

Team 1

1. Background & Motivation

The last few years have shaken up how businesses operate. Small, independent businesses are the most vulnerable to instability; their needs can be overshadowed by the wants and needs of their much bigger competitors. In this project, we will investigate the current situation of small businesses within city District 4 of Boston and determine the factors that attract them to the area. We hope by doing this project, we can strengthen and build new opportunities for the communities in District 4. We also hope to provide helpful insights so that the challenges of small businesses can be solved decisively and illustrate where they are succeeding, so that success can be further extended. To gain a better understanding of this project, we had to understand the current landscape of District 4, which included identifying and analyzing the issues small businesses face.

2. Definitions and Data Collection

Because there is no clear measurable definition of some key concepts, we give some quantitative definition of some of them according to some research. We define small businesses as “companies that have less than 25 employees.” We also defined overrepresented as industries with a 25% increase in the business count by industries compared to other districts. We decided on less than 25 employees for the small business definition because that limit captured most businesses within the data and also excluded huge companies with multiple branches, after skimming through the data. While we were worried that business chains and franchises would influence our data through their inclusion in this definition, we concluded that the difference made would be negligible due to the fact that with so few employees each of these businesses

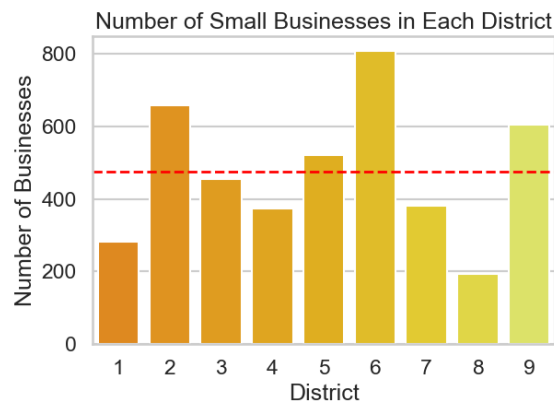
were operated and ran very similarly to small businesses. We were also cautious about the bias that would be introduced if we chose to cherry-pick which businesses to remove from our data in order to clean it. Over 90% of the businesses we considered had under 25 employees. As for the definition of over-representation, we were severely limited by the data and simply chose it because it was enough of a separator value when we compared to other districts and looked at Boston overall.

This report contains two major parts: the base project and the extension project. The base project is where we analyze the given district shape file and Boston Planning and Development Agency (BPDA) business listings to understand the current situation small businesses in District 4 face. We would focus on answering these two questions: “What businesses are over-represented in District 4” and “How are businesses doing based on foot traffic.” On the other hand, the extension project aspect of the report is where we expand on the analysis of small businesses based on our self-defined topic. We would look into the impact of Covid-19 on small businesses and the government support on small businesses in District4 to help them overcome Covid-19.

3. What Businesses are Over-Represented

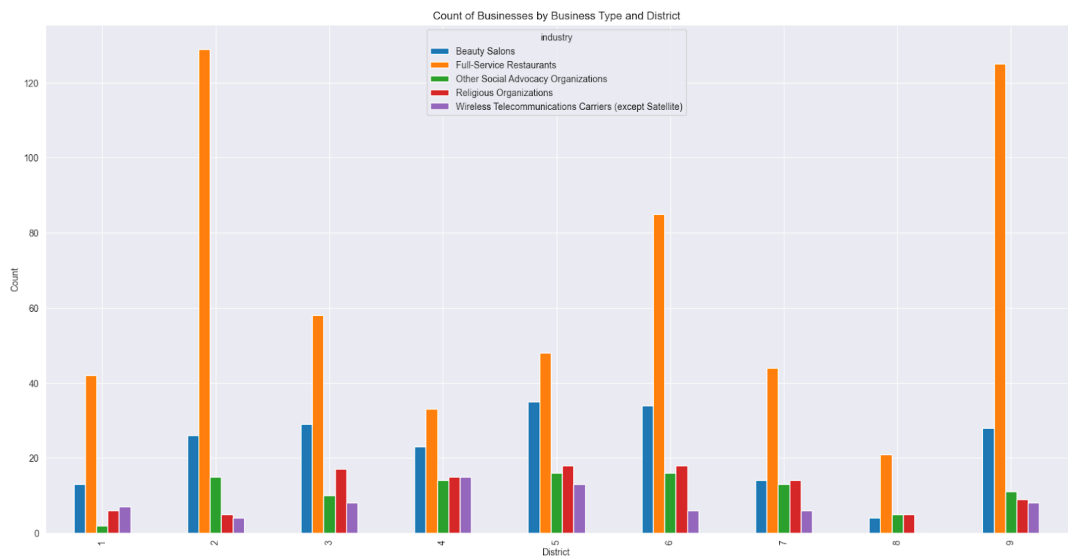
There was a fair amount of work in terms of exploring the data and defining terms and building accurate interpretations when answering the question: “What businesses are over-represented in District 4”. One of the first problems we encountered was an appropriate definition of a small business? Although the federal government interpreted small business as a business with less than 500 employees, this definition did not help us come to a definable conclusion or solution. We defined a small business as a business that employed less than 25

employees. Even with this definition, we are unsure if it helps us truly understand the landscape of businesses in District 4. We do not believe that employee count should be the only factor involved, however, given the limitations of the data, this was the best factor we had. Once we processed our data to only include businesses that fit the small business definition, we had to determine which district each business was within. Once we were able to separate the businesses into their respective districts, it was time to see how District 4 fared. We grappled extensively with how we should compare District 4 to other districts. Although each district had a relatively similar population, they varied drastically in business count, which would surely impact our interpretations. Moreover, was it fair to expect districts to have similar amounts of different business types? We decided to limit our exploration to the districts with similar business counts. We compared District 4 to Districts 3, 5, and 7.

