Crime, Cash, and COVID-19: a Bidirectional Impact on Crime via Income and Unemployment during COVID-19

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***Abstract*— Here we investigate the relationships between crime rates, unemployment, and median household income in New York State (NYS), focusing on the changes in these relationships due to the COVID-19 pandemic. Despite the historically positive correlation between crime and unemployment, the pandemic-induced isolation occurred with a significant decrease in crime rates, via a hypothetical reduction in crime conducted with peer groups. Additionally, upon lifting isolation restrictions, a surge in crime occurred, surpassing pre-isolation levels, despite declining unemployment and rising household income. Through our analyses more patterns and anomalies were uncovered, illuminating the bidirectional impact of the COVID-19 pandemic on crime dynamics in NYS.**

I. INTRODUCTION

Historically crime rates have been positively correlated with unemployment rates [6,8] and negatively correlated with median household income [7]. Isolation procedures began in March 2020 in response to COVID-19 in New York State which significantly decreased crime rates during the pandemic [2,3]. This contradicts the historically established relationship between crime, unemployment, and income. This decrease in crime was mainly driven by decreases in minor offenses which are typically committed in peer groups [2]. After NYS isolation restrictions were lifted in June 2021, the crime index surged above pre-isolation levels despite unemployment rates decreasing and household income increasing, once again disrupting historical trends (Fig. 1). Nonetheless, based on historical patterns we would expect the crime index to increase but remain under pre-isolation levels given that unemployment rates were decreasing and household income increasing. In this study, we performed temporal and spatial analyses to examine the trajectory of crime rates, income levels, and employment across counties in NYS. We uncovered patterns and anomalies in the relationship between types of crime, unemployment, and income that may explain the bidirectional impact of the COVID-19 pandemic on crime. We found that overall crime during and after the pandemic is most affected by financial crimes which rejected our initial hypothesis. We believe those results are due to the underreporting of non-financial related crimes during the pandemic [1]. We also found that while pre-pandemic financial crime trends can be predicted with some accuracy, pandemic and post-pandemic trends are unpredictable. And that there were no differences in the proportion of types of crime in rural vs. urban areas, nor are there significant differences across counties.

Notable observations from the data over time (Fig 1), are included in Figure 2.

II. LITERATURE REVIEW

The global impact of the COVID-19 pandemic has permeated various aspects of daily life, prompting researchers to investigate its multifaceted effects. One notable area of study revolves around the unexpected changes in crime rates in the United States during the pandemic. Bowman et al. (2020) delved into this complex issue and reported a consistent finding across major news sources, indicating a substantial decrease in crime across the United States since the initiation of isolation procedures. The decline was particularly evident in metrics such as police calls for service, with reports from various cities, including Chicago and Washington, showcasing significant reductions [4,5,9]. However, they argued that the overall decrease might mask a simultaneous surge in specific types of crimes, particularly those of a more severe nature [2]. They found that often minor offenses committed in peer groups were posited to be more susceptible to changes in social dynamics brought about by lockdowns and social distancing measures [2,10].

Crimes that are not financially motivated (non-financial crimes) such as murder, rape, and aggravated assault are crimes committed in peer groups. Thus, we argue that non-financial crimes were the greater contributor to the crime trend during and after the pandemic in comparison with financial crimes such as Larceny, burglary, robbery, and motor vehicle theft which are peer-group crimes.

III. HYPOTHESIS AND GOALS

The aforementioned patterns as seen historically contradict our preliminary observations of the data (Fig 1). Thus, we hypothesize that the COVID pandemic had a bidirectional impact on crime in NYS as follows: non-financial (not related to money) crime rates were negatively driven by pandemic isolation procedures, and financial crimes (related to money) were positively driven by the pandemic's impact on unemployment and income. We aim to demonstrate the pandemic's effect on the relationship between income and unemployment and most importantly, crime. We also aim to demonstrate that the total amount of crime is mainly attributed to the amount of non-financial crime.

IV. DATA

Unemployment data was published by the United States Bureau of Labor Statistics. Median Household Income data was published by the United States Census Bureau. The Crime Total data set was published by the NYS Division of Criminal Justice Services. NYS Rural Counties are defined as those with a population of less than 200,000. Classification

of rural and urban counties of NYS was done with the information obtained from the U.S. Census Bureau in 2021.

