How Different Lockdown Measures within the United States Have Affected the Economy since COVID-19

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***Abstract*—This report investigates the impact of COVID-19 lockdown policies on spending, and whether said policies impacted the economic recovery of a city. We chose to focus on New York City, New York, a state that enforced a mandatory lockdown, and Omaha, Nebraska, a state that did not issue any stay-at-home or complete lockdown orders. This report uses data from the Opportunity Insights data tracker, a non-partisan, not-for-profit organization located at Harvard University. In order to conduct this analysis, we created several time series plots and conducted t-tests using our chosen variables. We found that spending overall was significantly different in the two cities – spending in arts and entertainment decreased while grocery spending increased in New York City, and arts spending increased while grocery spending remained unaffected in Omaha. Our t-tests indicate a significant difference as well, with a p-value < 0.05. In conjunction, our t-tests and time series plots both suggest a rejection of the null hypothesis, thus, we conclude that lockdown policies have an impact on spending. However, due to our limiting factors (mainly the confounding variables which occur due to the differences in population, primary industry, and other aspects of the two cities), we are unable to concretely determine the exact impact lockdown policies have. Still, we believe our analysis could result in useful contributions regarding policy decisions, namely the impact that national disasters may have on spending and potential areas of impact to focus on.**

I. Introduction

A. Research Question

Was there a difference between how quickly a major city in a lockdown state vs a major city in a non-lockdown state "bounced-back" economically after the COVID-19 pandemic?

B. Background

The COVID-19 pandemic caused a rapid deceleration and decline of the American economy compared to pre-pandemic measures, resulting in rising unemployment rates as many families faced economic hardships and businesses struggled to stay afloat. The sharp contraction of economic activity created a need for economic policies addressing the current challenges and looking forward to rebuilding a post-COVID economy. As such, some states reacted by lifting lockdown restrictions (or never imposing them at all), while others waited to prioritize the health of their citizens and minimize transmission.

To break down and adequately answer our question, we chose to compare total spending, arts, entertainment, and recreation spending, and grocery and food store spending in New York City, New York vs Omaha, Nebraska. While choosing which cities to focus on through the lens of our research question, we looked at lockdown policies enacted at state-level. We chose New York City as an example of a city which thoroughly enforced lockdown procedure early into the pandemic, as Governor Cuomo issued a stay-at-home order (more specifically the "New York State on PAUSE" executive order [1]) to be implemented on March 22nd, with an earlier "State of Emergency" declaration being made on March 7th — only six days after the first case found in NYC. Conversely, Omaha, Nebraska did not declare an official stay-at-home order for the entire duration of the pandemic. The state implemented a cap on indoor crowds on March 16th (ten days after the first case), but some businesses (including bars) were allowed to reopen as early as June 1st, 2020 [2].

Looking at initial economic reports for both states, New York seems to have been hit harder by the pandemic and is taking longer to recover to pre-pandemic levels, with an unemployment rate of 21% in May 2020 and a slowly recovering tourism industry that was hit hard by sudden closures [3]. On the other hand, Omaha was impacted less severely, and its recovery seems much quicker, with growth in tourism and an influx of entertainment/nightlife activities [4]. When considering this question, we must also keep in mind the dif-

ferences in population and primary industry between these two cities. Still, we aim to address the gap in knowledge focused on how consumer spending in major cities is impacted by lockdown policies, especially when considering the epicenter of the outbreak against a less intense epidemic. In doing so, we hope to gain insight on how economic policies impact consumer behaviors in times of crisis, thus informing future policy decisions.

C. Data Description

There are 48706 observations in this data set, and 24 variables. In this project, we chose to use four variables:

- `cityid`
  - The city identifier that the county is assigned to.
  - We further isolated cities with IDs 2 (New York City) and 40 (Omaha).
- `spend_all`
  - The spending done in all spending categories by people residing in the city (based on zip code of residence not based on zip code of purchase).
  - This is measured in the percent change in spending in comparison to the index period of January 6, 2020 – February 2, 2020.
- `spend_aer`
  - Spending done in arts, entertainment, and recreation.
  - This is measured in the percent change in spending in comparison to the index period of January 6, 2020 – February 2, 2020.
- `spend_grf`
  - Spending done in grocery and food stores.
  - This is measured in the percent change in spending in comparison to the index period of January 6, 2020 – February 2, 2020.

