

Livable Streets Bus Equity

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1. An introduction to the topic, the client, and what problem they are trying to solve

Yu Liang, Xiang Li

Background:

This report is focused on establishing safe and equitable public spaces while proposing transportation solutions in Massachusetts. It focuses on current and future plans to address bus commute time disparities in Massachusetts, particularly examining the impact of these inequalities for Black riders and LatinX communities. A significant difference in bus commute times between Black and White riders is highlighted, with Black riders spending an additional 64 hours per year on buses compared with White riders. Similarly, there is a time disparity of 10 hours in the LatinX community. The MBTA's services are not equitably distributed, with Black and Latino communities particularly facing longer commute times. This caused regional and racial disparities within the MBTA's bus service.

Abstract:

This report analyzes racial disparities in bus commute times, focusing on differences racial groups, including black, white, and LatinX community riders. Through visualizations and data analysis, we explore the evolution of the 64 hours bus commute disparity between black and white riders over the past five years, examining regional variations. We compare 10-hour bus commute differences in LatinX communities with other racial groups. We assess the impact of COVID-19 on black and white riders and evaluate policy interventions to reduce disparities. Our goal is to provide a foundation to support decision-making and policy development.

Risk

There are some risks when doing this project analysis. The major risk of doing this project is that we are very hard to find the correct corresponding data. We can not find the correct data until a week before Thanksgiving break. This is no limit to the data missing and data type errors when processing the data. For example, the data of travel time to work for some minor groups is totally missing and there is some data that is not collected in float or int type which needs transformation this may result in the inaccurate evaluation of the commute gap between different groups.

2. Visualizations, organized by question, along with the accompanying documentation

Question 1(Yu Liang)

How has the 64-hour bus commute disparity between Black and white riders evolved over the past five years, considering both pre-Covid and Covid-affected periods, and are there discernible patterns or changes in the trend?

Analysis for Question 1:

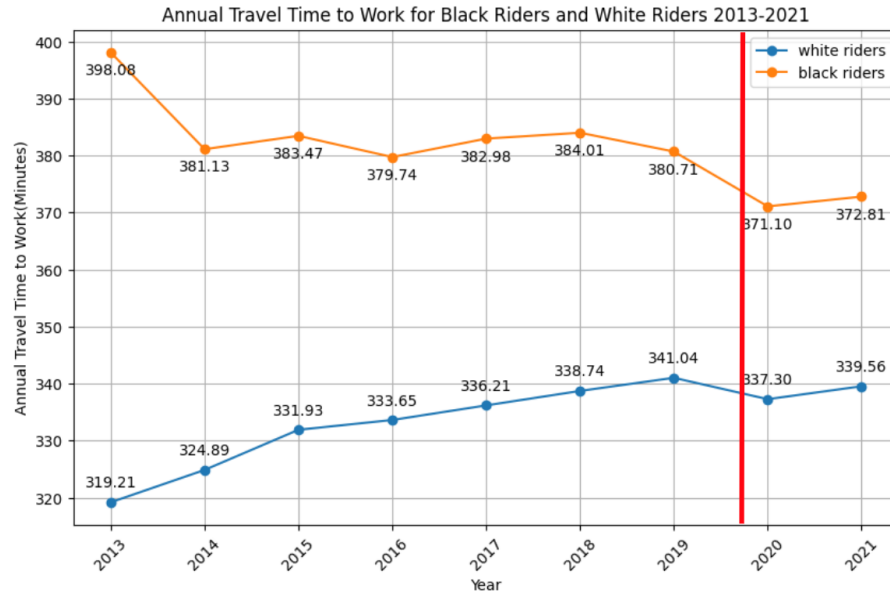


Figure 1: Average Travel Time to Work for Black Riders and White Riders 2013-2021

From Figure 1, the trend was continually increasing for white riders before Covid. For black riders, there was a sharp drop in commute time from 2013 to 2014, followed by small annual fluctuations from 2015 to 2019. commute times for both black and white riders decreased significantly in the Covid period, attributable to the impact of the Covid. The trend for both black and white riders declined sharply in 2020 compared to the previous year. In 2021, as the world began to adapt to Covid, commute times for both groups increased slightly compared to 2020 but did not return to pre-Covid levels. The overall trend from 2013 to 2021 shows that commute time for both black and white riders is decreasing, with a significant reduction in commute time during the COVID period. Based on Figure 1, we can infer that Covid had a temporary balancing effect on the commuting gap between black and white riders. However, without additional context or data for the years after 2021, it is unclear whether this equality trend will continue or return to pre-pandemic patterns. Therefore, we conducted linear regression analysis in question 3 to predict the future pattern after COVID-19.