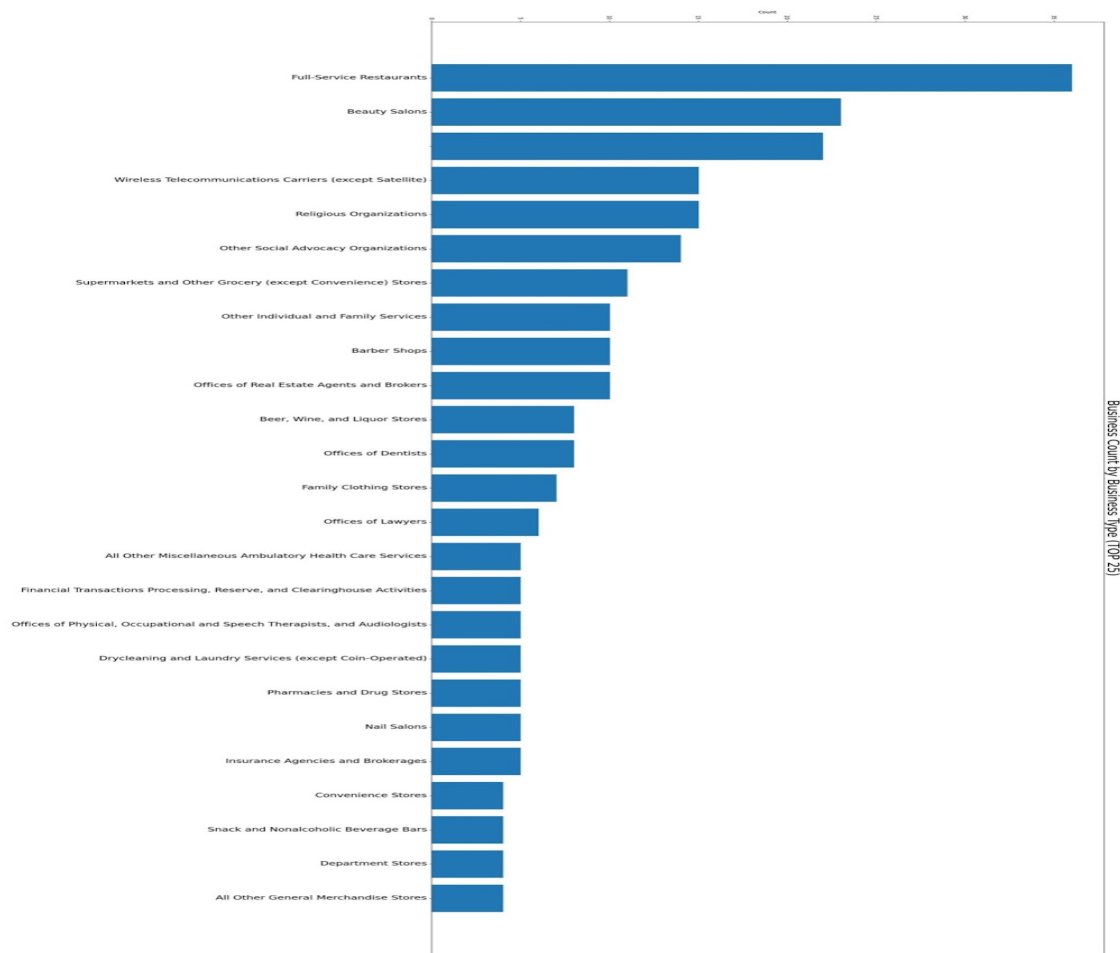


We found that the most prevalent businesses in District 4 were beauty salons, full-service restaurants, religious organizations, other social advocacy organizations, and wireless telecommunications carriers (excluding satellite). Compared to Districts 3, 5, and 7, District 4 had the lowest representation of full service restaurants, the highest representation of wireless telecommunications carriers (excluding satellite), it had approximately the same amount of religious organizations, which means it had a higher representation of them, due to the fact that

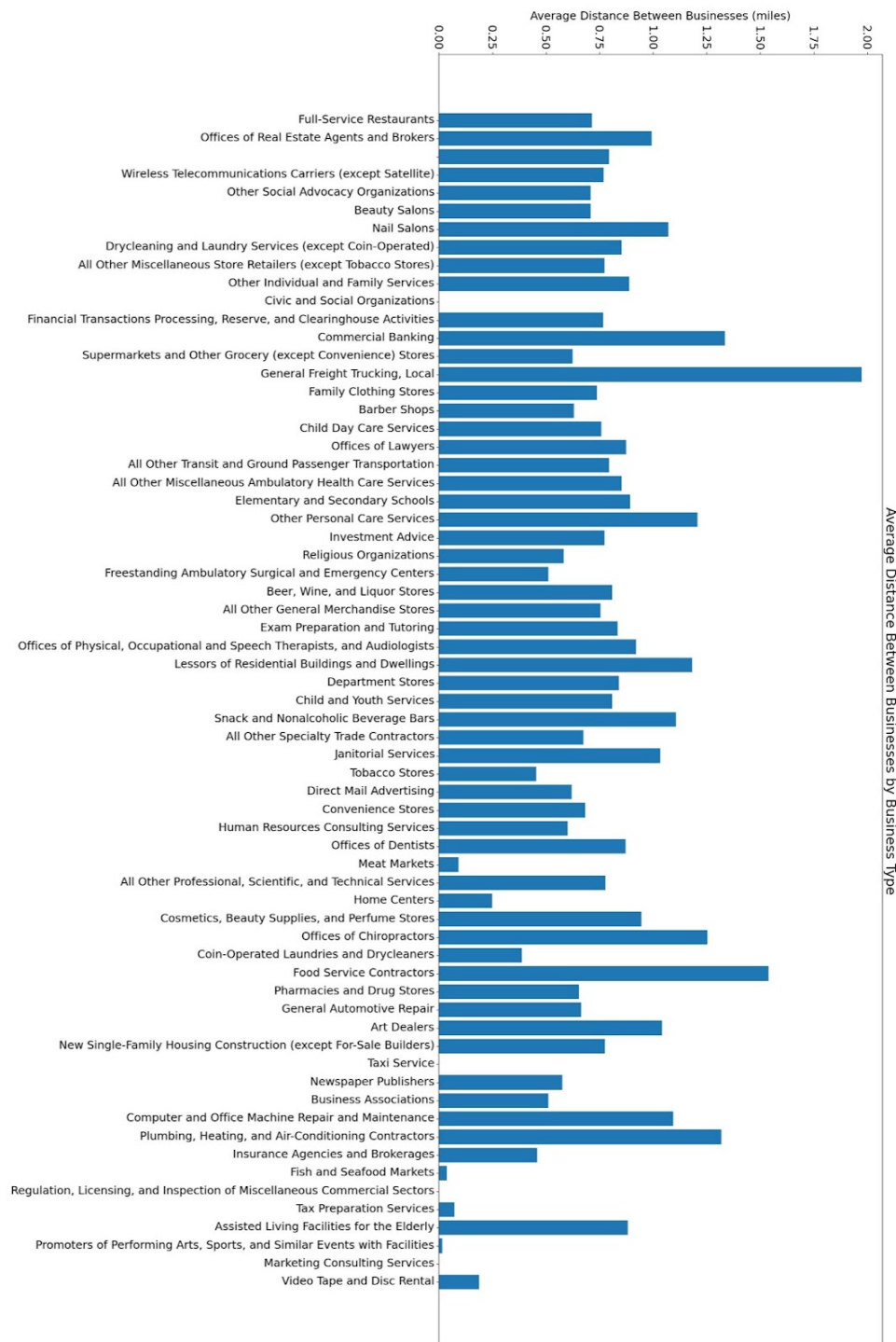
there were in general less businesses in District 4 compared to districts 3, 5, and 7. Finally, the representation of beauty salons and other social advocacy organizations is in line with the other districts so they are fairly represented.