A main limitation and challenge that we had during the data processing stage was that our raw data for median household income as well as crime counts was given by year instead of by month, this meant that we had fewer data points to observe patterns in during (2019-2020) and after the pandemic (2021-2023)

A. *Exploratory analysis*

Between 2010 and 2022, New York State saw a decline in crime and a rise in income, both leveling off after 2016. The unemployment rate initially jumped, then steadily decreased until the pandemic surge in 2020, showing a tremendous spike in unemployment, reaching higher than 16% at the beginning of 2020, it then was followed by a swift recovery in 2022. These trends, however, are varied across regions and demographics within the state (Fig 1)

We observed crime trends per county (Fig 3). We did not observe any significant difference in crime trends per county. While some counties have more crime counts than others overall the increasing and decreasing trend was the same for all.

We then explore the distribution of financial and non-financial crimes per county type (urban and rural) (Fig 4). Although we observed a switch in financial crime in Urban with rural counties in 2016, the proportion of these crimes did not vary for either county type. Overall, we did not find any interesting pattern in the distribution of types of crime in urban vs rural counties so we did not divide the data by county for the rest of our data processing.

We visualized financial crimes vs non-financial crimes for all NYS (Fig. 5). We observed that financial crimes decreased steadily from 2010 to 2019, then slightly increased in 2020, decreased again in 2021, and then spiked in 2022. Conversely, non-financial crimes remained constant from 2010 up to 2019, then gradually kept increasing. Overall, we can see that the shape of the total crime count has the same shape as the financial crime curve, suggesting that financial crimes are driving the trend of the total crime curve, contrary to our initial hypothesis. We explore such trends in detail later in the results.

Finally, we broke down the total crime amount into individual crimes (Fig. 6). We observed that larceny has by far the highest total count. It was also interesting to observe that larceny as an individual metric also has the same uptick as the total crime amount from 2021 - 2022.

TABLE I: Type of crimes divided by Financial and Non-financial Crimes

Type	Description
“Financial Crimes"	Burglary, Larceny, Motor Vehicle (MV) theft
“Non-financial Crimes”	Murder, Rape, and Aggravated Assault

Fig. 1: Crime rate, median household income, and unemployment rate from 2010 to September 2023 in NYS.

	Income	Unemployment	Crime
Before pandemic (2010- 2018)	Steady increase	Steady decrease	Steady decrease
During Pandemic (2019-2020)	**Drop like in 2012**	Large increase	Steady and low
After (2021-2023)	Steady increase	Large decrease	Large increase

Fig. 2: Income, Unemployment, and Crime trends by observed periods: Before, during, and after the COVID-19 pandemic

V. METHODS

DBSCAN was performed to cluster the data using the parameters: median household income, unemployment rate, and crime amount (Fig 2, 3). This clustering method was chosen because there is no assumption of circularity in the data, as there is for other clustering methods, such as k-means. The parameters were standardized before performing the clustering. The first clustering performed was on the data including the amount of crime for *all* types of crime (Fig 2). The crime values were then split by whether the crime was financial or non-financial (Table 1). The clustering patterns showed results similar and dissimilar to results for clustering that included all crime types, for financial and non-financial crime respectively.

To elucidate the patterns between clustering, specifically how parameter values for different years were clustered, an additional figure with reduced dimensionality is shown (Fig