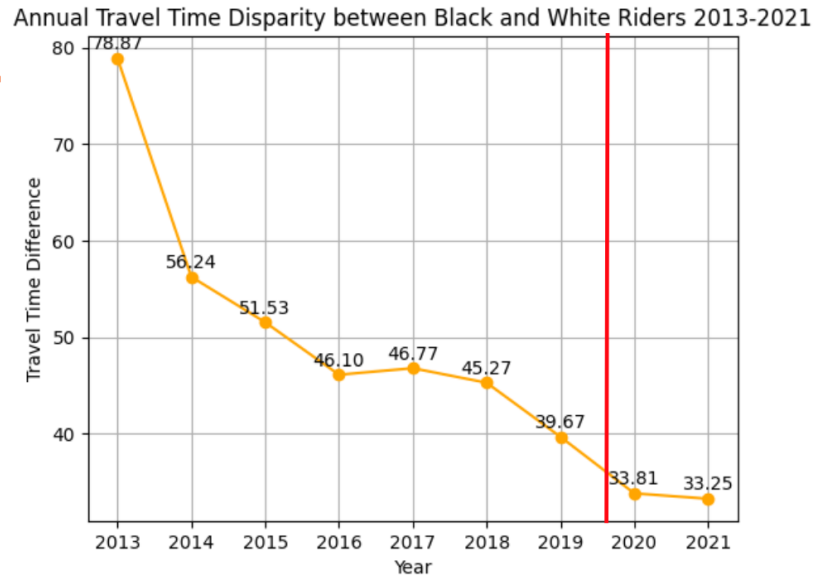


Figure 2: Annual commute Time Disparity between Black and White Riders 2013-2021

Annual commute Time Disparity Compared to White Riders



Black Riders +40 hours

Source: United States Census, 2017-2021

Figure 2 shows that the disparity in commute times has been gradually narrowing in the years before and during Covid. The most significant change occurs in 2020 when the disparity drops significantly to 33.81 hours. In 2021, it narrows to 33.25 hours. This may be caused by the fact that riders' normal commuting patterns were disrupted due to lockdowns, increased remote working, and other factors associated with COVID-19. However, the data suggest that it may have a relatively greater impact on reducing commute times for black riders, resulting in a significant decline in 2020. This trend clearly shows that the 64-hour commute time disparity has continued to narrow over the past five years. We updated the average difference in commute time between blacks and whites from 64 hours to 40 hours, based on the average difference observed over the last five years.

T-Test:

Null hypothesis(H0): Covid has no effect on the difference in commute times between blacks and whites. This means that the mean of the difference in commuting times before and after the pandemic is the same.

Alternative hypothesis(H1): Covid has an impact on the difference in commute times between blacks and whites. This means that the mean of the difference in commuting time before and after the pandemic is different.

The Result for T-tests:

T-statistic: -4.33; P-value: 0.0047

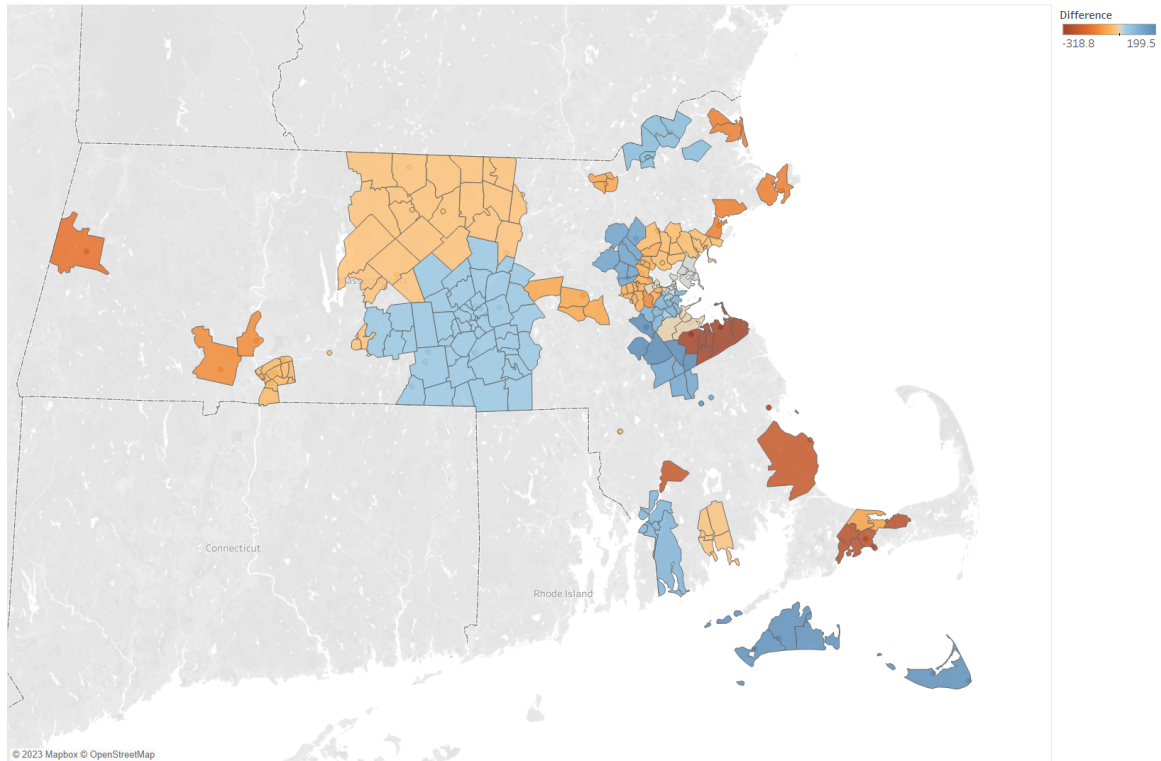
Interpretation:

This P-value is less than 0.05, we can reject the null hypothesis, indicating that there is a statistically significant difference in the commute time disparities between Black and White riders before and during the pandemic. The T-test for independent samples reveals a significant change in the difference, suggesting an impact of the Covid on rider behavior. This also suggests that the Covid did have an effect on the difference in commute times between blacks and whites.

Question 2(Bohan Wang)

Does the 64-hour gap in bus commute times hold consistent across different geographic areas or does it vary significantly, and are there specific regions where the gap is more pronounced?

Analysis for Question 2

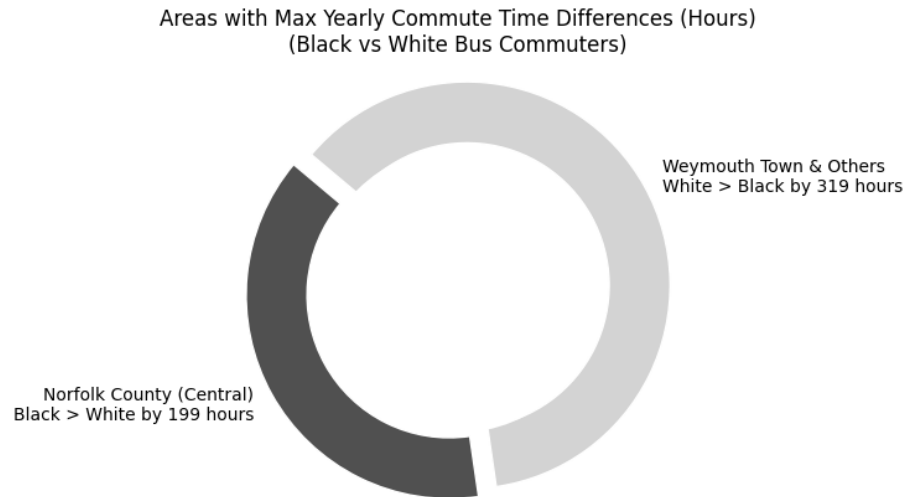


Source: United States Census, 2016-2021

Figure 3: Annual commute Time (hours) Disparity Between Black And White Bus Riders 2016-2021

Figure 3 is based on data from a total of PUMA areas from 2016-2021 in MA. Difference represents the amount of time (hours) that blacks spend commuting to work more than whites. The darker the red in the graph, the more whites in the area use buses to commute than blacks, while the darker the blue, the more blacks in the area use buses to commute than whites.

As we can see in Figure 3, the difference in commute times to work by bus for black whites is still relatively large in most areas. In central MA, the differences are smaller, but in the margins of MA, the disparities are larger. The results indicate that there are regional inequities that need to be addressed to ensure commute time equity in all regions.



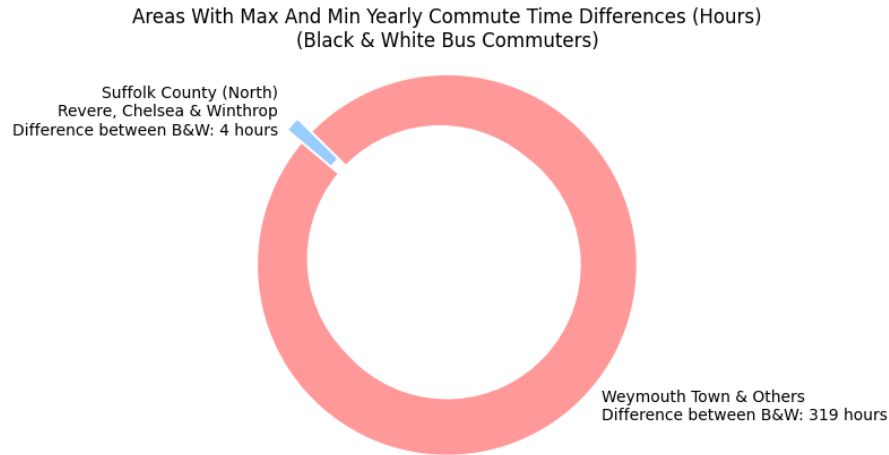
Black Riders **+199** hours in Norfolk County