We offer a visual of the 25 most common business types within District 4:



If we look at business representation from the perspective of how close businesses of the same type are in comparison to each other, within District 4 we can see that businesses tend to exist within .75 miles of another business of the same type. Since this is the range of most businesses, we will say that business types outside of this range are either over-represented if they are closer, or under-represented if they are farther. This definition may be too much of a blanket statement and with more data, we may be able to reach better conclusions with better definitions. Moving forward with this definition, it is best to interpret this definition through the lens of a consumer of these business types. For example, commercial banking businesses are on average 1.25 miles away from each other. This may mean that there is not a suitable market for more commercial banking businesses within District 4.



In conclusion, a few insights we can offer through this definition are the following: under-represented business types in District 4 can be categorized into three groups: niche businesses, retail businesses, and commercial businesses. Niche businesses, like offices of notaries, refrigerated warehouses, and software publishers. These businesses are not that common because while they are important, they are not as frequently utilized and so the market of supply remains low. The retail businesses are a shocking category considering how residential District 4 is. We would have expected that jewelry stores, electronics stores, and shoe stores have higher representation in District 4 but it is not the case. Maybe day-to-day consumers are shopping in Districts with more overall businesses due to the convenience of finding everything you need in one central location. Finally, the commercial businesses category is extremely important to helping us understand the problems with businesses in District 4. There is an under-representation of businesses like commercial banking, janitorial services, and food service contractors. This is a problem because commercial businesses that serve the general public rely on these services—if businesses have to go through more trouble to find businesses that can help make them successful, they will be less encouraged to operate within District 4. This is an even bigger problem for small businesses that typically have smaller management teams to operate every aspect of the business. Unfortunately, this is a destructive loop: if businesses aimed at other businesses do not exist or are harder to come by, less businesses will choose to operate in District 4, de-incentivizing the businesses aimed at other businesses from operating within District 4 as well.

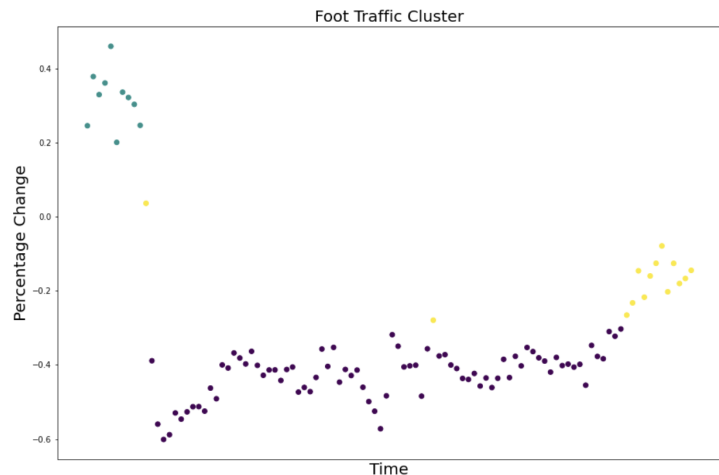
4. Foot Traffic Analysis

The data of foot traffic comes from BPDA dataset, which each file presents the percentage change of the foot traffic compared to last week in each main street in the Boston area. To analyze the foot traffic in District 4, the file corresponds to the mainstreets in district 4 selected and combined, and using the mean of all mainstreets to represent the foot traffic in district 4 as a whole.

For visualization, the following bar chart shows the monthly percentage change of the foot traffic in district 4. In this graph, it is observed that there is an enormous decrease in foot traffic, and the foot traffic has been negative for more than two years, which indicates that the foot traffic has kept decreasing.



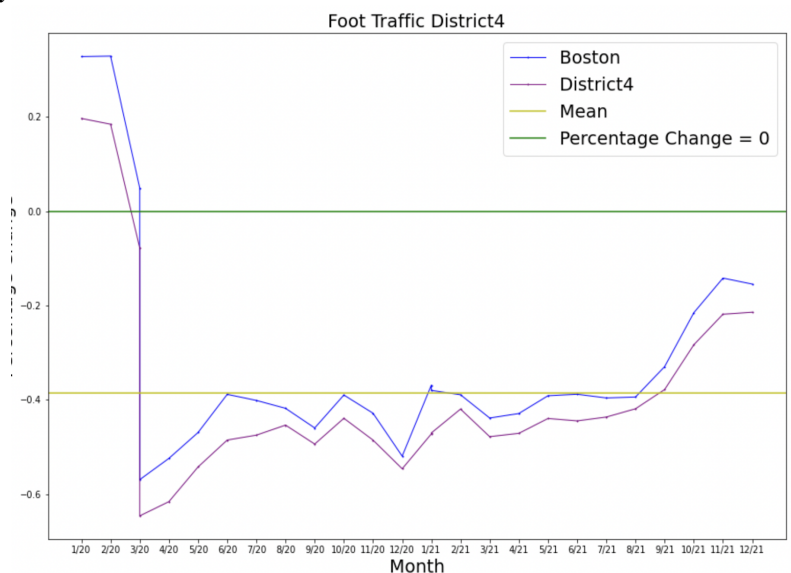
To further identify the trend of foot traffic and what happened to the small businesses, elbow method is used and it is suggested that there are mainly three big clusters of foot traffic, and the data is clustered using KMeans clustering. The clustering result is visualized as follows. This clustering



result points out three stages of foot traffic from 2020 till now, which can be explained by Covid-19, and this result also gives a view of how small businesses are doing during Covid-19.

In the graph, three stages are identified. The first stage is before March 2020, which is the stage before Covid-19, a positive trend is shown in this stage as the percentage change of foot traffic is always positive, which indicates the increase in foot traffic. However, after March 2020, the second stage comes, which corresponds to the beginning of Covid-19. At this stage, as shown on the graph, there is an immediate and enormous decrease in foot traffic, and this shows the huge negative impacts Covid-19 has brought to small businesses. During this stage, there is slight change in the percentage change on foot traffic, and the foot traffic remains negative, which shows the foot traffic keeps decreasing. After August 2021, the third stage comes, which is the recovery stage. In this stage, the foot traffic keeps decreasing, but at a slower rate as the percentage change is approaching zero. However, it is still far away from the foot traffic before Covid, and the speed of recovery is relatively slow. through online platforms.

After analyzing the foot traffic data of the whole boston area as shown on the graph, it is shown that not only District 4 but also the other districts in Boston is under negative impact of Covid-19, and District 4 is following the same trend with Boston Area. However, the foot traffic of District 4 is 14.37% behind the average of the whole Boston area, so the foot traffic of small businesses of district 4 can also be improved through other aspects.



