How Low-income Transit Riders in Boston Respond to Discounted Fares: A Randomized Controlled Evaluation

PRELIMINARY RESULTS

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Summary

The purpose of this project is to investigate how the cost of public transit influences low-income transit use and access and, thus, how a low-income fare policy instrument could improve the quality of life of low income transit users. A randomized controlled evaluation was conducted to study the effect of providing a 50% discounted MBTA fare to low-income individuals in the Boston region. Individuals receiving food stamps (SNAP) benefits were recruited and then randomly assigned to either receive a 50% discount CharlieCard or a regular CharlieCard. Participants daily provided the purposes of their transit trips via an automated text-based mobile-phone ChatBot tool. Pre- and post-study surveys were also administered by the ChatBot.

Preliminary findings of our research suggest low-income riders in the study took more trips as a result of receiving a subsidy. Compared to the control group receiving only a CharlieCard, those participants receiving a 50% discounted CharlieCard:

1. Took about 30% more trips.
2. Took more trips to health care and social services.

The research also suggests that low-income transit riders in the study use the MBTA differently from the average transit rider. Compared to the average MBTA rider, the low-income individuals participating in the study:

3. Took more of their trips during off-peak times.
4. Relied more heavily on buses and Silver Line.
5. Made more transfers among modes and routes (e.g., subway to bus to another bus).
6. More often paid with stored value on a card rather than one-day, seven-day, or monthly passes.

Finally, in answer to the question, “What do you think is the biggest problem with public transportation (MBTA) in Boston?” participants in the study:

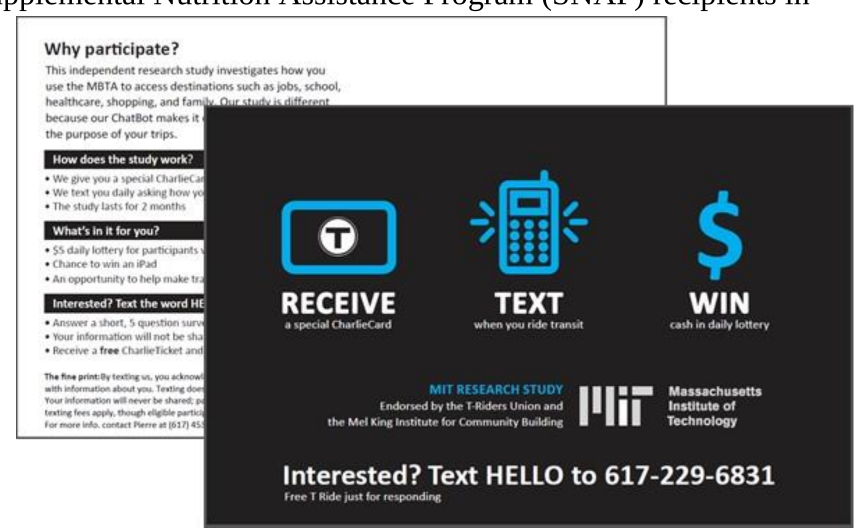
7. Reported reliability, affordability, frequency, and crowding as top concerns.

Overview

As transit authorities across the US have raised fares over the past decade, affordability has become a salient equity issue. With few exceptions (notably San Francisco and Seattle), transit authorities have not generally provided discounts to poor riders (federal policy established in 1972 does, though, mandate senior and disability discounts). Relatively little is known about how low-income households react to fare increases and how they manage transportation costs in the context of overall household budgeting. Anecdotal evidence, mostly from studies of the effects on employment and job training, suggests that transit affordability is a barrier to reach jobs, education, and other opportunities (i.e., access). However, the few existing studies of the impact of fare increases on ridership by the poor have produced contradictory results. Some studies have indicated that fare increases have little impact on low-income ridership behavior, supporting the theory that low-income transit users are "captive riders" with no choice but to pay the increases (considered an inelastic response). Other research has suggested that low-income riders take fewer trips when faced with fare increases (considered an elastic response), indicating that cost may be a barrier to mobility and access.