White Riders **+319** hours in Weymouth Town

Source: United States Census, 2016-2021

Figure 4: Areas with Max Yearly Commute Time Differences (Hours) (Black vs White Bus Commuters) 2016-2021

In Figure 4 we find the largest black-white disparity in commute time to work by bus. Blacks have up to 199 more hours commute times per year than whites in Norfolk County, while whites have up to 319 more hours commute times per year than blacks in Weymouth Town. It can be concluded that for riding public transit, the more unfair to blacks in Massachusetts is Norfolk County and the more unfair to whites is Weymouth Town.



Maximum difference between B&W **319** hours in Weymouth Town

Minimum difference between B&W **4** hours in Suffolk County

Source: United States Census, 2016-2021

Figure 5: Areas With Max And Min Yearly Commute Time Differences (Hours) (Black & White Bus Commuters) 2016-2021

In Figure 5, we find the maximum and minimum time gaps for black whites commuting to work by bus. Weymouth Town has the largest time gap at 319 hours per year. Suffolk County has the smallest time gap at 4 hours per year. We find the maximum and minimum time gaps for black whites commuting to work by bus. Weymouth Town has the largest time gap at 319 hours per year. Suffolk County has the smallest time gap at 4 hours per year. It can be concluded that the most equitable area in Massachusetts for transit is Suffolk County and the least equitable is Weymouth Town.

Question 3(Xiang Li)

How does the 10-hour bus commute disparity observed in LatinX communities compare with other racial groups, and are there common factors contributing to these discrepancies across different demographics?

Difference in Total Travel Time between Latinx and White Riders (2011-2021)

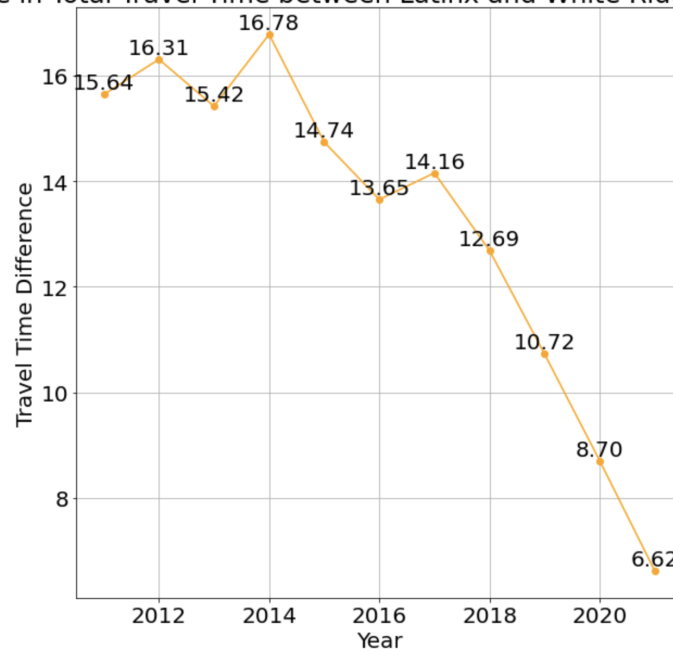


Figure 6: Difference in Total Travel Time between LatinX and White Riders(2011-2021)

Difference in Total Travel Time between Latinx and Black Riders (2011-2021)

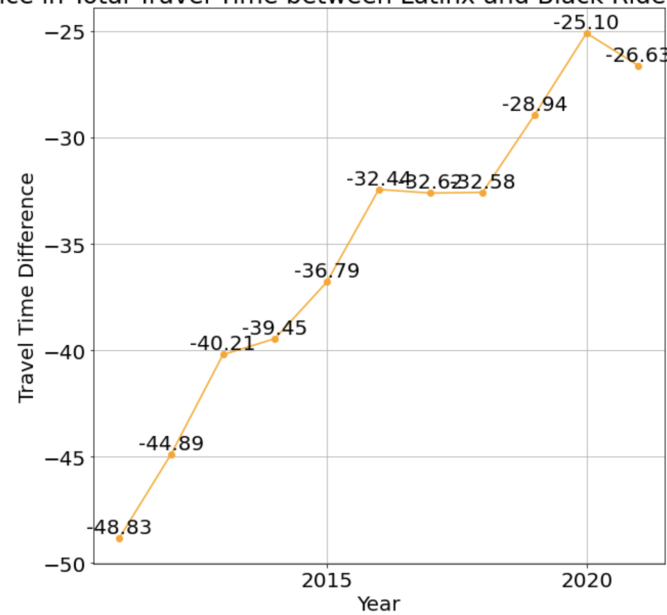


Figure 7: Difference in Total Travel Time between LatinX and Black Riders(2011-2021)

