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Does the demand response to transit fare increases vary by income?

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ABSTRACT

Changes in ridership at individual stations on Chicago's mass-transit rail system following fare increases in 2004, 2006, 2009 and 2013 are analyzed to determine whether the ridership response varies with the per capita income in the neighborhood surrounding each station. We find mixed results. For one of the four fare changes the decline in ridership is greater in lower-income neighborhoods than it is in higher-income neighborhoods. However, the reverse is found for another fare increase. For two of the increases there is no relationship between income and ridership response. These mixed findings are in line with the prior literature that also found an inconsistent relationship. We hypothesize that there are two competing forces at work. On one hand lower-income groups are more constrained in their budget, but on the other hand they have fewer options for switching to other modes.

1. Introduction

When a transit agency raises its fares, does the demand change by a similar proportion in all areas of the city, or does it vary with the income or other characteristics of individual neighborhoods within the city? This is a very pertinent question in the politically-charged environment in which heavy subsidized and largely publicly-owned transit agencies operate. Most of the North American transit industry charges a flat fare so increases apply uniformly to all riders. Consequently part of the political resistance to fare increases is the concern that lower-income riders may be disproportionately affected, and that these riders rely on inexpensive transit fares for basic mobility and access to jobs.

The issue requires an empirical investigation because there are two conflicting forces at work. On one hand, riders in lower-income neighborhoods are less likely to have access to a car, meaning that they are less able to switch modes in response to a fare increase. They would therefore be less fare responsive than riders in higher-income neighborhoods with greater car access. On the other hand, lower-income riders are less able to tolerate the effects of a fare increase as it represents a greater proportion of their daily budget. This would imply that they would be more fare responsive than higher-income riders. Four recent fare increases by the Chicago Transit Authority offer an opportunity to investigate the issue. Changes in the number of riders entering at individual rail stations are analyzed with respect to the income characteristics of the neighborhoods surrounding each station.

A couple of clarifications are necessary. The first is that this paper is not concerned with whether or not people in lower-income neighborhoods ride public transportation more or less frequently than those in higher-income neighborhoods (in other words, we are not estimating an income elasticity of demand). Rather it deals with whether there are systematic variations in how residents in neighborhoods of differing income characteristics react to fare changes. The second is that our data do not permit calculation of fare elasticities per se. This is because the changes in ridership are measured over a 12-month period, and exogenous demand shocks caused by the business cycle and changing gasoline prices occurred at the same time as the changes in fares.

2. Literature review

There is a large literature on the fare elasticity of demand for public transportation (see the meta studies by Hensher, 2008; Holmgren, 2007; and Wardman, 2014). However, there has been little attention paid to investigating whether the demand response to fare changes varies between riders due to differences in their incomes. The limited prior literature is summarized in the British (Balcombe et al., 2004, at page 61) and United States (Transportation Research Board, 2004, at pages 12–36 to 12–38) practical handbooks. The latter concludes (on page 12–36) that "[t]he effect of income on fare elasticities is not well researched."

The earliest paper appears to be Lassow's (1968) analysis of a fare increase in New York City in 1966. He found that ridership declined by

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8.6% at 10 stations in "depressed areas of the city," but by only 2.7% at stations near commuter railroad and bus terminals that were patronized by commuters of "presumably higher economic status." However, ten years later, Obinani (1977) found a contrary result after the 1975 fare increase in New York City. While in general he found "ridership reductions in roughly equal proportions from all major socioeconomic and demographic groups," there were suggestions that groups with annual household incomes of greater than $15,000 ($66,200 in 2015 dollars) were slightly more likely to change mode as a result of the fare increase. Moreover, the lowest rate of work-trip mode changes occurred among "household heads with lower incomes, having no more than a high school education, under 34 years of age, and nonwhite."

Experiments with free off-peak transit in the United States in the 1970s allowed observation of whether certain income groups were overrepresented among the generated ridership. Swan and Knight (1979) found that higher-income riders in Denver (from households with income more than $20,000, the equivalent of $78,200 in 2015 dollars) were more responsive to the fare reduction than were lower-income riders. However, further analysis of the Denver experiment by Mayworm et al. (1980) found little variation among income groups. But the latter authors did find some evidence that middle and higher-income riders (those with annual household incomes of $10,000 or more which equates to $32,600 or more in 2015 dollars) were more responsive than lower-income riders during a similar off-peak free fare experiment in Trenton, New Jersey.