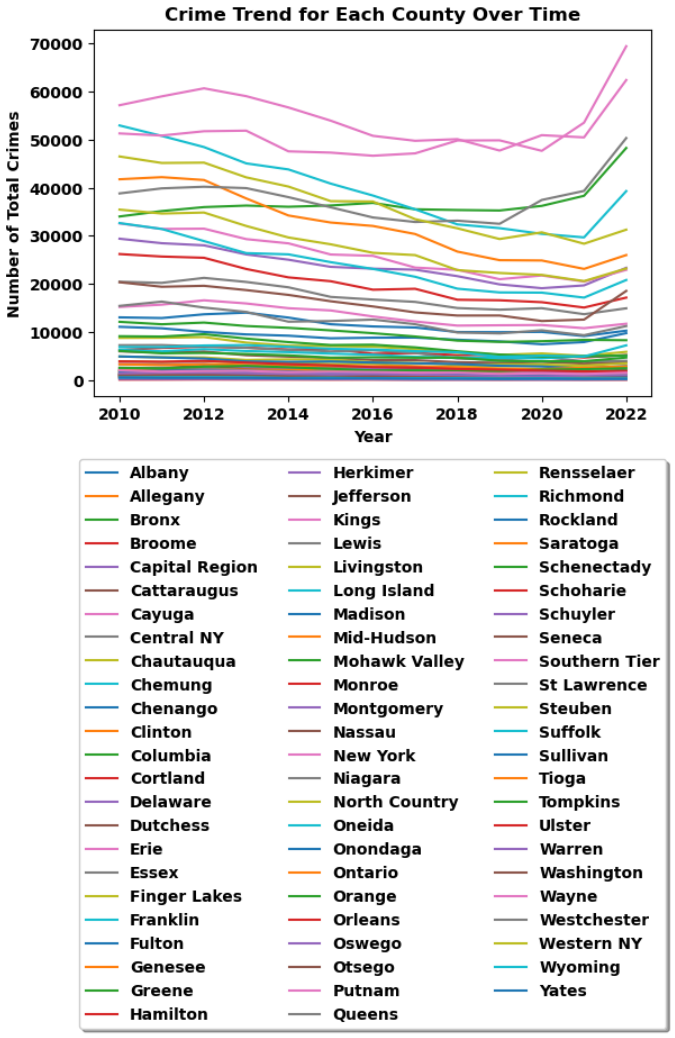


Fig. 3: Crime counts per year per county

3). In this figure, the clusters are colored by cluster number, and the marker shape shows what time period the point is from (Fig. 2).

Finally, we used Linear Regression to demonstrate the relationships between each of the factors (income and unemployment) and financial/non-financial crime. More specifically, the r-squared values were used to show how closely related financial and non-financial crimes were to unemployment and household income. R-squared values were taken from data from all time periods, then were separated from before COVID and during/after COVID (Fig 4). The Logistic Regression plots are superimposed on two by two matrices which reflect the corresponding R-squared values for the respective

VI. RESULTS

New York State crime amounts for financial vs. non-financial crimes, as well as rural vs. urban show clear upticks at the end of the pandemic, reaching their peak in 2022 with numbers exceeding 400,000 (fig 4). These figures also reveal