Difference in Total Travel Time between Latinx and American Indian Riders (2011-2021)

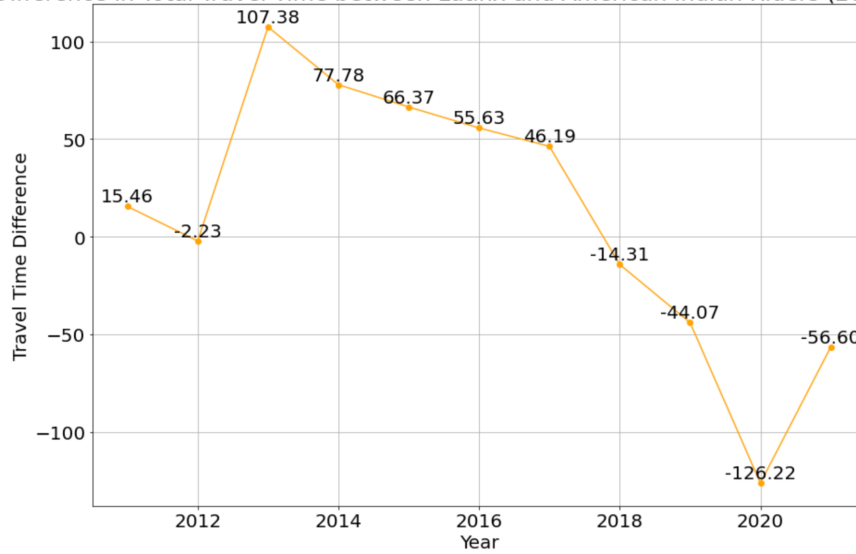


Figure 8: Difference in Total Travel Time between LatinX and American indian Riders(2011-2021)

Difference in Total Travel Time between Latinx and Asian Riders (2011-2021)

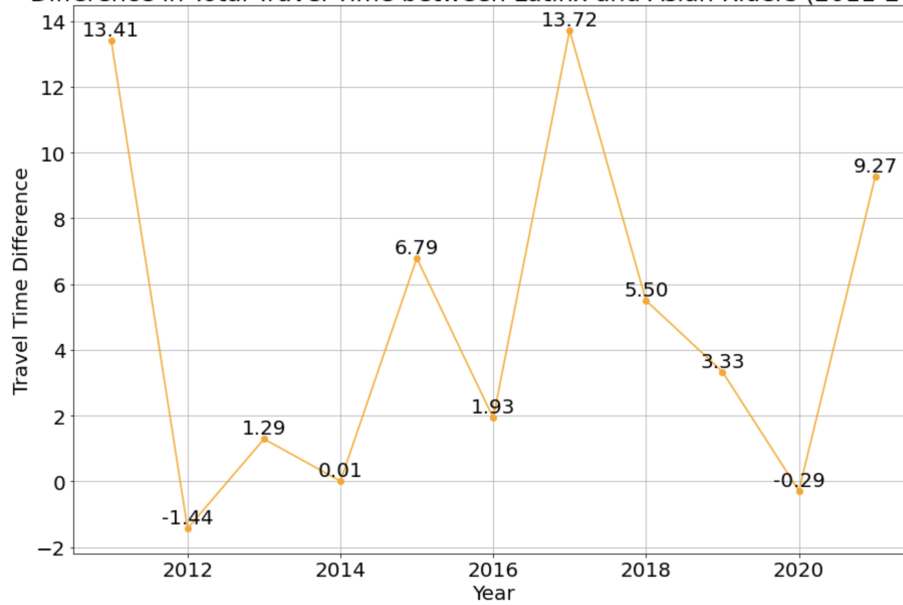


Figure 9: Difference in Total Travel Time between LatinX and Asian Riders(2011-2021)

Difference in Total Travel Time between Latinx and Other Race Riders (2011-2021)