The purpose of this project is to investigate how the cost of transit influences low-income transit use and access and, thus, how a low-income fare policy instrument could improve the quality of life of low income transit users. While other barriers to transit use are often cited, such as reliability, frequency, and destinations served, this research focuses specifically on understanding the relationship between the cost of transit cost and the ability of poor individuals and households to access life's necessities, such as health care or employment.

We utilized randomized controlled evaluation methodology to study the effect on travel behavior of providing a 50% discount fare to low-income MBTA riders. Participants were recruited by mailing postcards to 12,000 Supplemental Nutrition Assistance Program (SNAP) recipients in the MBTA catchment area. In addition, advertising placards were placed on buses throughout the core MBTA system. To qualify for the study, individuals must receive SNAP benefits and not be eligible for one of the existing MBTA subsidy programs (i.e., for seniors, persons with disabilities, or youth).



An automated text-based mobile-phone ChatBot tool was developed to facilitate the recruitment process. Interested individuals texted the ChatBot phone number to obtain more information and enroll in the study. After agreeing to be a part of the study, participants were randomly placed into either the control group (receiving an ordinary CharlieCard but with a special “study” sticker on the back) or the treatment group (receiving a special CharlieCard that deducts only half the regular fare for each use or that allows for the purchase of a $29 monthly pass[1]). Each participant was responsible for adding value or purchasing a monthly pass to their own card as they would normally. The study protocol was approved by MIT’s Institutional Review Board to ensure the rights, privacy, and welfare of the research participants. The study ran from February through May 2019 with rolling recruitment, and each participant was enrolled in the study for a 2-month period. Overall, a total of 240 participants were part of the study.

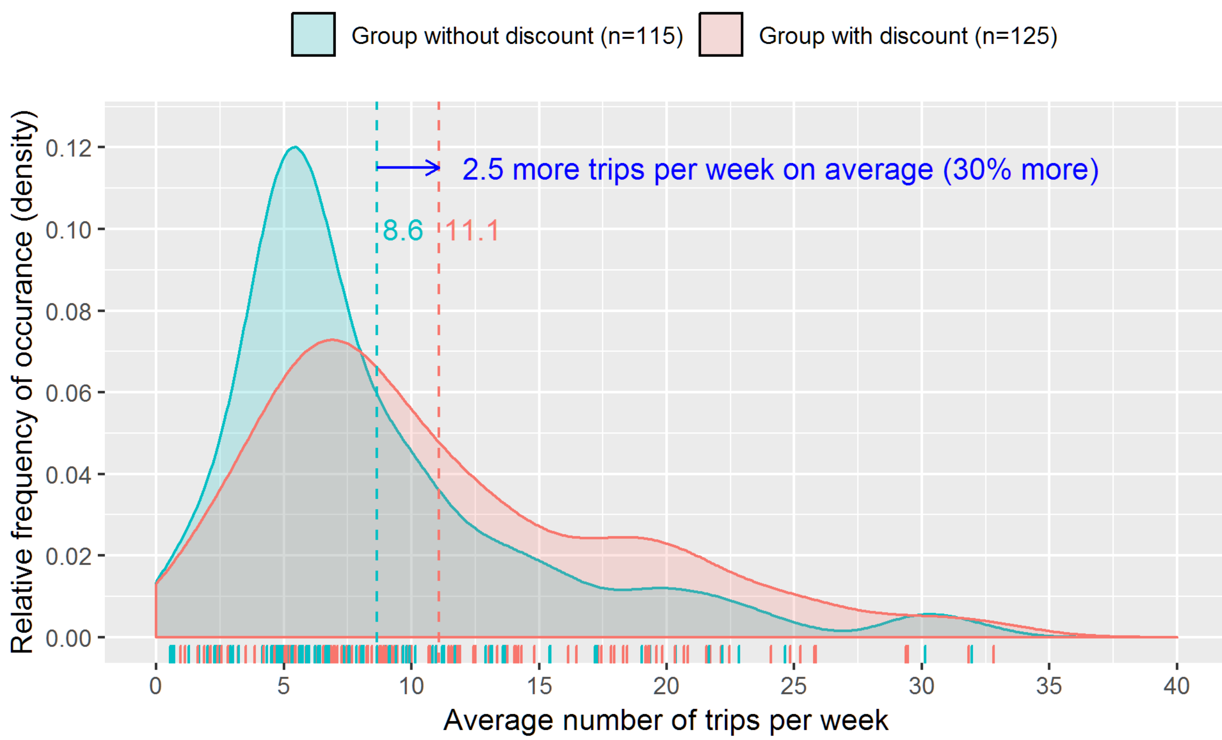
We recorded three types of data. First, we followed mobility patterns by tracking CharlieCard usage data to determine any difference in travel behavior, such as the average number of trips taken by each group and the time of day those trips were taken. Second, we collected daily travel diaries from each participant using the automated ChatBot. To encourage participation in the program, each day that a participant answered the ChatBot travel diary they were entered in a $5 lottery with multiple winners picked each day. Lastly, we asked several survey questions before and after the study, such as what barriers they face in using public transportation.