The foot traffic data shows the huge impact of Covid to the foot traffic, however, the decreasing foot traffic does not completely mean the recovery progress is far behind, because during Covid-19, some businesses were not able to survive due to the pandemic, while some of them might changes their way of providing services, for example, they might go virtual or hybrid, as they might provide their services. So within the extension project, the impact of covid on small businesses in district 4 would be further analyzed by looking at different perspectives other than the foot traffic.

5. Limitations

Lack of data is the major limitation. For example, for the data on foot traffic, the data starts only after January 2020, and is not updated to the last. Therefore, we are not able to look at the foot traffic before covid, and not able to analyze focusing on other aspects other than Covid-19. Since there is no long-term data about the foot traffic before Covid-19, we assume Covid-19 has a major responsibility for the change in foot traffic.

Also, there is no clear definition of some key concepts like small businesses and overrepresentation, so we could only give our own definition, and this might lead to some confusion and our result might include a slightly personal perspective because this is the definition we choose.

6. Extension Project

Extension Pitch

We want to look at Covid-19's impact on small businesses. It is related to our analysis of foot traffic of the small businesses. This extension project would help us understand how they strive for their businesses and how they are doing now.

Rationale

By looking at how small businesses go through the pandemic, we can learn how they grasp customers and what methods of government support actually helped them.

Questions for Analysis

To what extent does government support help small businesses from Covid-19?

To what extent are small businesses being affected by Covid-19?

Data Sets & Sources

- List of Boston businesses receiving support from Small Business Relief Fund
- Tracking PPP: Search Every Company Approved for Federal Loans - ProPublica
- USAPENDING website
- BPDA datasets
- COVID-19 Economic Impact Research
- List of Boston businesses receiving support from Small Business Relief Fund

Description

Through exploring the base project, we believe Covid-19 plays a huge role in the negative foot traffic of small businesses in District 4. Therefore, we want to know how much Covid-19 support the government provides to small businesses in District 4 to help them overcome the pandemic. We would also like to know how small businesses in District 4 survived the negative impact of Covid-19. By finding the answers to these questions, we can understand the relative government support, which may not only further support the existing businesses, but also attract new businesses to District 4, and evaluate how much support the small businesses need to overcome the impact of the pandemic.

7. Extension Project

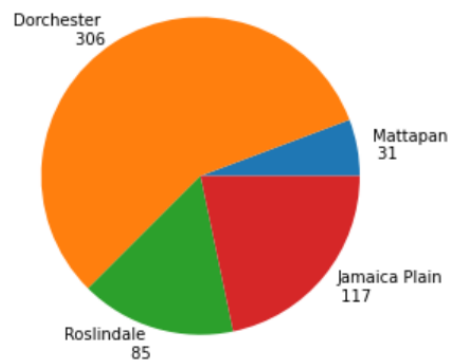
In order to answer the question of to what extent the government supports small businesses from COVID, the government spending would first be analyzed. After Covid-19 starts, the small businesses are under huge negative impact, so the government provides Covid-19 support and related resources to small businesses, including Covid-19 recovery funds by Boston Local Development Corporation (BLDC), Pandemic Unemployment Assistance (PUA), etc.

Small Business Relief Fund

The small business relief fund is provided to small businesses from 2020 till now. This refund is provided to the industries including food service and production, house cleaners and funeral homes, etc.

Using the dataset provided by the City of Boston, after filtering out all the small businesses that received this fund, it is shown that there are in total 539 small businesses that received this fund. The data of each neighborhood is visualized. It is shown that, within district 4, more than half of the small businesses that receive this fund come from Dorchester, which is 306, and then Jamaica Plain that includes 117 small businesses, and Mattapan has the least amount of small businesses that receives the fund. Therefore, within district 4, Dorchester is the neighborhood that receives the most amount of funds.

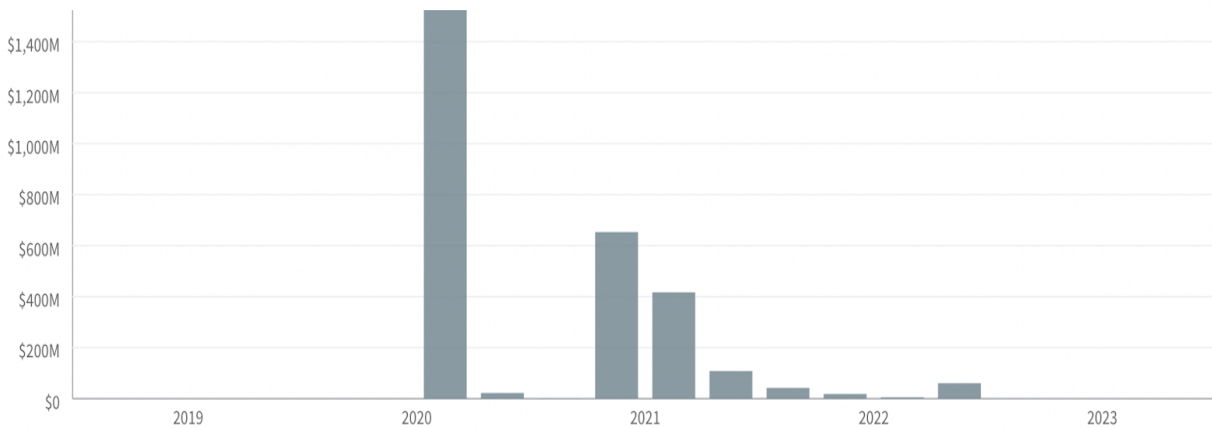
Number of Small Businesses Recieved Small Business Relief Fund



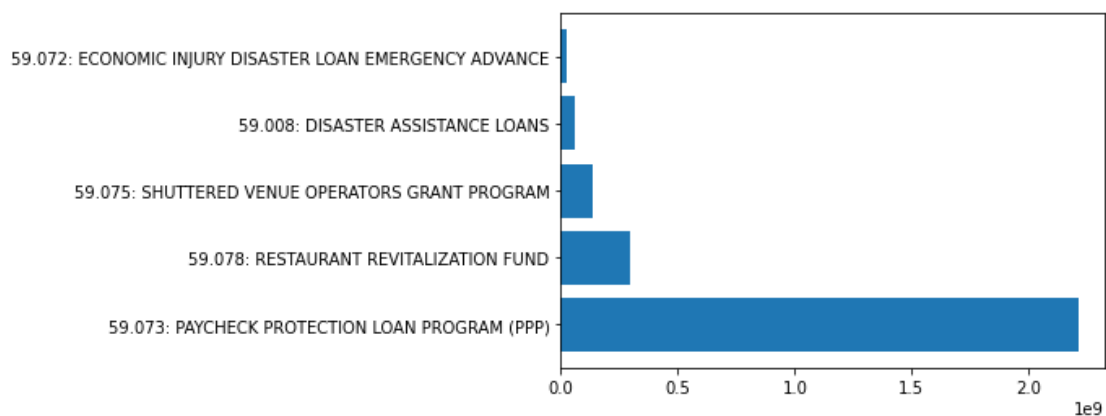
CFDA Programs

Alongside the small businesses relief fund, we collected data on all Covid-19 CFDA programs of small businesses in District 4. The graph below shows the amount of spending corresponding to time. We can see that the beginning of 2020, which is just after Covid-19 starts, the highest amount of government support is given to small businesses on Covid-19. The start of 2021 is another peak of government support, this might be because the government spending is offered to small businesses by year. After 2020, the amount of government support on covid to small businesses has decreased year by year, and there is little government support on Covid-19 right now. Basically the total amount of government spending on covid-19 small business

programs in district 4 is following the development and the stages of covid-19.

