IS PUBLIC TRANSPORT ELASTIC?

Trends in King County Metro Transit Ridership Before and After a Reinstatement of Fares

Photo: King County Metro

Executive Summary

This brief explores the impact of King County's fare reinstatement during the COVID-19 pandemic on ridership as well as differential effects across income groups. Our analysis finds that average ridership decreased by 6% after fares were reinstated. Interestingly, ridership appears to have declined the most among high-income riders, likely because they had more transportation options at their disposal to avoid the fare reinstatement. However, these results were not confirmed by statistical tests. More data is necessary to examine differential effects of the fare reinstatement on income groups and affirm the hypothesis that ridership declined most for high-income individuals.

Introduction

In response to the COVID-19 pandemic, King County Metro Transit ceased charging riders for using their transport services. King County Metro Transit reinstated fares on October 1, 2020. This brief examines the impact of the fare reinstatement on average ridership in King County and differentiates these impacts by income groups. Ultimately, this brief aims to help policymakers understand trends in ridership in King County during the pandemic, how charging fares impacted these trends, and equity concerns in terms of differential impacts across income groups. Understanding the consequences of the fare reinstatement is essential for making informed decisions about public transportation policy that promote equity and address the needs of the diverse communities within King County.

The brief begins by describing the data and analytical approach taken to understand the impact of the fare reinstatement. This is followed by a presentation of the main results, and then a discussion of the conclusions and recommendations for King County policymakers.

Analytical Approach

To analyze trends in ridership in King County, we leveraged three different data sets — Automated Passenger Count (APC) and bus schedule data, King County Metro (KCM) bus stops data, and American Community Survey (ACS) data. The APC and bus schedule dataset record bus trips over the study period as well as the activity at each bus stop, such as the number of passengers boarding and alighting. The KCM bus stops dataset provides geographic information on the location of each bus stop, and the ACS data records demographic information on census tracts in King County, such as median income, ethnic and racial composition, and population size.

King County Metro Transit reinstated fares on October 1, 2020. To understand patterns in ridership before and after the fare reinstatement, we analyzed trends in bus ridership by census tract from September 19, 2020 to October 31, 2020. We carefully selected this timeframe due to system changes implemented just before September 19, which impacted measures of ridership.[1]

Our analytical approach entailed calculating daily ridership based on stop activity at all bus stops within each census tract. With this, we created a measure of average ridership per census tract per day. To understand ridership across the entire county, we then averaged the ridership across census tracts for each day. Next, we compared the average daily ridership before and after the fare reinstatement to understand how trends may have changed. Additionally, we considered differential impacts of the fare reinstatement on socioeconomic groups in King County. To do this, we categorized each census tract as low-, middle-, or high-income based on the median income of the census tract. This allowed us to identify any disparate impacts of the policy across income groups.

Results

King County Metro Transit's fare reinstatement was followed by a small decrease in ridership. In fact, after the fare reinstatement, there was a 6.1% decline in average ridership. According to our analysis, this decline in average ridership was not random chance, but was driven by a systematic difference in ridership levels before and after the fare reinstatement.[2] This decrease in ridership can be seen in Figure 1, which displays average weekday ridership before and after fares were reinstated.[3]

Figure 1. Trends in Average Ridership across King County Census Tracts

As Figure 2 below shows, even before fares were reinstated, average ridership from middle- and low-income tracts was slightly higher than for high-income tracts. This pattern continues across the study period. Of the three income groups, ridership from high-income tracts declined the most after the reinstatement of fares. Following the fare reinstatement, high-income tracts experienced a 10% decrease in ridership. Meanwhile, ridership from middle-income and low-income tracts remained relatively unchanged. After the reinstatement, average ridership in middle-income tracts decreased by only 1.2%, while ridership in low-income tracts actually increased by 0.2%.

Interestingly, Figure 2 displays a visibly greater variance in daily ridership for high-income tracts. While ridership in high-income tracts is, on average, lower than low-income or middle-income tracts, there are multiple days where ridership in high-income tracts spikes quite high, particularly on days around the reinstatement of fares. This

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[1] For more information, see the "Changes to Variable Operationalization: Time Period Selection" section in the Data Appendix.

