Abstract

New York City's dramatic crime decline is a real brain teaser according to crime analytics experts. New York City's historic crime fluctuation over the past quarter of a century has been identified as an investigative phenomena. In the past years there was a saying spread by many stating "*Until things change, stay away from New York City if you possibly can*." You could see these phrases on the newspaper headlines constantly. Near panic ensued. New York's fiscal crisis of the mid-1970s is surely one of the weirdest moments in the history of the city one can say. It was a time when the wholesale disintegration of the largest city in the most powerful nation on earth seemed entirely possible. At this time the president, Gerald Ford, accompanied by his staff sought not to assist New York but to deliberately shame and humble it, and perhaps even replace it as the world's leading financial centre. As New York confronts a fiscal crisis, its leaders need to remember that the city owes its crime decline to a broad range of Time Series and Data Analytics to control the situation. In addition, maintaining the NYPD's commitment to its proven crime-fighting methods is crucial, of course.

Introduction

Communities in each of the city's boroughs were in advanced states of decay(Eterno, 2020). Neighborhoods, such as East New York or Brownsville in Brooklyn, were regularly compared to war-torn cities after the second world war. The Bronx, which had been a bastion of desirable upper-middle-class living until the mid-60s, was now burning nightly; once-magnificent apartment houses going up in flames lit by arsonists or landlords looking to

dispose of buildings they could no longer let or maintain.(Rosenfeld, 2020)

Triumphantly, we saw during the 1990s, crime rates in New York City dropped dramatically, even more than in the United States as a whole. Violent crime declined by more than 56 percent in the City, compared to about 28 percent in the nation as whole. Property crimes tumbled by about 65 percent, but fell only 26 percent nationally. Today, New York City is a vastly different place than it was 40 years ago. One can say it is cleaner, brighter, safer, more orderly and of course richer. According to the US Census, its population is close to a record 8.5 million people, which is up by more than 300,000 since 2010(Zimring, 2013). Once destitute and crime-ridden neighborhoods such as Crown Heights, or Bedford-Stuyvesant in Brooklyn, are rapidly being gentrified, which is something that would have seemed unimaginable in the days of Fear City.

Renown historical Data Analyst believe that it was the economic boom of the 1990s that encouraged people to remain on the triumphant path that brought about the drop in crime rates in New York City and the nation. The national unemployment rate declined 25 percent between 1990 and 1999, and by 39 percent in the city between 1992 and 1999. This study shows that a single percentage point decline in the jobless rate decreases burglary by 2.2 percent and motor vehicle theft by 1.8 percent(Ethier, 2010). Increases in the real minimum wage also significantly reduce robberies and murders: 3.4 to 3.7 percent fewer robberies with a 10 percent increase in the minimum wage and 6.3 to 6.9 percent fewer murders.

Crime here has been dropping exponentially for more than 20 years, making New York

one of the safest cities in America. In 2014, murders fell to 328, this is according to The New York Times. We witness the lowest figure since at least 1963, when the Police Department began collecting reliable statistics. This historic triumph was reflected in a huge increase in Tourism. For example there were more than 56 million visitors to New York in 2014, over five times the number that came in 1975. We will take a look at these figures shortly and point out the specifics pertaining to trend, cyclical, seasonality for each borough. This will not only help us understand the fluctuation of crime throughout the years but also help visualize when up-ticks or downtrends were mostly seen and we will able to correlate them with notable events are policy actions in this time period.

Trend, Seasonal and Cyclical patterns over the years

One key factor all historic Data Analyst remember to do is taking seasonality into consideration for time series analysis. According to O'neil(2009, pp.101) Seasonality, as its name suggested, refers to the seasonal characteristics of the time series data. It is the predictable pattern that repeats at a certain frequency within one year, such as weekly, monthly, quarterly, etc. The most straightforward example to demonstrate seasonality is to look at the crime data. We always expect the crime to be higher in the summer while lower in the winter in most places on Earth. Taking seasonality into consideration is very important in time series forecasting, such as crime fluctuation forecasting. For example, we may expect crime to have seasonality since the crime will be higher in the summer every year. The time series that considers the seasonal effects of the crime will be more accurate in year-to-year forecasting. In general, the goal of time series

analysis is to take advantage of the data's temporal nature to make more sophisticated time series analysis.

To properly forecast events, we need to implement techniques to find and visualize the long-term trends, seasonality, and residual noise in our data. By constructing our specific NYC Crime data frames, we see how the data is repeated and on what frequency. According to Block(2002, pp.108) Detecting seasonality can be straightforward if you understand the context of the data very well. As with any data in which you are not familiar with the context to discover the seasonality, the simple way is to plot the data and observe the periodic signals along with the time series.