While a complete analysis of the findings is not yet available, this report releases some preliminary results. In sum, we found that low-income riders in the study took 30% more trips as a result of receiving a subsidy and took more trips to access health care and social services. We also found that, compared with the average MBTA rider, the low-income individuals participating in the study took more of their trips during off-peak times, relied more heavily on buses and Silver Line, made more transfers among modes and routes (e.g., subway to bus to another bus), and more often paid with stored value on a card rather than one-day, seven-day, or monthly passes. They also reported reliability, affordability, frequency, and crowding as top concerns. The following pages provide details on these initial findings.

The authors would like to thank the MBTA advisory board for providing financial support, the Department of Transitional Assistance for assisting with the postcard mailing, the MBTA Office of Performance Management and Innovation for facilitating access to the CharlieCard usage data, and the MIT Abdul Latif Jameel Poverty Action Lab (J-PAL) for providing guidance on conducting randomized controlled evaluations.

[1] The discounted monthly pass costs $29 compared with the standard monthly pass which costs $84.50. Ordinary CharlieCard users can also purchase a weekly pass for $21.25 but because of limitations with the MBTA’s Automatic Fare Collection system, a weekly pass option is not available for discounted CharlieCard users.

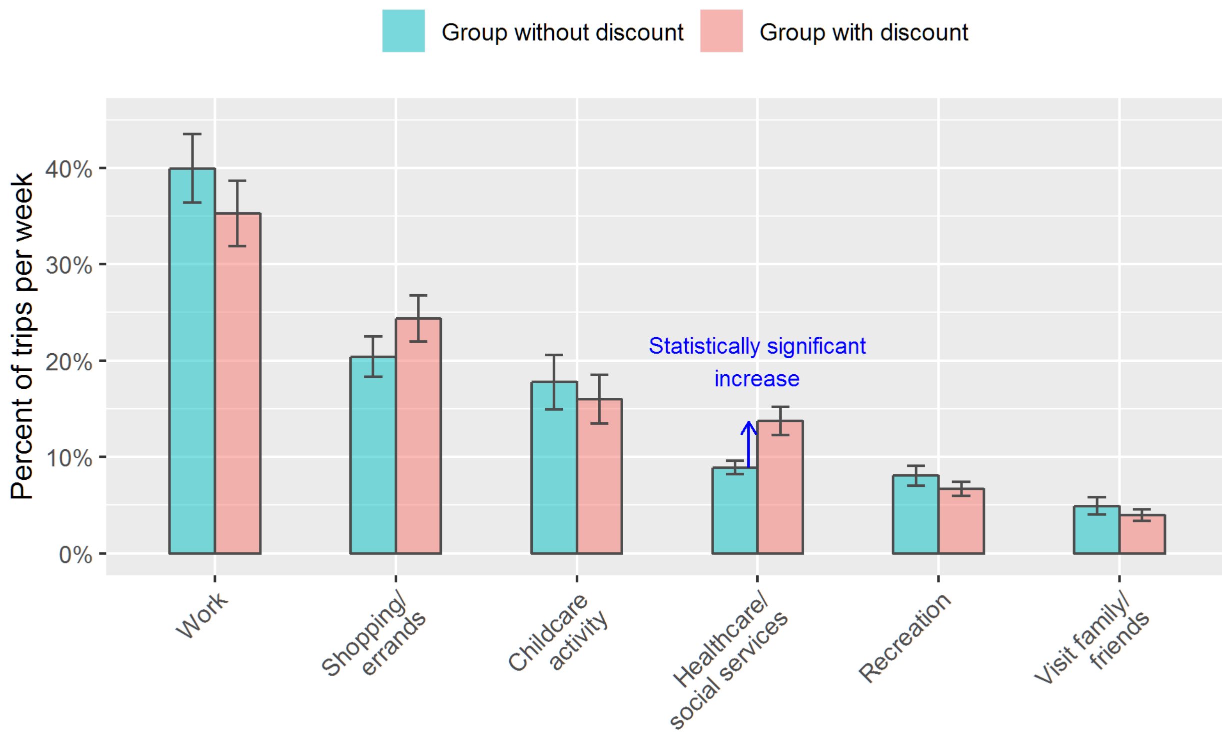
Figure 1. Low-income riders with a transit subsidy took about 30% more trips (2.5 more trips per week)