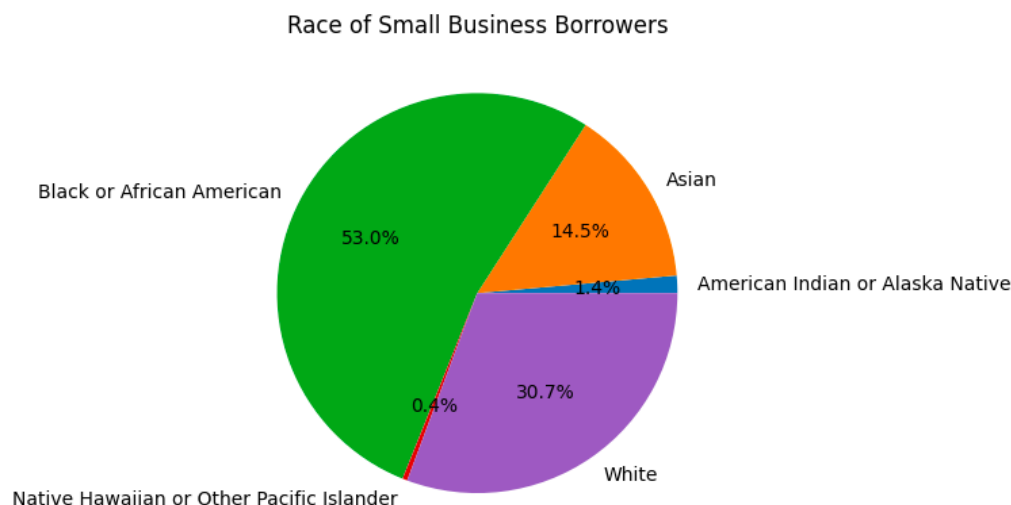


Among all the CFDA programs, we noticed that the most amount of Covid-19 spending on small businesses in district 4 comes from the Paycheck Protection Program (PPP), which provides \$2,215,133,519 to the small businesses in district 4 for covid-19 support. Then is the Restaurant Revitalization Fund, which provides only to restaurants, and it provides \$298,348,511 to restaurants in district 4. Since PPP is the program that provides the most support, then some further analysis is done to analyze PPP.



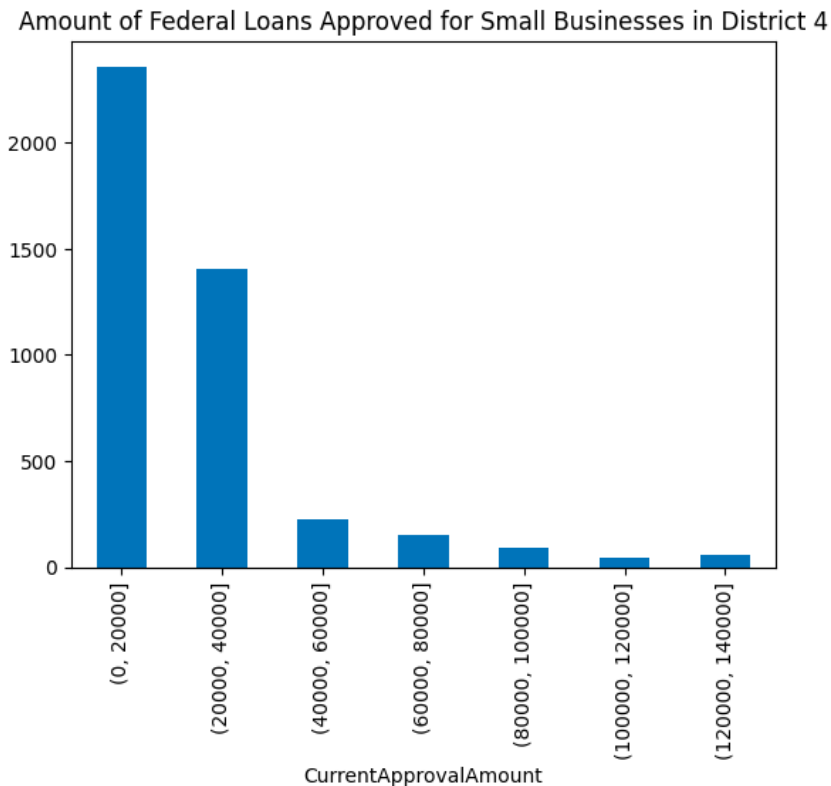
Paycheck Protection Program (PPP)

PPP is a loan program provided by SBA for small businesses to keep their workforce employed during the Covid-19 crisis that ended on May 31, 2021. Not only the loan can be used to pay for payroll costs, mortgage interest, rent, utilities and more expenses, SBA even forgives loans if all employee retention criteria are met. There are two types of PPP loan, one is the first draw (PPP) and the second is the second draw (PPS). First, we collected PPP loan data from the SBA website and filtered out the businesses in District 4. There were 3,684 businesses that received PPP and 674 businesses that received PPS. In terms of the race of the business borrower, 77.2% of them chose not to indicate their race. Amongst the 22.8% of those that did indicate, more than half were Black or African American. 30.7% indicated themselves as White, and the remaining consists of Asians, American Indian or Alaska Native, and Native Hawaiian or other Pacific Islander.