Researchers and policy makers often take for granted that seasonal fluctuation in crime is an established fact. To suggest otherwise goes against the grain of a long tradition in criminol-ogy. The assumption that crime occurs seasonally continues to be made today. Murder is a seasonal offense. Rates are generally higher in the summer, except for December, which is often the highest month and almost always 5 to 20 percent above the yearly average(Rosenfeld, 2020). Some types of crimes fluctuate with the seasons, while others do not. The same crime may show seasonal fluctuation in one geographic area, but not in another. In addition, the decision as to whether or not a particular series is seasonal depends upon the conceptual and operational definition of seasonality the decision-maker uses. Generally, a number of years of data are necessary in order to answer the question of whether crime is seasonal with confi-dence. A series shorter than seven years is considered too short for a definite decision about the

presence of seasonality.

The reason for this becomes clear if you consider that, in one year, you observe one instance of each month. In six years, you would have only six observations of Januaries, six observations of Februaries, and so on. With an increasing number of observations (years), seasonal fluctuation can be described more accurately. A few extreme values will have less effect on the total analysis in a long series than they will in a short series. Also, with a very short series, only strong seasonal fluctuation is likely to produce statistical significance(Zimring, 2013). In general, the longer the series, the more likely that relatively weak seasonal fluctuation (that is,however, consistent over time) will be significant. It is not surprising that different analysts, analyzing the same crime but for varying time periods, would reach different conclusions about the presence of seasonal fluctuation in that crime.

Time Series Analysis by the numbers

When observing the NYC Shooting time series graph(by quarter from 2006-2021) it is visually certain that there is a seasonal trend in how NYC shootings occur. You'll notice from the seasonal plot that there is heavy volume in the occurrence of shooting indeed in the Quarter 3 of the year. This proves for certain our piece hypothesis that summer time(quarter) is in fact the highest for shooting occurence in NYC. You will see that this trend spiked even more noticeably around 2020 to about 400-500 occurrences. Many will correlate this to the days of covid. You'll notice around this time many newspaper publications stating NYC shootings and homicides soared in 2020, crime data shows. Shootings and murders skyrocketed in 2020 throughout the

Big Apple. The number of shootings soared 97% from 777 in 2019 to 1,531 in 2020 and murders jumped by 44% from 319 to 462, according to the NYPD. The city watched violence cut through all five boroughs in 2020, sometimes taking down innocent victims in crimes that shocked the city, such as the shooting of 1-year-old Davell Gardner, who was killed at a Brooklyn barbecue in July. The NYPD said it made arrests in about 32% of the shooting incidents and established probable cause to arrest a suspect in an additional 6% of the cases, according to the release. NYPD detectives cleared 54% of homicides that occurred within calendar 2020, the release states. The NYPD boasted a 29% increase 4,253 v. 3,299 in annual gun arrests for 2020 compared with 2019 – including 2,057 gun arrests in the last quarter of the year. The arrests came despite the NYPD disbanding its undercover anti-crime teams that were responsible for large numbers of gun takedowns in prior years.

From the data summaries you will notice that accompanying these statistics are numbers of location to where these shootings occurred most frequently. You'll notice the highest number occurrences attached to Public Housing - Multiple dwelling at about 4549. Followed by Multi-dwelling Apartment buildings at 2662. You'll even notice that the precinct with the most number of shootings in the summary coming in at 1462 is 75th precinct. Another noticeable detail about the summaries is that you'll see there appeared to be from 2010 to just before 2020 a decrease in the shootings. A noticeable spike is season and hold for a few quarters after this. Next you'll see an analysis of time series decomposition is a process of deconstructing a time series into the following components. For example, the trend which general movement over time,

next is seasonal which is behaviors captured in individual seasonal periods and last residual which is everything not captured by trend and seasonal components. This technique is most often used for analyzing historical time series data. It's also sometimes used for forecasting. Modeling trend and seasonality at once might be a too difficult task, so tackling components individually might be a better approach. If seasonality and trend are part of the time series then there will be effects in the forecast value. As the pattern of the forecasted time series can be different from the older time series. For this analysis you'll see I used the technique known as additive decomposition. Basically if the components of the time series are added together to make the time series. Then the time series is called the additive time series. By visualization, we can say the time series is additive if the increasing or decreasing pattern of the time series is similar throughout the series.