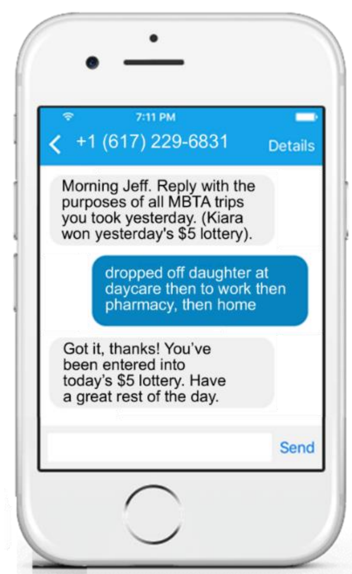
The average number of transit trips per week taken by each participant was calculated from individual CharlieCard usage data obtained from the MBTA's automated fare collection system data warehouse. A single trip is considered a journey from an origin to a destination including all transfers. Figure 1 compares the results between the two groups of participants. On average, those who did not receive a discount (blue) took 8.6 trips per week while those who received a discount (red) took 11.1 trips per week, a difference of 2.5 trips per week which is a 30% increase. The uncertainty associated with the results is ± 1.6 trips per week at a 95% confidence level.[2]

[2] A Welch two sample statistical t-test indicates that, at a 95% confidence level the group receiving a discount did take more trips per week on average than the control group—in other words, we are 95% confident we did not see this result by chance. The uncertainty associated with the results is 2.5 ± 1.6 trips per week, equivalent to a confidence interval of 0.7 to 4.1 trips per week. This means that the likely true increase in trips lies somewhere between those extremes. There is a large confidence interval around the findings because of the large underlying standard deviation (how spread out the data is) of about $\sigma = 6.7$ trips per week. A larger sample size would be needed to increase our confidence in the results.

Figure 2. Low-income riders with a transit subsidy took more trips to health care and social services