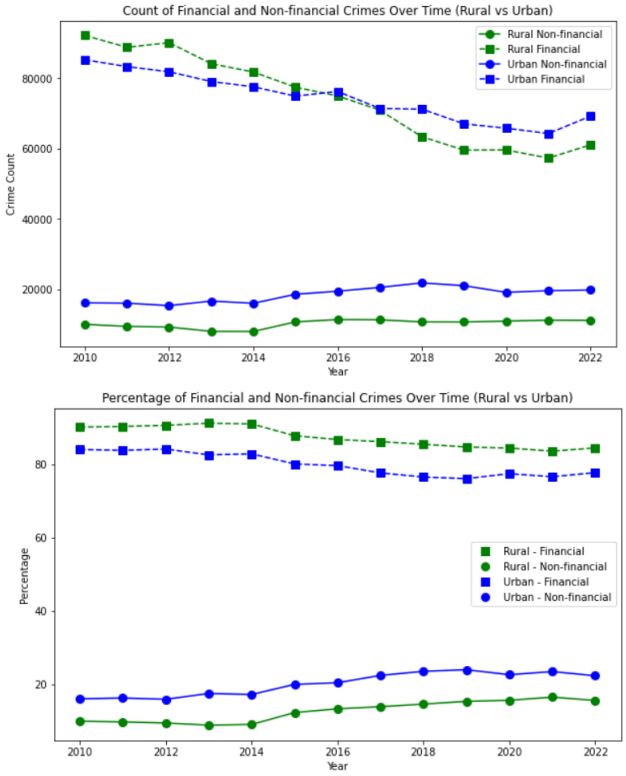


Fig. 4: Financial vs Non-Financial Crimes in Urban vs Rural Counties

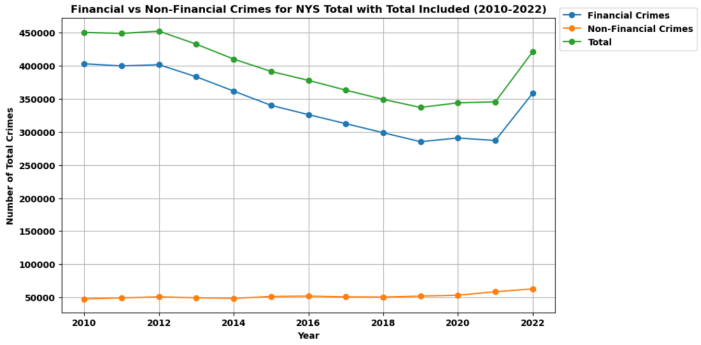


Fig. 5: Crime count, median household income, and unemployment rate from 2010 to September 2023 in NYS.

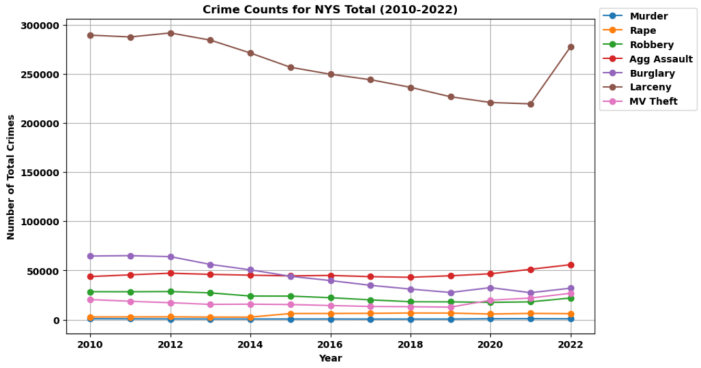
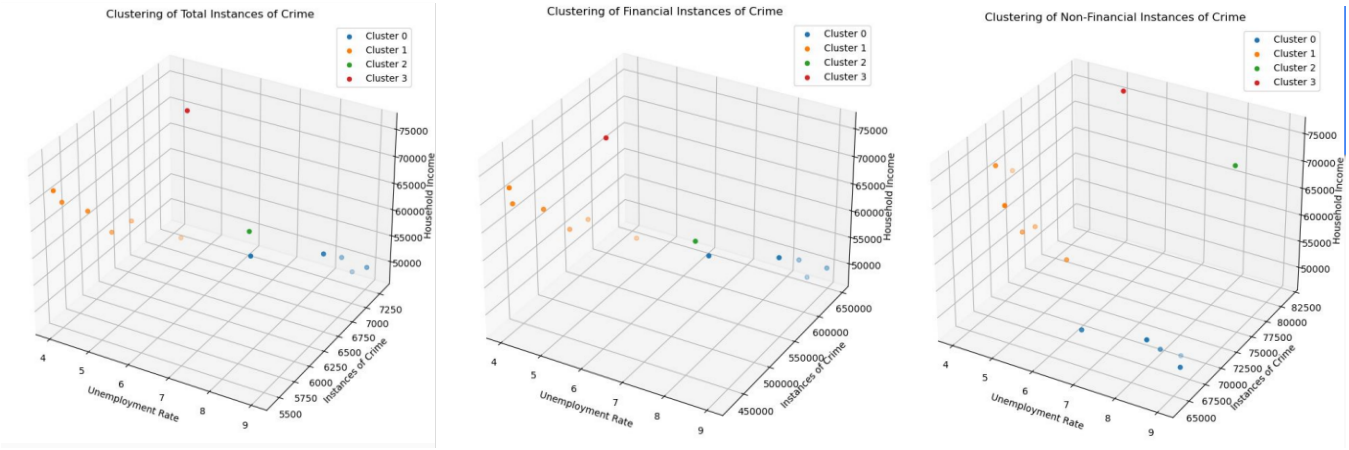
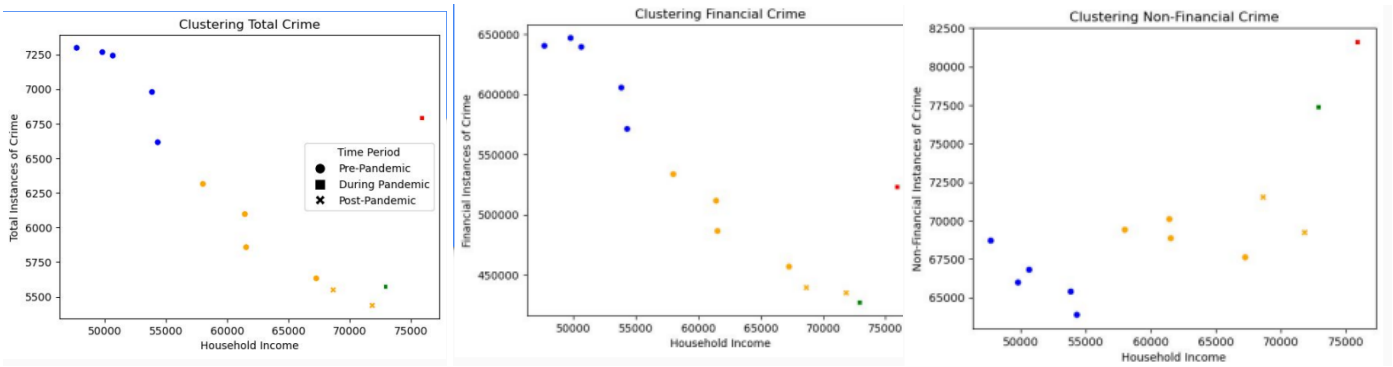