This data is pulled from the Opportunity Insights [5] data tracker, a non-partisan, not-for-profit organization located at Harvard University, and credit/debit card spending data from Affinity Solutions [6].

II. Analysis

A. Exploratory Data Analysis

The purpose of our exploratory data analysis is to get an initial look into the change in spending of people residing in New York and Omaha compared to the pre-COVID index period defined above. In order to get insight into this, we must create some plots. Through these plots, we can get an expectation of the results our statistical testing should provide. We can also check our data to make sure that it satisfies the conditions necessary to run the statistical tests that we want to use for our analysis.

For total spending (`spend_all`) and entertainment spending (`spend_aer`), normality conditions for the t-test failed [Fig. 1]. Food spending (`spend_grf`) followed an approximately normal distribution. However, due to the abundance of data that we have, we feel confident that a t-test is still the most suitable to analyze our data and produce relevant results.

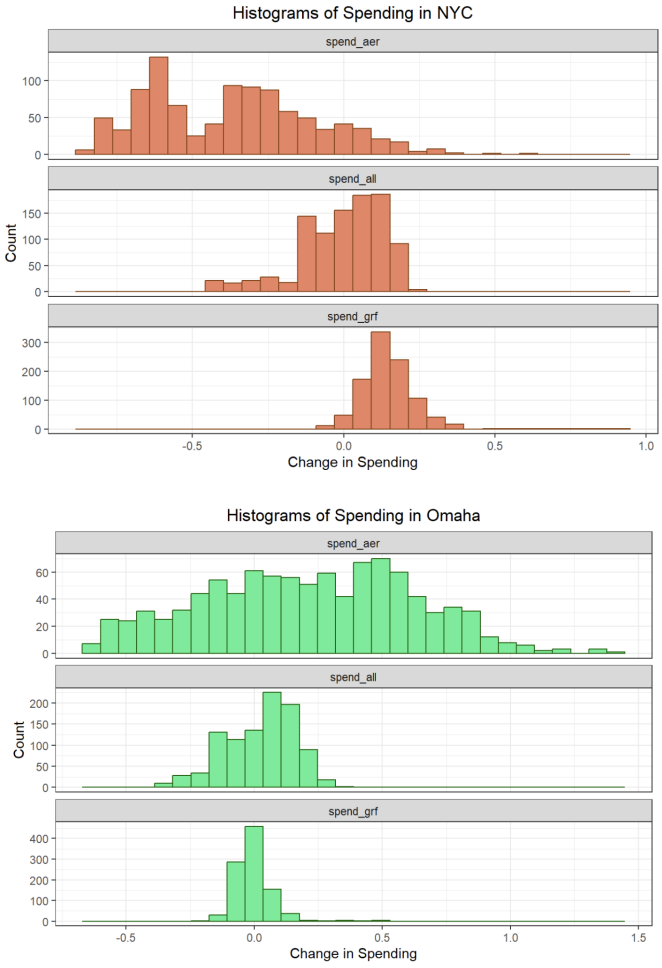

Fig. 1. Histograms of percent change in spending categories compared to the index period.

Based on these plots, we see that the median percent change in resident spending does not appear to differ as much between categories for Omaha compared to New York [Fig. 2]. Interestingly enough, however, none of the spending categories for either city have a negative median percent change in spending, except for New York's change in `spend_aer`. This percent change is noticeably larger than the rest of the spending categories for New York. Based on these boxplots, we would expect the difference between mean spending in New York City and Omaha in these spending categories to be non-zero.