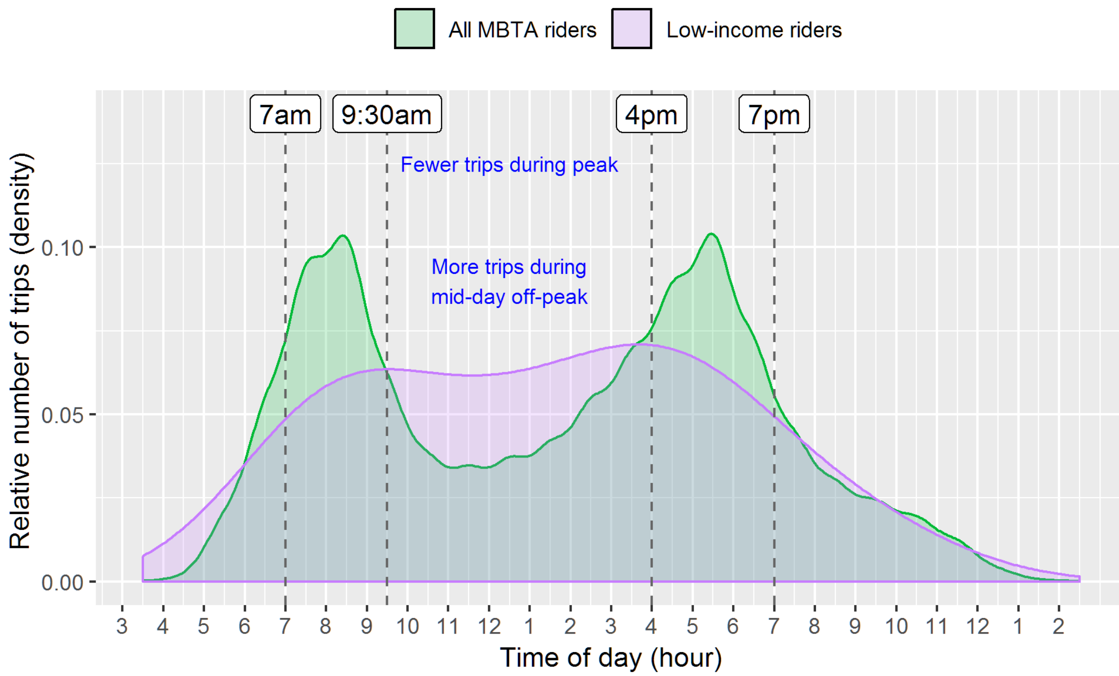


The automated ChatBot collected daily travel diaries from each participant. Daily at 9 AM, the Chatbot texted the following to each participant, "Reply with the purposes of all MBTA trips you took yesterday (or say none)." Approximately 20,000 travel diary responses were collected overall. Figure 2 compares the average number of trips for each purpose between the group not receiving the discount (blue) and the group receiving the discount (red). While those receiving a discount made slightly fewer work trips and more shopping/errand and health/social service trips (which includes visits to the doctor, hospital and social services), only the differences in the latter trip purposes were statistically significant.[3]



[3] The black lines represent the margin of error. "Healthcare/ Social services" is the only category where these error bars do not overlap indicating confidence that there was an increase.

Figure 3. Low-income transit riders took more of their trips during off-peak times



The MBTA and other US transit authorities have expressed concerns that a low-income fare discount might induce additional ridership during the weekday peak hours that already experience crowding. Figure 3 shows the fraction of trips per hour throughout the day. The low-income participants in the study took a higher fraction of off-peak trips than the average MBTA user[4] (shown in green), noticeably in the middle of the day.

Figure 3b

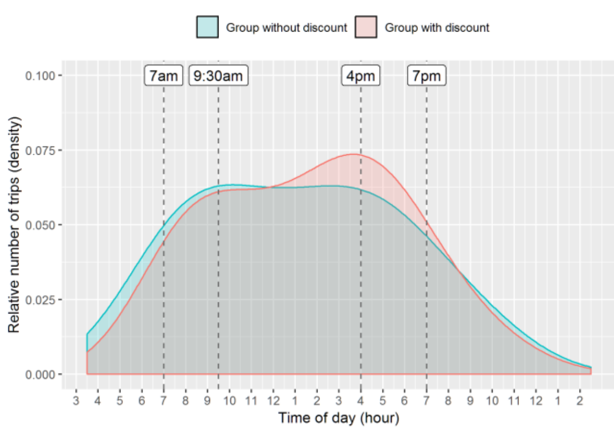
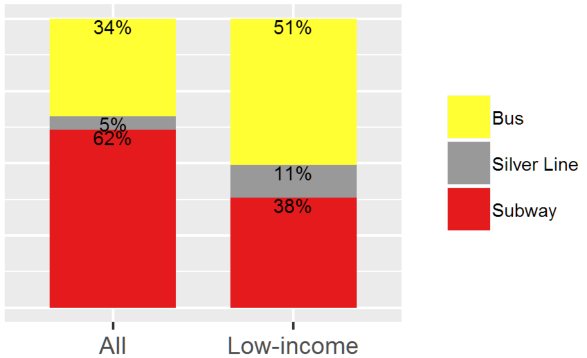


Figure 3b compares the two groups in the study. While similar, participants receiving a discount did take a slightly higher fraction of their trips in the afternoon leading up to the PM peak.