Additive Time Series Decomposition - Trend strength

You'll notice from the analysis that in the data there are several data from the different boroughs pertaining to a certain Quarter of the year. This allows us to join and group the total of shootings for a certain Quarter in addition to specific Year for comparison. From observing the output of our STL for the grouped by borough data we can clearly see which is stronger and weaker in this respect. Seasonal-Trend decomposition using LOESS (STL) is a robust method of time series decomposition often used in economic and environmental analyses. The STL method uses locally fitted regression models to decompose a time series into trend, seasonal, and remainder components. Coming in at number 1, we see the trend_strength the strongest for

Brooklyn at 0.853639. Secondly, Manhattan with 0.826397. Weakest in this respect would be Staten Island at 0.4322117. For almost all categories you'll see Brooklyn has the strongest seasonal_strength as well as the highest in 'spikiness' measure. Curvature is also spotted at 62.4462547. Advantages of the STL decomposition are that the seasonal component can change over time, the rate of change is controlled by the parameter seasonal width. The parameter robust

can be set to true to remove effects of outliers on the calculation of trend and seasonal component. Also the results of the STL is defined for all points of the time series data. The Classic Decomposition also splits the time series into trend, seasonal and remainder component. The methods to determine the different components are simpler, the trend is often over-smoothed, so that rapid rises and falls are smoothed out. Also the seasonal component does not change in magnitude with time. The trend and the remainder component has missing values at the beginning and end of the series, due to using Moving Average Filter to determine the trend component. Otherwise the Classic Decomposition is capable of performing a multiplicative decomposition.

Season Strength - categorical variable comparison(vic_age_group)

You'll also notice using the time series features I was able to analyze output from boroandrace_shootings so we can witness which Victime age group showed the strongest seasonal strength. For the three main boroughs of Bronx, Brooklyn, Manhattan there is a strong VIC_AGE_Group of 18-24. Lowest age group for victim of course being less than 18 years of age or over 65 years of age. They say economic hardships exacerbated by the pandemic and a

lack of government support to those hardest hit are among the primary culprits. New York is experiencing the worst gun violence it has seen in nearly a decade, all while it continues to fight a pandemic that has killed tens of thousands of New Yorkers and left many more jobless and hungry.

In 2021 alone, 299 people have been shot, a 54% increase over the same time last year, and the most the city has seen since 2012. While determining why these crime patterns exist is up to interpretation–be it holiday travel, work-life stressors, changes in temperature causing behavioral changes, etc., these trends are critical to be mindful of. While the seasonal behavior of crime is evident in NYC, some communities display stronger seasonal crime swings than others. Boroughs with a larger economic hardship change over the course of the year, like Bronx and Brooklyn consistently shows a strong seasonal effect. It is still subject to changes in activities and thereby criminal opportunities. Key among the activities that appear to influence seasonal variation in crime, are no school during the summer and substantial summer tourism, providing a boost in population of potential offenders and potential victims alike.

Routine Activities is an opportunity-based theory of crime, holding that crime occurs when a motivated offender finds a suitable target in the absence of capable guardianship. When applied to the problem of seasonality, Routine Activities theory places importance on the movements and congregation of populations. This mechanism suggests that the summer months witness a surge of crime largely because of an increase in public activities. Factors such as

tourism, summer vacation from school, and populous downtown areas all provide a greater intermingling of would-be criminals and potential victims and proponents of the theory understand this as the primary driver in seasonal crime fluctuations. We are pointed in direction of controllable factors like the strengthening of guardianship in summer months with changes in routine behavior that increase target suitability for motivated offenders.

Lag Plot and Autocorrelation analysis points

When analyzing NYC shooting trends a feature that help in deciphering the data is a lag plot which checks whether a data set or time series is random or not. Random data should not exhibit any identifiable structure in the lag plot. Non-random structure in the lag plot indicates that the underlying data are not random. Lag plots were used to determine facts such as if the data were random. Determine if there was serial correlation in the data. Also if there are outliers in the data. In as much as randomness is an underlying assumption for most statistical estimation and testing techniques, the lag plot should be a routine tool for researchers. For this section I wanted to pinpoint for the specific borough of Bronx(since it demonstrated high shooting freq) for 2020. You'll notice the statistics obtained from output show in 2020 as suspected Quarter 3 had the highest number of shooting trend at 90.5. This is noticeably more than Quarter 1 at 48.5. Autocorrelation is the correlation between two observations at different points in a time series. For example, you'll notice Bronx borough come in with ACF -0.05389353 for Q3, -0.49802024 for Q2 and 0.05191377 for Q1.When these correlations are present, they indicate that past values influence the current value.

Conclusion

In conclusion, although we have seen unprecedented spikes in NYC shootings, viewing an overall snapshot of the past 50 years, we see an evident triumph of NYC over crime. In addition, it is well known that during certain quarters(Q3-Summer) time we see an uptick in incidents. We attribute the steady decrease of shootings in NYC due to today's NYPD officers which are expanding their focus by studying crime trends and monitoring community complaints, such as those to 311, that shed deeper insight into the geneses of crime. Proactive engagement with offenders, relentless investigations and follow-up, and rapid deployment are proven methods to reduce crime and disorder on the streets, in the subways, or in public housing. As New York confronts a fiscal crisis, its leaders need to remember that the city owes its crime decline to a broad range of public and private agencies. Maintaining the NYPD's commitment to its proven crime-fighting methods is crucial, of course. But so is the broader citywide emphasis on public order.

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