Fig. 6: Crime counts per type from 2010 to 2023 in NYS



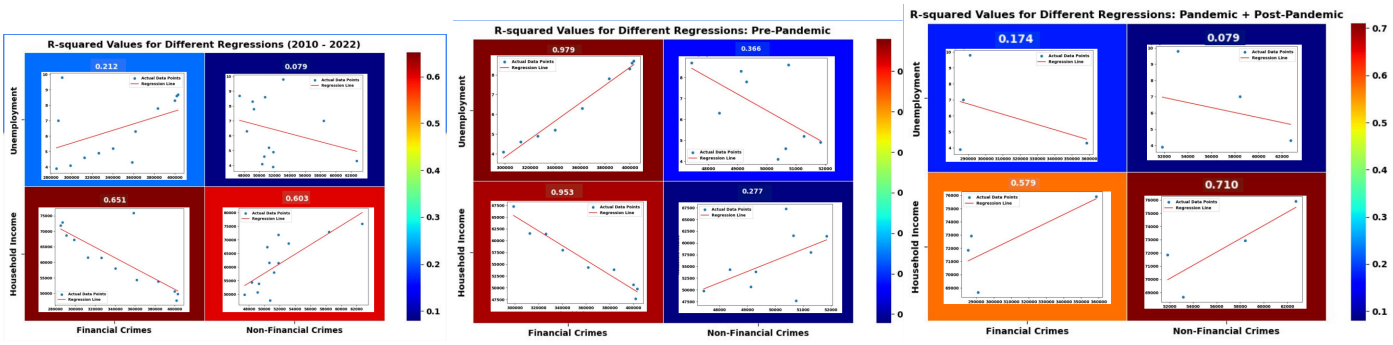
(a) (b) (c)

Fig. 7: DBSCAN clustering results. A, B, and C all use the parameters amount of crime, median household income, and unemployment rate. Total number of crimes, number of financially motivated crimes, and number of non-financial motivated crimes were used for A, B, and C respectively.



(a) (b) (c)

Fig. 8: DBSCAN clustering results with reduce dimensionality by removing the unemployment rate parameter while visualizing. The DBSCAN was run with same parameters as in Fig 2. This visualization is intended to show the differing patterns between total, financial, and non-financial crime. Each of the clustering schemes show the same distribution of points from each time point within each cluster.



(a) (b) (c)

Fig. 9: Linear Regressions for all time (A), before COVID (B), and during/after COVID (C). Results from the regressions are superimposed on a two by two heatmap of the corresponding R-squared values.

that the vast majority of these crimes are financial, with over 350,000 of these crimes being financial ones.

As seen in all three of the DBSCAN clusters completed (fig 8), points from the pre-COVID time period are either in cluster 1 or 2, points from during COVID are in clusters 3 and 4, and points from after COVID return again to cluster 2. This is uniform in figure 8 A, B, and C.