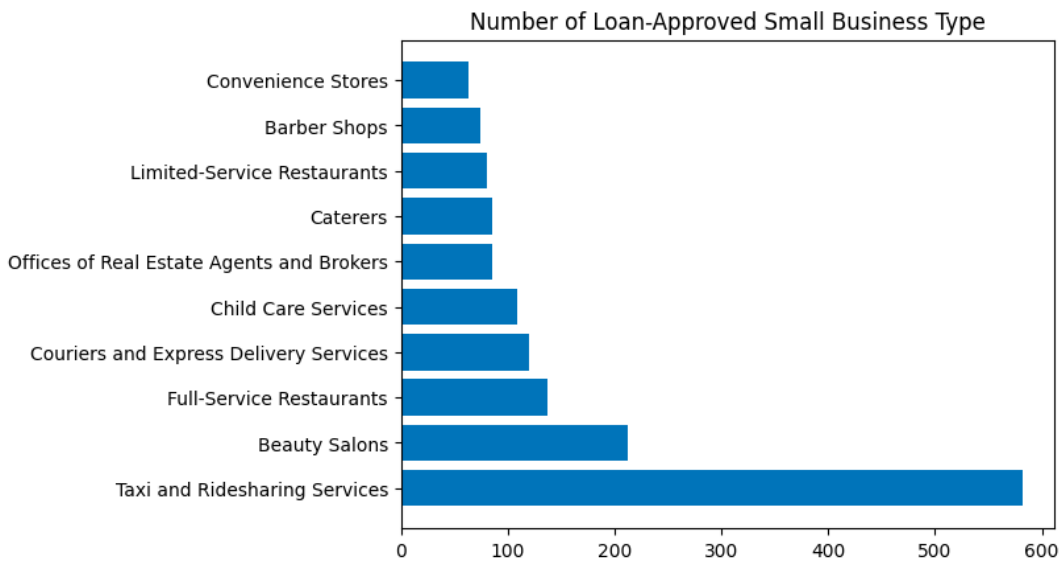
Next, we analyzed the amount of loans approved by SBA for each small business. 2,358 businesses received a loan from 0 to 20,000 dollars, 1,403 businesses received a loan from

20,000 to 40,000 dollars, 226 businesses received a loan in the range of 40,000 to 60,000 dollars, 151 businesses received a loan between 60,000 to 80,000 dollars, 91 businesses received a loan between 80,000 to 100,000 dollars, 44 received a loan between 100,000 to 120,000 dollars, and 59 businesses received a loan between 120,000 to 140,000 dollars. This resulted in a total of 102,352,996 dollars of financial support provided by the federal government.

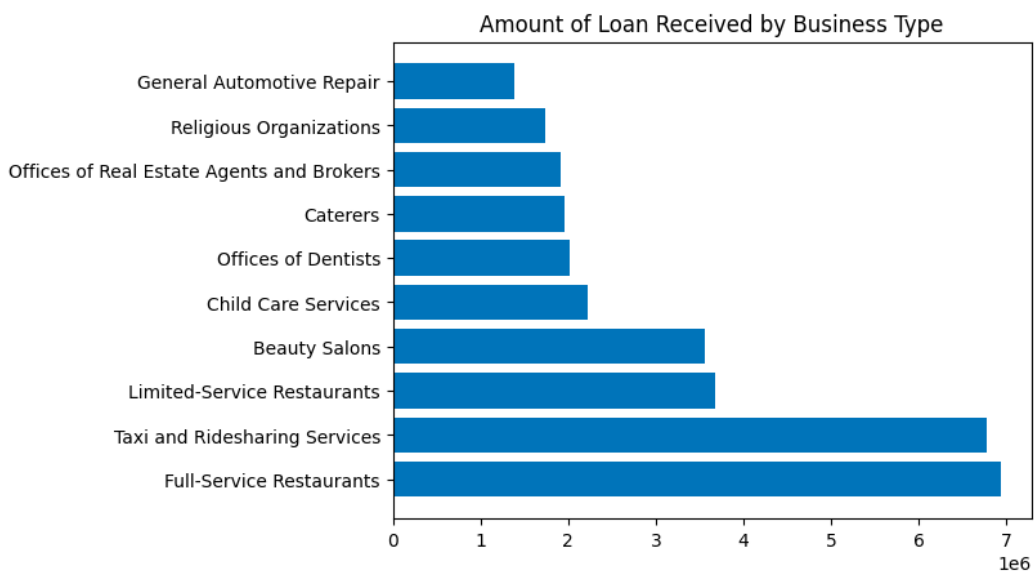


The next aspect of the PPP data we analyzed was the business type of small businesses receiving loans. We summed up the business types according to the provided NAICS 6-digit code and displayed the 10 most common types. Nearly 600 loans were approved for taxi and ridesharing services. 213 loans were approved for beauty salons, and the remaining common business types were full-service restaurants, couriers and express delivery services, child care services, offices of real estate agents and brokers, caterers, limited-service restaurants, barber shops, and convenience stores. Some of these business types, such as full-service restaurants and

beauty salons, match with the common business types found in District 4 in our base project analysis.

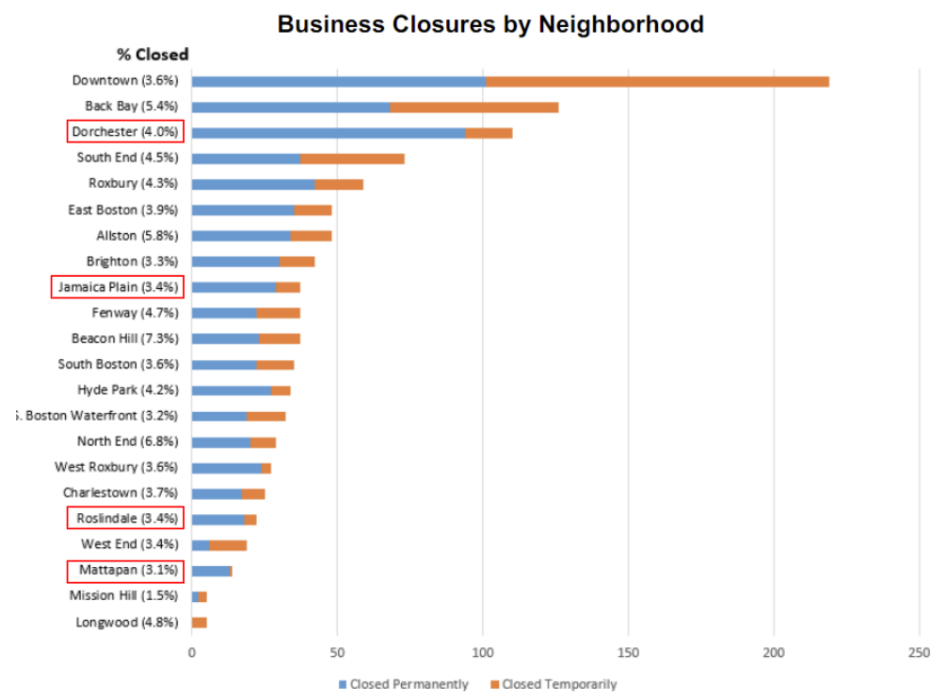


In addition, we also looked into the amount of loan received by business type. Full-service restaurants, though not the business type with the most number of loan-approved companies, received the most amount of loan, which was \$6,936,599 in total. This corresponds to our analysis where full-service restaurants are overrepresented in District 4.