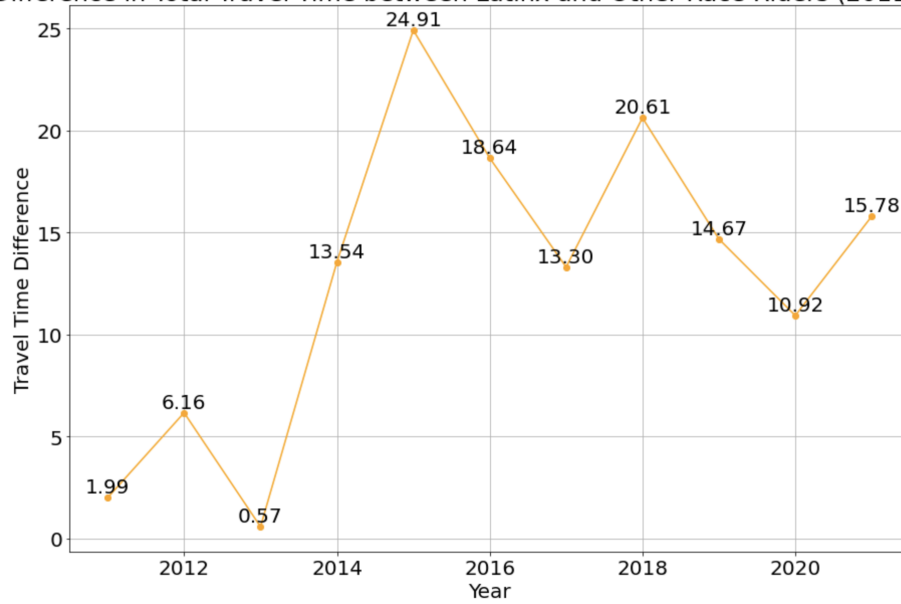


Figure 10: Difference in Total Travel Time between LatinX and Other Race Riders(2011-2021)

Difference in Total Travel Time between Latinx and Riders in two or more races (2011-2021)

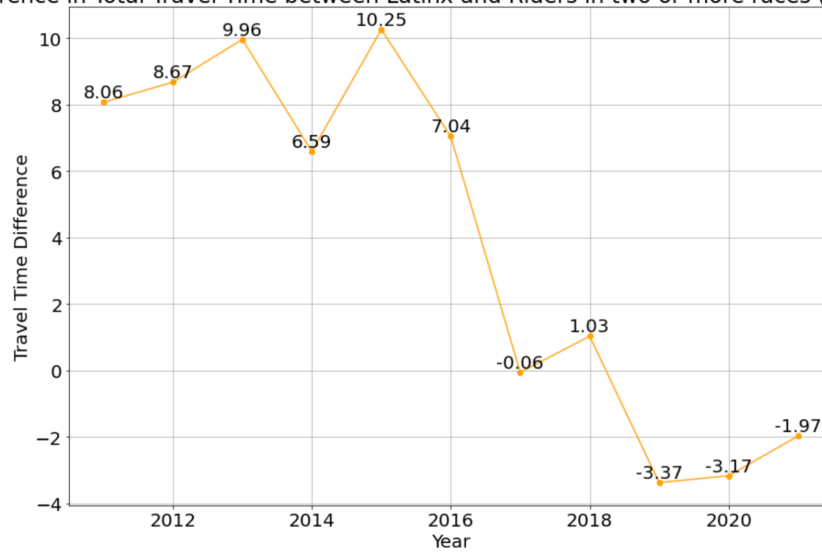


Figure 11: Difference in Total Travel Time between latinX and Other Race Riders(2011-2021)

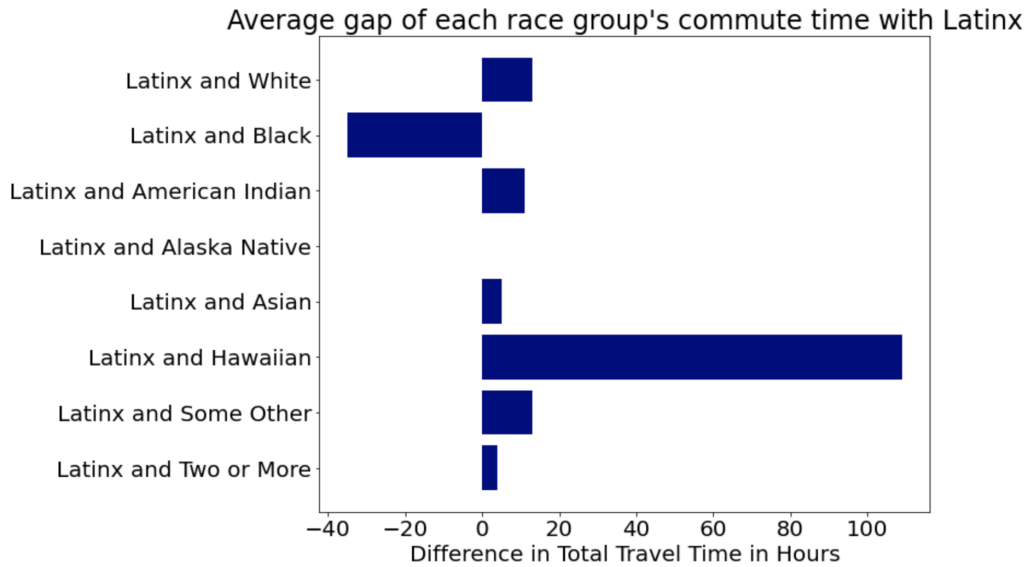


Figure 12: Average Gap of Each Race Group's Commute Time with LatinX

Analysis for Question3

We are using the five years of data from the year 2011 to the year 2021 to calculate the average commute time of each group by the formula: $\text{Average_time} * 2 * 5 * 50 / 60 / \text{years}$.