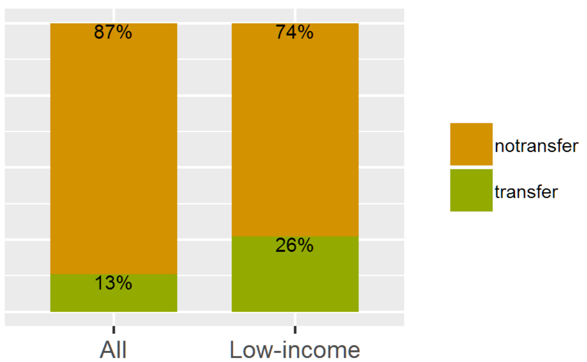
[4] Data for the month of March 2019 was used to represent the average across the MBTA bus and subway system.

Figure 4. Low-income transit riders relied more heavily on buses and Silver Line



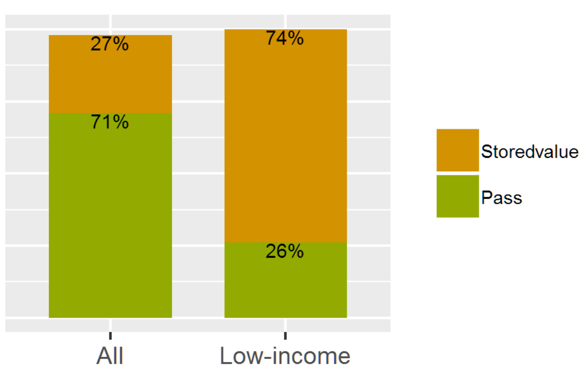
CharlieCard usage data for the participants in the study was used to determine the percent of trips taken on different modes and compared with all users on the MBTA subway and bus system for March 2019 (Figure 4). Low-income participants in the study relied on bus service for over 60% of their trips, while the average across the system was about 40%.

Figure 5. Low-income transit riders made more transfers among modes and routes (e.g., subway to bus to another bus)



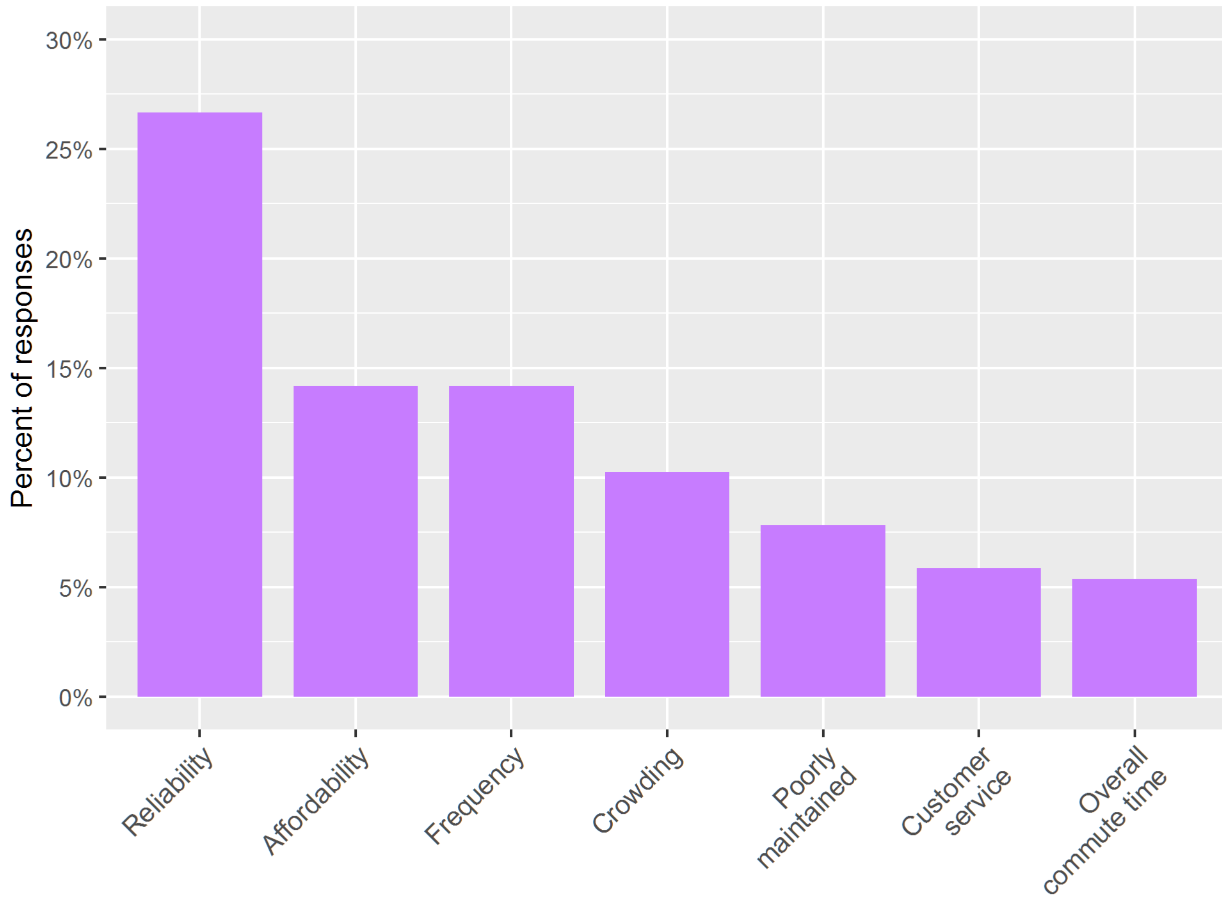
A similar analysis was conducted comparing the number of trips that required a transfer for the participants in the study and MBTA riders overall (Figure 5). Low-income riders take twice as many trips (26%) requiring transfers than average.