B. Methods

In order to answer our research question regarding the difference in how quickly a major city in a lockdown state vs a major city in a non-lockdown state "bounced-back" economically after the COVID-19 pandemic, we chose to use a dataset from Opportunity Insights. Opportunity Insights is a team of researchers at Harvard University that share data and research in the hopes of improving economic mobility and opportunity in the United States. The particular dataset

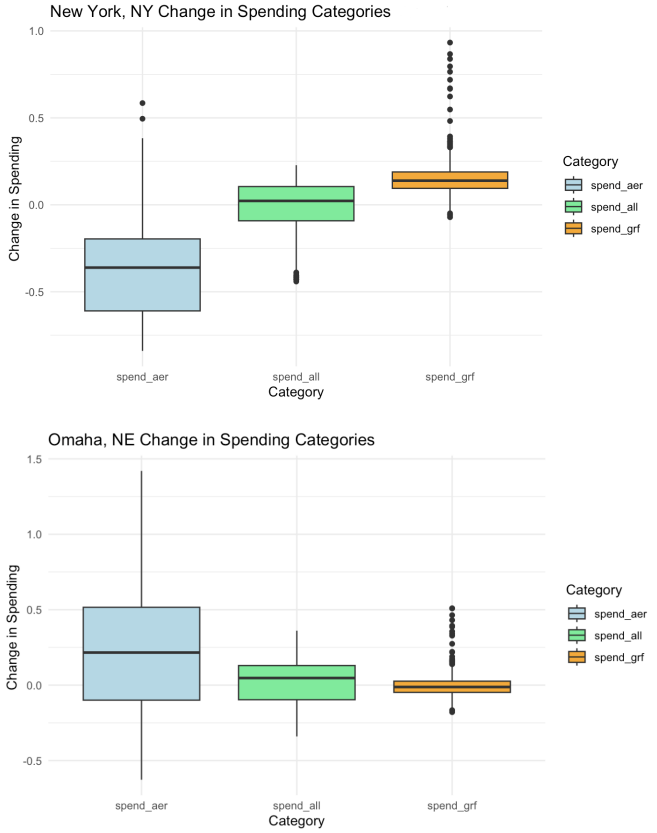

Fig. 2. Boxplots of percent change in spending categories compared to the index period.

we selected came from a collection of datasets Opportunity Insights has regarding the economic impact of the COVID-19 Pandemic. In particular, our dataset is concerned with consumer spending data in different US cities. This spending data was sourced from Affinity Solutions, a company that receives daily credit and debit spending information that they then improve upon by pairing it with geographic and demographic information.

In order to answer our research question, we began by selecting the two cities we hoped to investigate. We selected New York City as one of our cities as it is both the most populated city in the United States and a major city that had a fairly restrictive COVID-19 policy. For our second city, we chose Omaha, Nebraska, as Nebraska never issued a stay-at-home order.

The dataset we selected contains data on the change in spending relative to an index period of January 6, 2020, to February 2, 2020. This is spending data sorted into different spending categories ranging from January 2020 - June 2024 with daily observations until June 5, 2022, after which it is a 7-day lookback moving average. The spending categories are determined by Affinity Solution's grouping merchant codes that indicate the category of both the merchant and merchant activity. The location of the spending is based on the zip code where the consumer lives (not necessarily where the purchase transpired).

We decided to look at three spending categories: spending in all categories, spending in arts, recreation, and entertainment, and spending in grocery and food stores. We chose to investigate spending in all categories to give us an idea on how spending changed in each city in a general sense. We also wanted to investigate spending in arts/recreation since this could help to show how COVID-19 affected spending in social settings on inessential yet enjoyable purposes, a spending category we expect would see significant drops as more and more people stayed at home in lockdown states, yet one that may not see much difference in non-lockdown states. Finally, we chose to look at grocery and food store spending since the sense of emergency at the beginning of the pandemic heavily impacted grocery shopping behavior in some states, so this category could be helpful in determining when a sense of a return to normalcy occurred in different states.