Based on the above plots, we can see there is a very significant gap between Latinx communities and Hawaiian communities which is a 109-hour gap. Compared to each group, there is a significant decrease gap in the Two-or-more race rider group, the American Indian rider group, and the white rider group. One interesting point to notice is that the Black group rider always has a longer commuting time than Latinx communities.

Question 4(Xinyu Zhang)

To what extent did the Covid-19 pandemic impact the bus commute times for both Black and white riders, and how has this impact contributed to the existing disparity in hours spent on buses?

Analysis for question4

This question is based on conclusions from question 1. Figure 13 is the average commute time to work for black and white riders. The blue and green line represents the actual commute time, while the dashed lines indicate the time predicted by the linear model. For both Black and White riders, the actual commute times in 2020 and 2021 were lower than predicted. This suggests that the pandemic likely reduced commute times for both racial groups, possibly due to less traffic congestion as more people worked from home and there were fewer jobs to commute to because of lockdowns and economic slowdown.

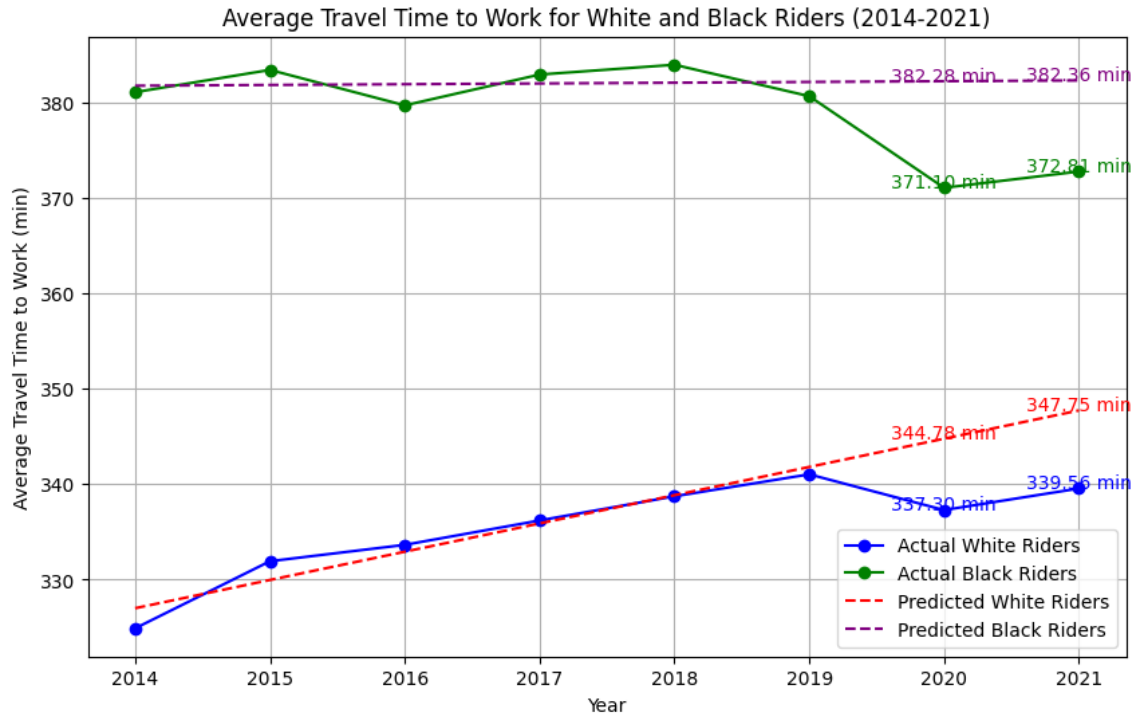


Figure 13: Average commute Time to Work for White and Black Riders

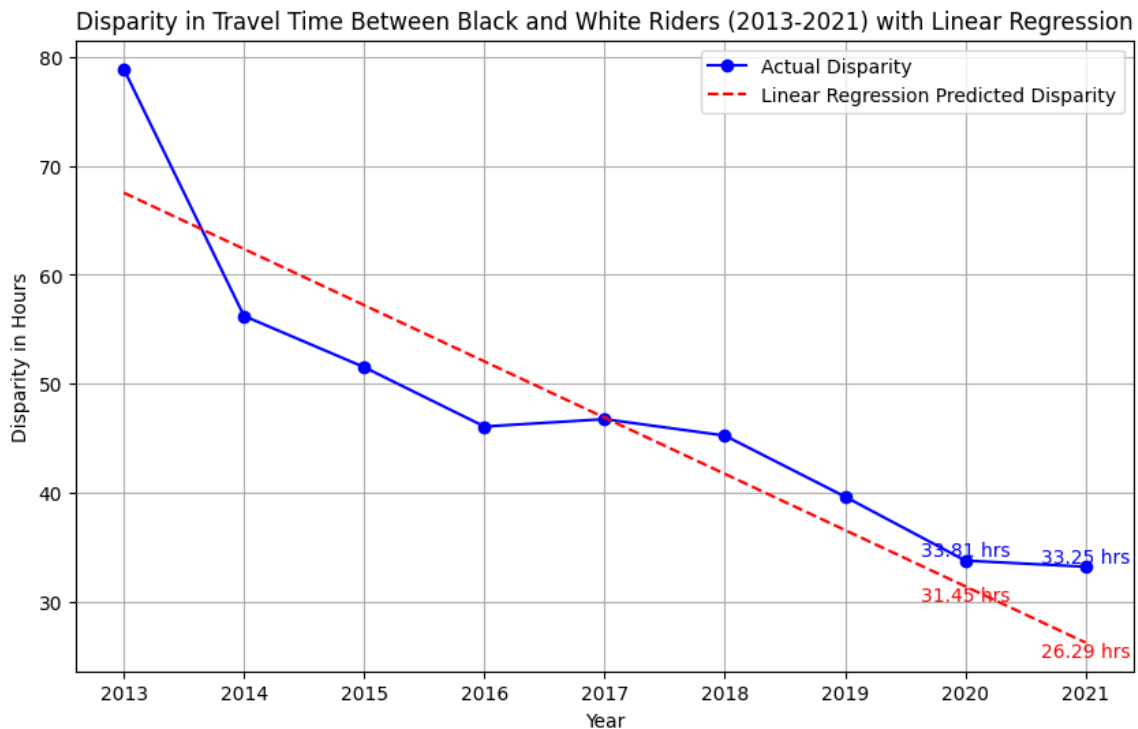


Figure 14: Disparity in commute Time between Black and White Riders with Linear Regression

Figure 14 illustrates the disparity in commute time between Black and White riders. We can see that the actual disparity in 2020 and 2021 was greater than predicted. While

commute times decreased for both groups, they did not decrease equally. The actual data for 2020 and 2021 show a smaller decrease or a plateau compared to the prediction, which means that the pandemic slowed down the trend towards decreasing disparity.

For 2020: The difference is approximately 6.98%.

For 2021: The difference is significantly higher at approximately 20.92%.

The larger difference in 2021 could imply that the changes in commute patterns due to the pandemic in 2020 may have extended in 2021, further affecting commute disparities.

3. A final summary of what can be taken away from the report as a whole.(Yu Liang, Xinyu Zhang, Xiang Li, Bohan Wang)

- a. Have there been any policy interventions or initiatives aimed at reducing the bus commute disparity, and can data analysis determine the effectiveness of such measures over the years?

Policy:

1. Develop data-driven regional planning that prioritizes route planning and service improvements with the largest time gaps. Aim to make commute times equitable for all races.
2. Work deeply with communities with large time gaps(for example, the communities that are majority black) and prioritize understanding their specific needs and challenges. Also, adjust more appropriate service policies based on their feedback. The policy of adding more buses in the report of *64 Hours: Closing the Bus Equity Gap* can be a good choice.
3. Redefine the Key Bus Routes program and adopt more flexible guidelines to allow for greater service frequency for routes with high rates of underserved riders.

Determine the Effectiveness for Previous Policy:

According to analysis for question 1, we can find that the difference between the commuting time of black and white riders decreases year by year. This shows that previous policies have been effective in reducing the inequality of commuting time for different racial groups in Massachusetts.

The presentations on the [MBTA website](#) detail the improvement plans implemented for the bus network redesign from 2018 to 2022. MBTA have [identified High Priority Corridors](#) and redesigned bus networks. These initiatives are reflected in our data as well. However, due to factors such as the COVID-19

pandemic, it's challenging to determine the direct correlation between these policies and the reduction in commute times in recent years. While the policies aimed to enhance the bus system, external factors like the pandemic could have significantly influenced commute patterns and times.

b. General summary of findings

For this report, we focused on investigating whether there are inequities in Massachusetts' transit commute times. We found large disparities in transit commute times by race. But the gap is decreasing each year. In addition, we used t-test and found that COVID-19 has a significant impact on the commute time gap. During the COVID-19 pandemic years of 2020 and 2021, commute times for both Black and White riders were lower than predicted, suggesting a reduction in bus travel time possibly due to pandemic-related changes. There are also large differences between different areas, with areas such as Norfolk County and Weymouth Town having the largest differences. While the MBTA has implemented many measures in response to these issues, such as a redesigned transit network for example, the effects of these measures are difficult to assess due to the impact of COVID. Our projections suggest that without more appropriate policies being applied, these commute time disparities are likely to continue.