[2] For information on the statistical test used to arrive at this conclusion, see Table 1 in the Data Appendix.

[3] This analysis focuses on ridership on weekdays only. For more information on how the measure of ridership was determined and why it only focuses on weekdays, see the Data Appendix.

volatility in daily ridership near the fare reinstatement may have driven the large decline we found in average ridership from high-income tracts. This hypothesis is further evidenced by our statistical analysis, which found that the decline in ridership from high-income census tracts was not necessarily driven by systematic differences in ridership levels. Thus, the 10% decline in ridership from high-income census tracts may have been driven by the unusual variance in ridership from these tracts on certain days around the time of the fare reinstatement.

Figure 2. Trends in Average Ridership by Income Group
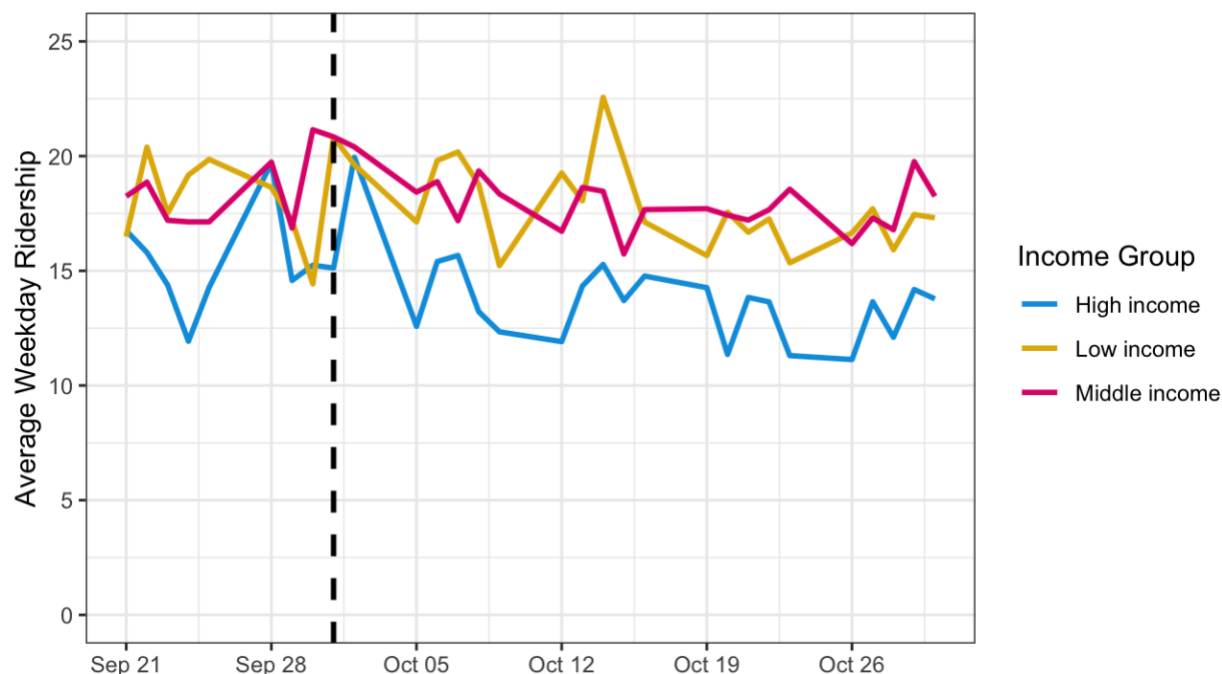
Conclusions

The results presented here suggest that King County Metro Transit's reinstatement of fares was followed by a small but significant decline in ridership. Though we cannot be sure that the fare reinstatement *caused* the decline, we can conclude that ridership decreased after this change was made. Similarly, the analysis finds that average ridership declined for high-income census tracts. This decline was larger than the overall decrease in ridership, but we cannot be sure that the difference in average ridership from high-income census tracts reflects an overall trend of decreased ridership from high-income tracts. We hypothesize that particularly high ridership from high-income census tracts in the days leading up to the fare reinstatement may have driven these results.