To answer our research question based on this data, we decided to use a paired t-test. The paired t-test compares the change in spending in each spending category across the two cities. This is to see if the mean difference in change in spending relative to the index period is zero or nonzero between the two cities. We compared the change in spending on each day across cities. If the mean difference in spending is zero, this indicates that over this span of time, the change in spending in New York City and Omaha compared to the index period is the same. We chose a paired t-test since we wanted to compare the difference in spending in the two cities (in which case a t-test is applicable as we are investigating a difference in means). Since the observations in each city are independent, a paired t-test was most appropriate.

In addition to our t-tests, we performed exploratory data analysis to determine the spread of the spending data as well as to see if normalcy conditions were satisfied. We also created time series displays in order to visualize how spending changed in each of the three spending categories over the course of the pandemic in each city.

Some limitations we encountered were that using a t-test could make it difficult to see seasonal economic trends in our results. Additionally, the use of a paired t-test gives us the ability to see if on each day the change in spending relative to the index period is different between the two cities. However, since a paired t-test uses the mean difference between observations, this may make it difficult to see if there are certain periods where the difference in change in spending is drastically different or relatively similar in the two cities (the results are reflective if on average the change is spending is different over the course of the entirety of the time period).

C. Results

Our paired t-tests and time series plots indicate that there is a difference in the change in spending relative to the index period across the two cities [Table I].

Since all p-values are less than 0.05, we reject the null hypothesis that there is no difference between mean change in spending in New York City and Omaha in all categories,

Category	T-Statistic	DoF	P-value
All	-20.561	980	$< 2.2 \times 10^{-16}$
Art, Ent, & Rec	-65.707	980	$< 2.2 \times 10^{-16}$
Groc. & Food	73.92	980	$< 2.2 \times 10^{-16}$

Category	95% C.I.	Mean Diff.
All	$(-0.030, -0.025)$	-0.02755
Art, Ent, & Rec	$(-0.598, -0.563)$	-0.5804
Groc. & Food	$(0.150, 0.159)$	0.1544

TABLE I
PAIRED T-TEST RESULTS OF SPENDING IN NEW YORK CITY COMPARED TO OMAHA.

arts, entertainment, and recreation spending, and in grocery and food store spending. There is sufficient evidence that over the course of the pandemic, on average, the change in spending relative to the index period in these different categories differs between New York City and Omaha. The mean difference of each of the t-tests indicates that there is a larger difference in change in spending in art, entertainment, and recreation and grocery and food store spending between the two cities than there is in overall spending, however, the p-values indicate that the difference in average change in spending is noteworthy in all three categories. This larger difference between the two cities within the more specific spending categories is also reflected in the time series we ran.

We next plotted time series graphs of spending changes in each city from 2020 to 2024 [Fig. 3]. Generally, we see that the changes in combined spending follow nearly identical trends for New York City compared to Omaha. However, changes in arts and entertainment seemed to differ between the two cities. For New York City, changes in spending seemed to follow a more negative trend compared to Omaha, which has positive changes in arts and entertainment spending starting much earlier than New York City. For grocery spending, we saw a reversed trend, where changes in grocery spending in Omaha generally remained unaffected while grocery spending increased in New York City. Generally, we see that arts and entertainment spending decreased while grocery spending increased in New York City, while arts spending increased and grocery spending was unaffected in Omaha. Overall, the gap between the time series of the two cities further reflect that the change in spending (while following similar trends in terms of where fluctuations are located), is different across the two cities.