DBSCAN clustering for each of the time periods allow us to see similarities between cluster fields from three different crime totals (total crime, financial crimes, and non-financial crimes). We observed that the clustering for financial crimes bore the most resemblance to the clustering from total crime. It can therefore be seen that Financial Crimes have much more influence over total crime amount figures than non-financial crimes do.

Finally, from Linear Regression, we can see how well the individual factors of unemployment and household income fit the crime amounts of the time periods we analyzed (total time period, pre-pandemic, and pandemic + post pandemic). The r-squared values of the total time period are relatively low, but household income as it relates to both financial and non-financial crimes is seen to have a higher r-squared value, and therefore relation.

When it comes to the pre-pandemic figures, financial crimes become much more predictable with Linear Regression based on our factors. With an unemployment r-squared of 0.973 and a household income r-squared of 0.953, the relation between these factors and financial crimes fits best when we consider our post-pandemic time period (2010 - 2018). Non-financial crimes from the same time period have much lower r-squared values, meaning at even this time, factors like unemployment and household income were poor indicators of non-financial crime amount.

In regards to the pandemic and post-pandemic time period, all r-squared values are too low to make any conclusions about the relation of factors like unemployment and household income to crime amounts, both financial and non-financial. Financial crimes become almost completely unpredictable by these metrics, with an unemployment r-squared of 0.174 and a household income of 0.579 for financial crimes. The non-financial crimes for household income seem a little bit better, coming in at a 0.710 r-squared, but with an abysmal 0.079 r-squared for unemployment as it relates to non-financial crime. With the sparsity in data after the pandemic, a higher r-squared cannot be seen as indicative of a trend. This is why even though the r-squared value of household income is relatively high in relation to non-financial crimes, it would be wrong to say that household income is a good predictor of non-financial crimes for the pandemic and post-pandemic time period.

We know, based on the r-squared values taken from different time periods, that before the pandemic, unemployment and household income were relatively good predictors of the amount of crime in New York State. During and after the pandemic however, these factors become almost useless when it comes to predicting how much crime there will be.

VII. DISCUSSION

We visualized preliminary data for the purpose of seeing initial trends in the data we collected. We expected to see crimes increase alongside a decrease in household income and an increase in the unemployment rate. What we saw instead was a major increase in crimes a year after the aforementioned increase in unemployment rate.

We thought we would see non-financial crime clusters have the most influence over total crime clustering, but contrary to our hypothesis, financial crimes had far more of an impact and were much more responsible for the overall shape of the clusters than the non-financial crimes were.

The main reason that clustering for total crime and financial crime look so similar is because of the sheer volume of financial crimes. This can be seen in fig 3, where total crime follows the same pattern as financial crime, whose overall numbers are far higher than those of non-financial crimes.

The clustering for total crime and financial crime do bear some differences, but just like the number of non-financial crimes relative to everything else, these differences are minute.

In this way, our initial hypothesis was rejected and Non-financial crimes do not drive overall crime during nor after the pandemic. We believe this is due to the under-reporting of non-financial crimes. Indeed, a city-level analysis across various U.S. cities, found inconsistent patterns in crime rates during the pandemic, with some areas experiencing increases and others remaining stable. Notably, the study highlighted the limitations of relying solely on official police data, pointing out the underreporting of certain offenses, such as intimate partner violence (IPV) [1].

Finally, for Linear Regression, we wanted the R-squared values to be as high as possible for every time period with the hopes to reveal a trend in the data. As R-squared values for pandemic and post-pandemic time periods were gathered however, it became clear that there would be no trend found for it.

The patterns we expected to see stemmed from our own assumptions about crime, unemployment, and household income, as well as our predispositions about how the pandemic affected these factors.

We wanted to find a clear trend between income and unemployment in relation to crime for every time period. We thought that this trend would be for crime to increase as the unemployment rate goes up and household income goes down.

The existence of COVID-19 regulations however, as well as severe nuance in regards to pandemic-related financial situations, has caused a lack of predictability with these factors in relation to each other.

One of the issues we found in the information-gathering phase was the lack of data after the pandemic. The pandemic and post-pandemic totals were taken by year, so the only years we have to work with are 2019 - 2022 for that time period. As a result, any trend that is found for that time period with Linear Regression can't be seen as reliable. If we

were to find data for each month, there could have been much more information gathered for each time period, and the Linear Regression lines found would be far more accurate.

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