In conclusion, after analyzing different programs of government support on small businesses in district 4, it turns out that the government spending is relatively evenly distributed compared to the number of businesses in each business type. The restaurants, both limited-service restaurants and full-services restaurants, which is the type of business that we considered as most overrepresented in the base project, have received the most support. Also, compared to other neighborhoods in district 4, Dorchester has received the most amount of support.

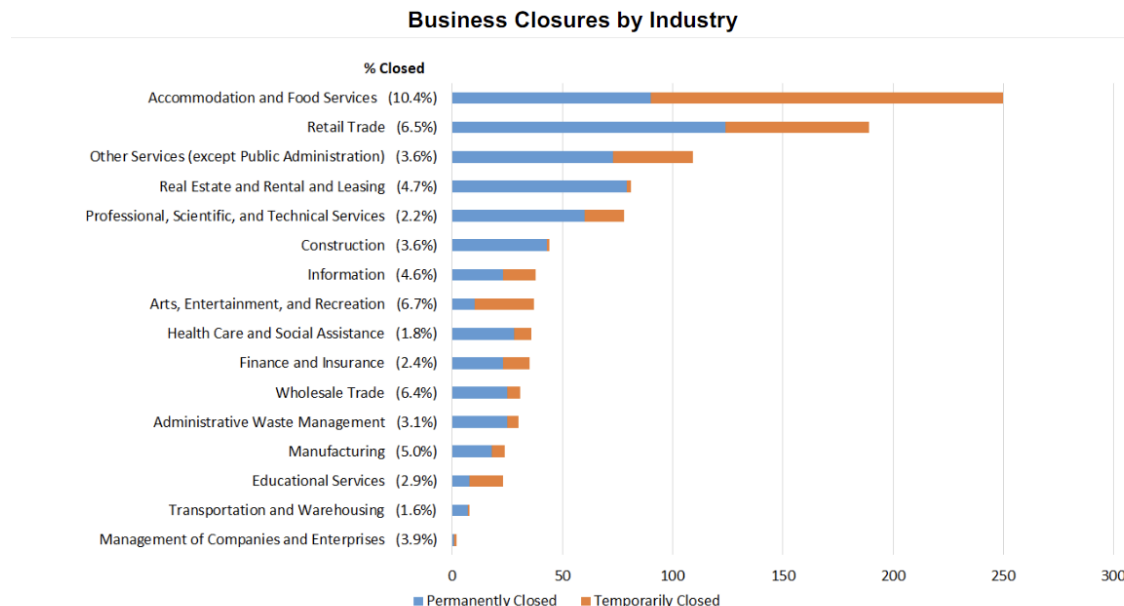
Small Businesses Closures:



Approximately 1,300 Boston businesses (4%) closed in 2020. Compared to Boston as a whole, the business close rate of all neighborhoods within District 4 are all lower than the

average. Roslindale and Mattapan are the ones that are being least impacted, and Dorchester has the highest close rate, which is 4%, same as the average of the whole Boston area.

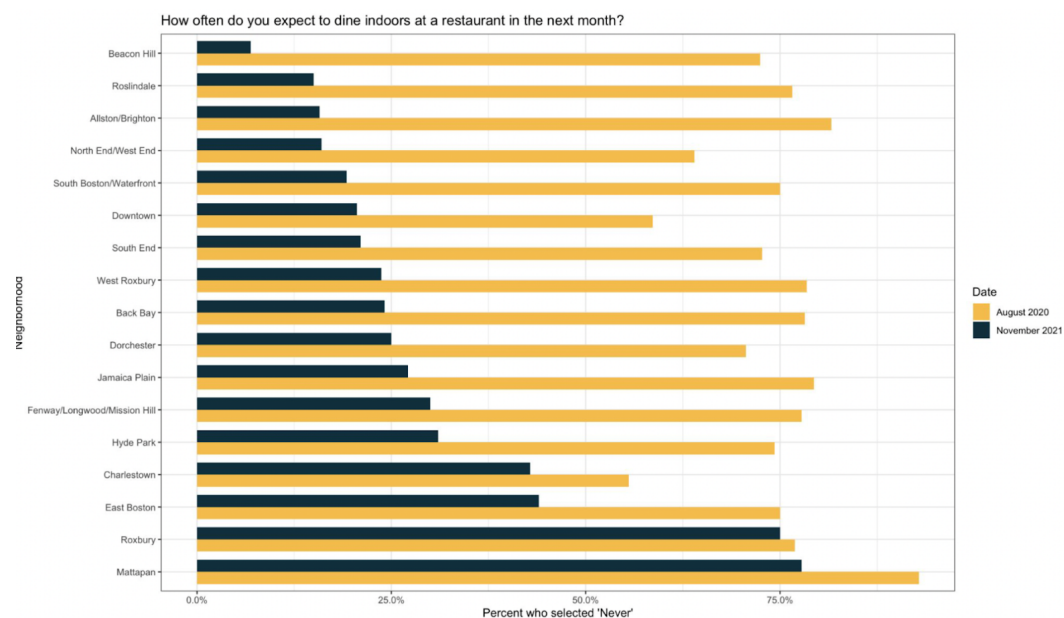
District 4 is less impacted compared to commercial neighborhoods when looking at the visualization of business closure in different neighborhoods. The impact of the COVID-19 pandemic on business revenue has been uneven across Boston's neighborhoods. Commercial areas that depend on commuters, tourists, and students for customers experienced the greatest decrease in in-person retail spending. Boston residents also reduced their participation in in-person activities at places where they perceive the risk of infection to be high. Therefore, more consumers would prefer to spend money to the businesses within District 4 rather than commute to the commercial area.



Among all the industries of small businesses in district 4, accommodation and food services has seen the highest share of businesses close at 10.4 percent. Then there is the retail

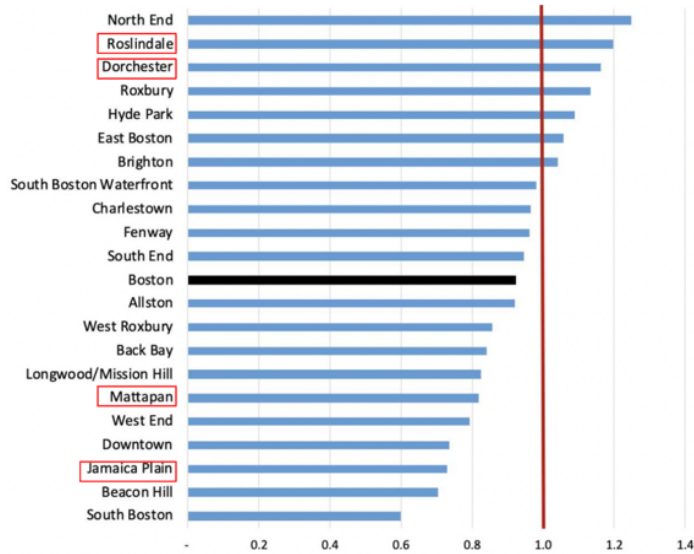
trade, and this is following the same pattern with the number of small businesses within district 4. Since the food services is the industry that is being most impacted by Covid-19 and also the small businesses that receive the most funds and exist the most, further analysis would be done to analyze the restaurant data during Covid-19.