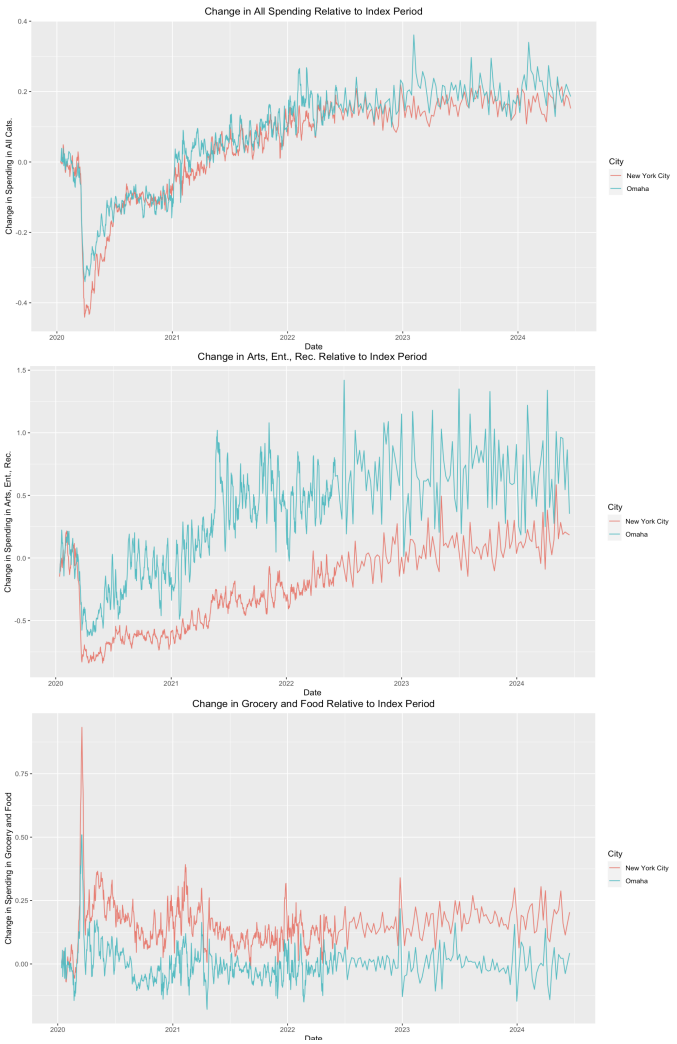

Fig. 3. Time Series plots of spending in New York City compared to Omaha.

III. CONCLUSION

A. Summary

Based on the results of our t-tests and time series graphs, there is a significant difference in change in spending relative to the index period between Omaha, Nebraska and New York City, New York. In terms of our research question, this indicates that there was at minimum a difference in the amounts of change in spending in comparison to the index period across the two cities. Thus, while we can not conclusively assert which city "bounced-back" faster (an already subjective term), there is evidence that the rate at which the cities returned to normalcy in terms of spending was different (otherwise we would expect to see no gaps between the time series as well as no difference in the average change in spending). In short, our results indicate that there was a difference between how quickly a major city in a lockdown state vs a major city in a non-lockdown state "bounced-back" economically after the COVID-19 pandemic.

Regarding real-world impact, we believe that this study provides valuable information for policymakers to consider when developing economic policy for crisis scenarios. While we are unable to provide a concrete answer as to which city "bounced back" the fastest, our study provides information regarding specific industries (one being a necessity, the other an amenity), as well as the assurance that there is a significant difference between these cities. We believe this information is useful for economic relief efforts, highlighting which industries may need greater focus. Furthermore, this information suggests that cities with stricter policies may need greater economic support when compared to those with fewer restrictions. Overall, this analysis ensures that economic policies regarding

crises are able to be proactive when mitigating economic instability.

B. Limitations

Aside from the limitations referenced in our methods sections, our key limitation occurs in substantial differences between the cities we chose. A clearer understanding of the issue at hand can be achieved using data from more similar cities. While the two cities chosen here fit the criteria set (lockdown vs non-lockdown), there are other socio-cultural factors at play that influence spending in both cities. Furthermore, one must consider the impact of New York City being the epicenter of the pandemic in the United States, and therefore being hit harder than Omaha, which was not an extreme hotspot in the same manner.

C. Recommendations

In further investigation, we would suggest the comparison of two cities more alike in population or industry in order to have a more balanced analysis with fewer confounding factors. Furthermore, we would consider exploring a more robust method of analysis, possibly using linear models to determine whether COVID-19 lockdowns were a significant factor in spending increases or decreases.

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