This analysis faces several important limitations. Due to challenges with data availability, our analysis examines ridership over a short time period. In particular, our data for the period before fares were reinstated spans only 12 days. This makes it difficult to detect long-term patterns in ridership. Likewise, our analysis is not causal. That is to say, we cannot be certain that the fare reinstatement caused the overall decline in ridership. There may have been some confounding factor in King County, like a second wave of COVID outbreaks, that made residents less likely to use public transit during this time period. Thus, it is important that policymakers do not conclude that increasing fares for public transit necessarily decreases ridership.

Policy Implications & Recommendations

The results of this study imply that ridership decreased in King County after fares were reinstated on Metro Transit. However, trends in ridership seemed to vary across income groups. In particular, ridership from middle-income and low-income census tracts did not change significantly when Metro Transit began to charge fares again. This finding aligns with a similar study of ridership in King County, which suggested that low- and middle-income individuals had

a relatively inelastic demand for public transport during the COVID-19 pandemic.[4] This means that, as public transport fares change or as health conditions make public transport risky, some individuals may adjust their behavior and take other means of transport. Meanwhile, lower-income individuals likely have fewer transportation options and thus do not adjust their behavior in reaction to fare changes or a pandemic. On the positive side, this suggests that ridership among lower- and middle-class individuals will remain relatively consistent over time. But, from an equity lens, this may be concerning. These individuals have fewer transport options and, thus, must bear the costs of any changes to the system.

As such, we recommend that King County focus on collecting more granular data on the socioeconomic status of public transit riders over a longer timeframe. Our analysis only looks at tract-level socioeconomic characteristics and uses this to make inferences about the demographics of riders. In addition, there was a high level of variance in ridership from high-income tracts, particularly around the period of the fare reinstatement, which may have biased our analysis. Collecting more granular data would allow policymakers to better understand *who* relies on public transport and bears the costs of financing this system and how changes to fares impact their ridership behavior.

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[4] See Brough, R., Freedman, M., & D.C. Phillips. 2020. "Understanding socioeconomic disparities in travel behavior during the COVID-19 pandemic." *Journal of Regional Science 61,* 753-774.

Data Appendix

Introduction

This appendix provides details on the data used to evaluate the impact of King County's fare reinstatement on ridership and its differential effects across income groups. Specifically, we explain how we define ridership, identify socioeconomic groups, and handle missing data and outliers.

Feature Engineering

Ridership - Ridership is defined as the average daily inbound boardings on weekdays across census tracts. We focus on inbound boardings only to imply that a rider lives in that particular census tract and ensure that they are not double counted when they return home, allowing for more accurate tracking of ridership. We also focus on weekdays, as preliminary analysis showed no significant changes in ridership during weekends, while weekdays were significantly impacted by the fare reinstatement (see Figure 3). This approach is reasonable since people typically use public transportation for commuting to work during weekdays. A t-test was also performed on average ridership before and after the fare reinstatement, revealing a significant difference in ridership for weekdays, but not for weekends or total ridership (see Table 1).

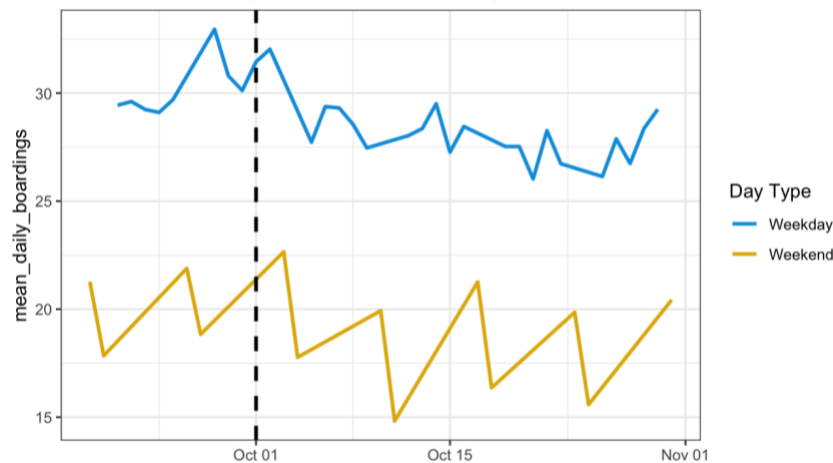**Figure 3. Average Inbound Daily Boardings by Weekday and Weekend per Census Tract**