Figure 6. Low-income transit riders paid more often with stored value on a card rather than one-day, seven-day, or monthly passes



As shown in Figure 6, low-income riders in the study paid for about 25% of their trips using a pass and 75% using stored value on their CharlieCard. On the MBTA system overall, about 70% of trips are paid for using a pass.

Figure 7. Low-income transit riders report reliability, affordability, frequency, and crowding as top concerns they face with the MBTA.



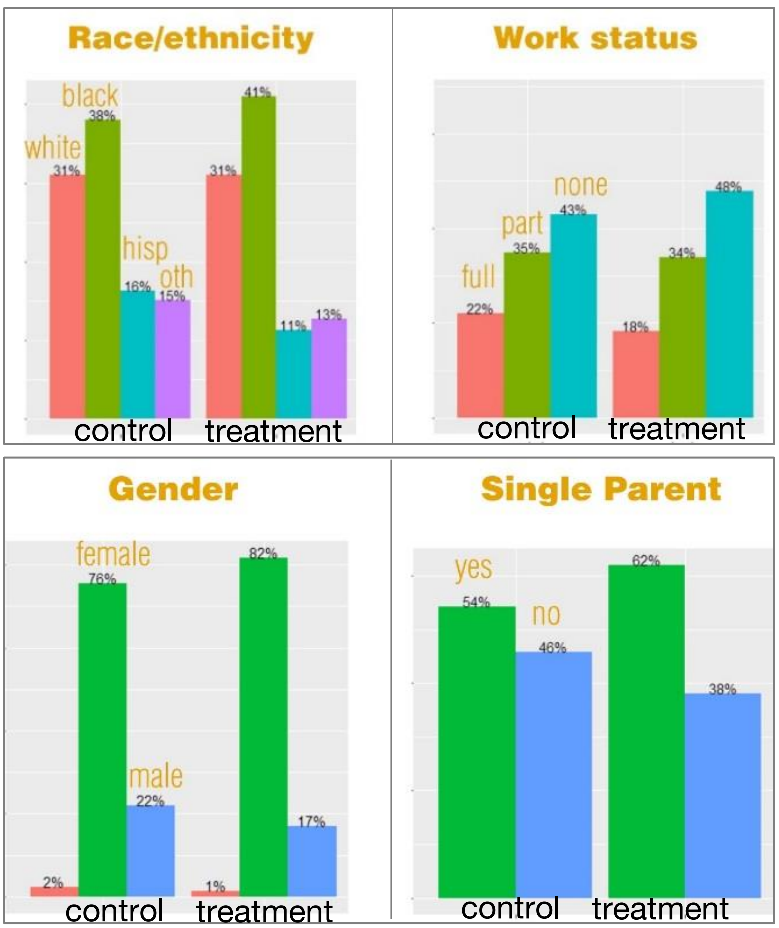
Finally, to better understand low-income riders concerns with MBTA service, the following open-ended question was asked of all participants at the beginning of the study: “What do you think is the biggest problem with public transportation (MBTA) in Boston?” As shown in Figure 7, reliability was the most frequently mentioned concern, followed by affordability, frequency of service, and crowding.