Restaurant Spending



Comparing November 2021 and August 2020, in November 2021, there is a noticeable difference in that consumers are more confident about dining indoors in restaurants. More confidence in consumers will impact how restaurants operate, i.e., more consumers and more profits. Especially within district 4, there are many restaurants. The consumers within district 4 are more likely to dine indoors which also indicates they trust the local businesses and the covid is nearly getting to an end.

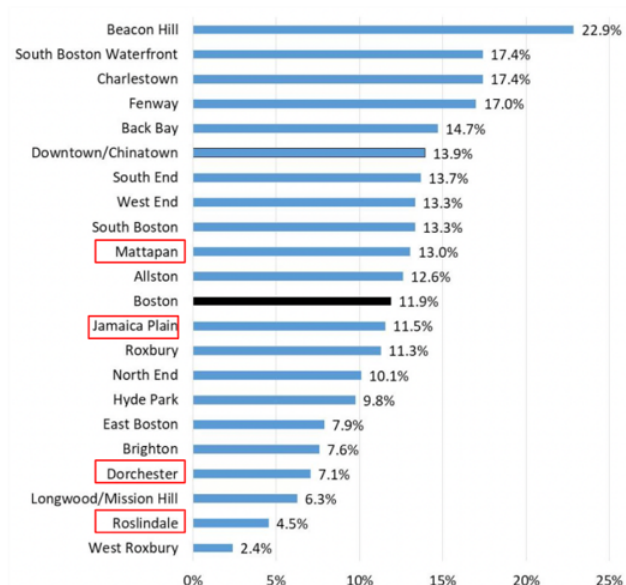
In-Person Restaurant Spending in October 2021 Comparing to October 2019



Comparing the restaurant spending before the pandemic and October 2021, the restaurant is on a recovery in general. Specificity in district 4, the restaurant in areas like Roslindale and Dorchester doing very well in recovering that spending exceeds the pre-pedantic spending. However, other areas like Mattapan and Jamaica Plain are still below average. Those areas might need some attention or help as needed.

Within the years 2020 and 2021, upon analyzing permanent restaurant closures within districts, district 4 is below the average. Only Mattapan is slightly above the average, which is 13%. Other areas like Jamaica Plain, Dorchester, and Rosliadate are 11.5%, 7.1%, and 4.5%, respectively. However, Mattapan and Jamaica Plain have more restaurants closed than the other two areas within district 4, which might also be a reason that the restaurant spending at Mattapan and Jamaica Plain is lower than in Roslindale and Dorchester.

Share of Neighborhood Restaurants Permanently Closed in 2020 and 2021

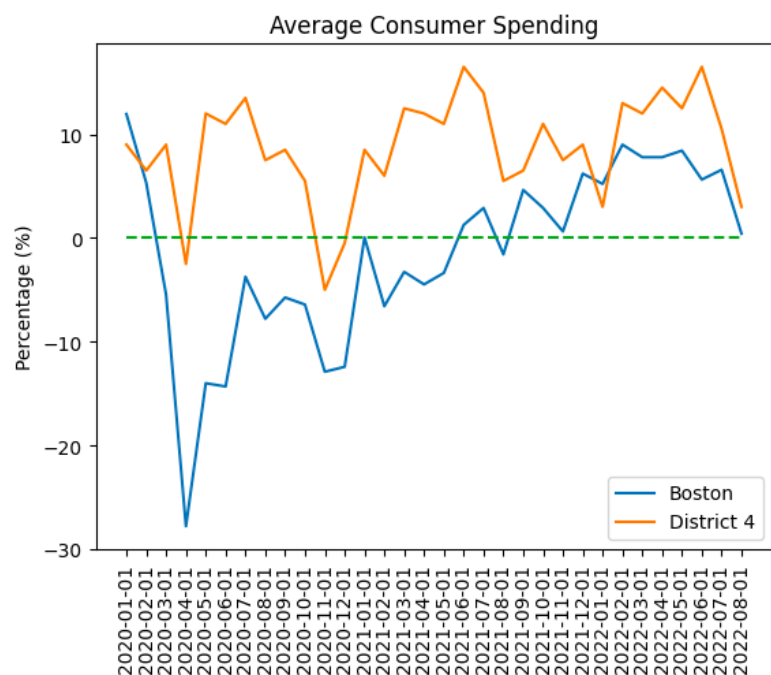


In conclusion, compared to the other districts, district 4 is being less impacted by Covid-19, no matter looking at the overall business closure or specifically the restaurants. A possible explanation is because district 4 is a residential district rather than a commercial district, and people would be less likely to commute between districts, so they would prefer to eat or make spending decisions in district 4, which makes district 4 being less impacted by covid-19.

Consumer Spending

Consumer spending is an important aspect of measuring the impact of Covid-19. We looked into the mainstreet spending data and calculated the average of consumer spending for the whole Boston and for District 4. The graph below shows the comparison from January of 2020 to August of 2022. We can see that Boston as a whole was greatly affected by Covid-19; there was a sharp decrease in the percentage of consumer spending in April of 2020, which was when the pandemic began. Though we see a

similar trend for that of District 4, it is clear that District 4 was not affected as much. The trend of District 4 mostly remains above 0% and generally has a percentage of consumer spending greater than that of the whole Boston. The consumer spending also shows that district 4 is not being affected much by covid-19.



Conclusion

In conclusion, the government support on Covid-19 to small businesses is following the distribution of small businesses in district 4. Restaurants are the type of business that receives most funds. Moreover, among all the neighborhoods in District 4, Dorchester is receiving the most amount of government support to have small businesses overcome Covid-19.

After looking at the business closure, restaurant data and consumer spending in District 4, it turns out that District 4 is being less impacted by Covid-19 compared to other commercial Districts, and impact is less than the average impact of the whole Boston area. The small business in District 4 is recovered now.

Limitations & Challenges

Throughout the extension project, we were very limited in the data we were able to collect in order to analyze foot traffic and how businesses spent the government support they received during the most impactful months of Covid-19. Many of the problems we encountered revolved around the precision of the data we were able to collect and the standardization of this data. An example of an issue we faced with precision is that much of the data we were able to collect was not to the precision of data on the street level and we were largely confined to data concerning Boston as a whole. An example of an issue we faced with standardization was that we had with the EPA Smart Location Database. While the data had high precision – down to census tracts, mapping each tract to the appropriate city districts had an impact on the accuracy of our data location. We had hoped to use this data to provide insights on district employment, access to transit, and employment types.