Table 1. T-Test Results Comparing Total, Weekday, and Weekend Ridership

Comparison	Mean Boardings Before October 1, 2020	Mean Boardings After October 1, 2020	t	P value
Total	26.734	25.504	0.71	0.486
Weekday	30.121	28.272	3.692	0.004
Weekend	19.959	18.738	0.923	0.383

Socioeconomic Groups - First, we conducted our analysis on income groups by dividing census tracts into three income levels (high, middle, and low-income groups) based on the 25th, 50th, and 75th percentiles of the census tract median income distribution. Ultimately, 99 census tracts were categorized as high-income, 196 as middle-income, and 99 as low-income. Table 2 below shows the results of t-test on ridership by income group. In addition, we explored race (majority white tracts and majority minority tracts) and occupation types (majority white collar and majority blue collar tracts). However, our analysis did not reveal significant differential effects of the policy between majority white

and majority minority tracts or between majority white collar and majority blue collar tracts. This is likely due to the method in which tracts were categorized. Labeling a tract "majority white" or "majority blue collar" means inferring that all riders from that tract are white or blue collar, so we lose meaningful variation in the data with this categorization.

**Table 2. T-Test Results Comparing Ridership by Income Group**

Income Group	Mean Boardings before October 1, 2020	Mean Boardings after October 1, 2020	t	P value
High-income	15.333	13.797	1.712	0.115
Middle-income	18.291	18.069	0.366	0.722
Low-income	17.960	17.999	0.962	-0.049

Data selection

Time Period Selection - We limited our research to the period between 2020-09-19 and 2020-10-31 because there were significant service changes enacted on 2020-09-19, which caused a substantial increase in overall ridership from 2020-09-01 to 2020-10-31.

Outliers - Upon calculating the total number of boardings at each bus stop per day, we discovered some extremely large boarding figures at a few stops on weekdays. We examined these stops and found that most were in tract number 53033008102. By mapping bus stops and census tracts in King County (Figure 4), we noticed that most densely populated tracts were around geographic coordinates *(122.3W, 47.6N)* at the top left corner, close to census tract 53033008102's location *(122.336W, 47.605N)*. We concluded that the high ridership at these stops was primarily due to the area's higher population density. We decided to keep these outliers as they reflect the unique features of this area, including its high population density and demand for public transport.

Figure 4. Geographic Distribution of Tracts and Bus Stops in King County
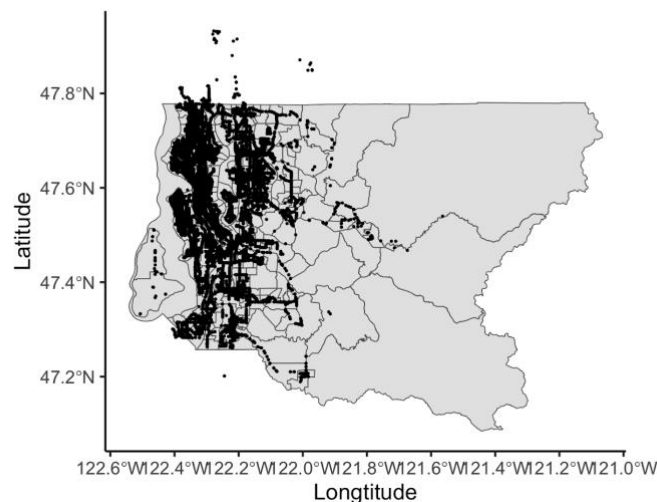
External or Supplementary Data - We did not utilize external or supplementary data sources, as the current dataset suffices for analysis.

Missing and Incomplete Data - Some missing values were found in income and racial subgroups. Specifically, four tracts had NA values for median household income, and one tract for racial information. We simply excluded these tracts from our analysis.