET

In this section we will compare an appropriate budget for 2020 assuming that there is a median decrease in crime this year to what the current budget is. We will use the exponential models since it had the highest R^2 value. We will also use the linear model, to illustrate a hypothesized (yet debunked) budget if CPD budget proportionally decreased crime.

V.I Table of Overfunding

Hypothesis
Both models will predict a value lower than the current CPD 2020 Budget indicating that the Chicago Police Department is overfunded.

Model	Predicted Budget (*violent* crime model)	Predicted Budget (*property* crime model)
Linear	**$1,555 million** ($81 million surplus)	**$1,571 million** ($65 million surplus)
Exponential	**$1,580 million** ($56 million surplus)	**$1,593 million** ($43 million surplus)

Analysis
The actual CPD Budget for 2020 is $1,636 million. Analysis continues in V.II and V.III.

V.II Exponential Model

A Generous Prediction
Using our accurate exponential model, we assume that each increase in the police budget has a smaller effect on crime rates (law of diminishing returns).

The predicted Police Budget Total for 2020 with a median decrease in Violent Crime and Property Crime ranges from 1.580 to 1.593 billion dollars. To put that in perspective, our exponential model claims that the CPD Budget is overfunded by 43-56 million dollars (0.53-0.70 standard deviations).

V.III Linear Model

An Idealistic Prediction
Using an idealistic model where each increase in police budget is directly proportional to a decrease in crime, we predict the following CPD Budget for 2020.

The predicted Police Budget Total for 2020 with a median decrease in Violent Crime and Property Crime ranges from 1.555 to 1.571 billion dollars. To put that in perspective, our exponential model claims that the CPD Budget is overfunded by 65-81 million dollars (0.80-1.01 standard deviations).

Statistic #7: "Using Linear and Exponential models, the 2020 CPD Budget was overfunded by $43-81 million."

V.IV Comparison to Other Budget Items

Comparing the CPD Budget to other Finances

The 1,636 Million Dollar CPD Budget, large as it is, is at least overfunded by $43-81 million.

Other 2020 Budget Items include:
- $10.0 million for affordable housing and homelessness
- $9.0 million for violence prevention
- $21.2 million for mental health services

These three items have been proven to show long-term change in decreasing crime in a community. With the predicted CPD budget surpluses ranging from $43-81 million, these three items alone could have doubled their budget (according to the exponential model – more realistic) or tripled their budget (according to the linear model – more idealistic) in 2020.

Statistic #8: "The predicted 2020 CPD budget surplus could have doubled or tripled the total amount allocated to affordable housing and homelessness, violence prevention, and mental health services."

Section V Takeaways

Using a more idealistic linear model that assumes the CPD budget proportionally decreases crime for each dollar spent on them, this model predicted that CPD was overfunded by $65-81 million in 2020.

Using a more realistic exponential model that assumes the CPD budget has diminishing marginal returns and each dollar spent has less effect on decreasing crime, this model predicted that CPD was overfunded by $43-56 million in 2020.

These surpluses alone could have doubled or tripled the total amount allocated to affordable housing and homelessness, violence prevention, and mental health services.

SECTION VI: FUTURE DIRECTIONS AND CONCLUSION

VI.I Future Directions

This project was difficult to narrow down to one specific topic because there are so many different ways to answer the question: are the police overfunded? Here are some ways to expand this analysis:
- Analyzing how police budget decreases crime rates in cities other than Chicago
- Introducing other budget items such housing and homelessness, violence prevention, and mental health services to models that predict decrease in crime rates.

VI.II Conclusion

From this analysis on the relationship between crime and police budget in Chicago, I would like to take away 2 major points:

1.) Does the City of Chicago *effectively* decrease crime by funding CPD the amount they do?

When predicting crime from police budget, an exponential regression model was better at predicting than a linear regression model. Here is the significance of each:

- The <u>linear</u> regression model assumes that an increase in police budget will have a proportional decrease in crime. Each dollar spent on the police will have the same effect on decreasing crime.
- The <u>exponential</u> model assumes that an increase in police budget will have diminishing returns on decreasing crime. Each dollar spent on police has less of an effect on decreasing crime.

Although the linear regression model and a proportionate decrease in crime is idealistic and effective, the exponential model was better at predicting crime and thus we can conclude:

Spending more on the Chicago Police Department has a weaker effect on decreasing crime rates. If each dollar spent on CPD has diminishing returns, and we are already spending a significant part of the Chicago Budget on Police, perhaps reallocating money from the CPD budget to those that have less funding would have a stronger impact on decreasing crime.

2.) Is the Chicago Police Department overfunded?

According to the linear and exponential models, the CPD 2020 Budget is overfunded by approximately $43-81 million which is enough to double or triple the current budget for affordable housing and homelessness, violence prevention, and mental health services.

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