Appendix: Potential bias in the study

As with any research study, various factors may have biased the study results such that the findings do not validly represent reality. Many of these potential biases have been addressed in the study design itself or subsequently in the data analysis. The key ones are discussed here.

To avoid human bias, the participants were assigned to either the treatment or control group at random by computer algorithm. After the participants were randomized, the two groups were compared based on a set of five variables to confirm balanced representation on gender, race, age, employment, and single-parenthood. The average age is 36 for the control group population and 37 for the treatment group. Figure A1 compares the two groups according to the other four variables.[5]

Figure A1. Demographic balance between the two study groups



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[5] A t-test or chi-squared 2-sample test for equality of proportions indicates no statistical difference between the demographic characteristics between the two groups.

Another potential concern is that, for some reason, participants in the control group might drop out of the study at a higher rate than treatment group participants (i.e., “differential attrition”). The study was designed such that the ChatBot daily travel diary with the daily $5 lottery draw would be the primary incentive for continued participation. Each participant was provided with a refrigerator magnet with contact information. Participants could contact us via email, phone, or text to encourage communication. The average number of days of participation in the study was similar for the two groups: 55 for the control group and 58 for the treatment group.

In these type of research studies, the possibility always exists that participants might make up responses in order to be eligible for the prizes. To avoid this problem with the ChatBot diary, participants who did not take a transit trip the prior day could answer “none” and still be entered into the lottery.

Because the control group did not have an incentive to always use their designated CharlieCard (since there was not a discount associated with it), members of this group may not have always used their card for travel. If another card was used, we might not be able to include those trips in our counts. To mitigate these concerns, special labels were placed on all of the study CharlieCards to help participants distinguish it from other cards and make it feel more special than an ordinary card. In addition, we asked participants to provide the serial numbers for any CharlieCards they were using before the study to be able to fill in missing trips if they were taken on a non-study card.

We would expect the treatment group, on the other hand, to be more likely to always use the study’s CharlieCard because of the discount it provided. But individuals in this group might share their card with others. For one check on this risk, we asked each participant in this group, at the conclusion of the study, how frequently they shared their CharlieCard (to encourage an honest response, we also told them it was not a problem if they did share their card). Only 5% indicated that they shared their card and the majority of those who said they did indicated that they did so infrequently.

The most robust check to confirm that we were properly accounting for the trips taken by the participants was to cross-reference the CharlieCard usage with the daily ChatBot diary response to identify discrepancies. On a day where trips were associated with a CharlieCard, we would expect to see the response on that day's travel diary entry to contain trip purposes—if not, someone other than the participant might have used the card. Similarly, on a day where trip purposes were reported, we would expect to see activity on the CharlieCard—if not, the participant might have used a different CharlieCard for the trip. The table below summarizes the percent of each type of mismatch. The percentages are not significantly different between the treatment and control groups suggesting a low risk for this type of bias.

	Treatment group	**Control group**
Activity on CharlieCard but not on ChatBot	8%	7%
Activity on ChatBot but not on CharlieCard	2%	3%

A final check compared the average response rate to the daily ChatBot diary between the treatment and control groups. On average, study participants responded to over 50% of the daily diary texts, with the average for the treatment group slightly higher than that for the control group. Figure A2 shows the response rate distributions for the two groups, which suggests little difference in the response rate behavior between the two groups.

Figure A2. Demographic balance between the two study groups