Cummings et al. (1989) used both stated and revealed preference data to examine the effects of three Chicago Transit Authority fare increases in the early 1980s. For work trips, the authors found that lower-income riders (from household with incomes of less than $30,000, the equivalent of $64,800 in 2015 dollars) had slightly more fare sensitivity than higher-income riders. However, there was no difference in fare sensitivity for non-work journeys.

Mackett (1990) used a micro-analytical simulation model to estimate the fare elasticities for bus service in the British city of Leeds. He found a limited variation between the socio-economic groups, and estimated a fare elasticity of −0.67 for unskilled manual workers, −0.69 for skilled manual workers and −0.62 for non-manual workers.

Halcrow Fox and Associates (1993) found in Britain that "the greater a traveller's income, the more elastic the response to a fare increase." For mass-transit rail they concluded that for work trips the fare elasticity was −0.2 for low-income riders, −0.3 for medium-income riders and −0.5 for high-income riders. For non-work trips the fare elasticities were −0.6, −0.65 and −0.75 respectively.

Molnar and Nesheim (2011) used the 2008 National Travel Survey in Britain to estimate fare elasticities for local bus service in areas outside of London. They found that the travelers drawn from the middle three quintiles of annual household incomes (from £12,500 to £50,000, which is approximately $21,000 to $84,000 in 2015 dollars) had broadly the same fare elasticity of −0.36. Travelers in the lowest quintile of household income had a slightly more elastic demand of −0.39 and those in the highest quintile of household incomes were slight more inelastic at −0.32.

The United States practical handbook (Transportation Research Board, 2004 at page 12-7) concludes that "[t]he effect of income … is less clear, but it appears that most fare changes have affected ridership of lower income groups … less than other groups." A journal article summary (Paulley et al., 2006) of the British handbook makes a stronger statement that "[t]ravellers with high incomes tend to have higher elasticity values because their higher car ownership levels mean that they have an alternative when fares increase." This statement would certainly be consistent with the findings of Halcrow Fox and Associates (1993) for rail service. However, the results in Mackett (1990) and Molnar and Nesheim (2011) for bus services in Britain suggest that there is not a strong relationship, and that higher-income riders might actually be less fare sensitive.

3. Methodology and data

This study is an aggregate demand analysis. Aggregate analysis has advantages and disadvantages. The advantage is that transit fare increases occur reasonably frequently and therefore there is plenty of empirical data on the revealed choices of riders. The disadvantage is that unlike disaggregate demand studies (Ortúzar and Willumsen, 2011) it does not give insights into which types of people may switch modes or discontinue some trips, and their decision making process. However, while aggregate models usually miss out on the nuances of decision making, in this case the income disparities between different neighborhoods in the City of Chicago are large. The average per capita income in the areas surrounding stations varies from $10,000 a year to $75,000 a year.

3.1. *Transit in Chicago*

The Chicago Transit Authority (CTA) provides bus and heavy rail elevated and subway train service in the City of Chicago and inner suburbs with a fleet of 1,700 buses, and 1,000 railcars operating on eight rail routes. It services a population of 3.4 million. This analysis concerns ridership at rail stations. A similar analysis might be possible for bus services if access was available to boardings data at individual bus stops. However, publicly available data are only reported at the level of individual bus routes.

3.2. *Transit fares in Chicago*

The CTA single-trip pricing structure is a flat fare irrespective of distance traveled or time of day. The CTA also offers multi-day and monthly passes that can be used on both the bus and rail system. Stored-value electronic media purchased from vending machines can be used for single trips on either mode. The electronic stored-value fare media replaced pre-purchased tokens in 1999, and cash payment to an agent at a station was discontinued in 2009 (albeit the vending machines fulfill the same function). Cash can still be used to board a bus. The price of a single ride on the bus has been 25 cents cheaper than rail since 2006. Chicago does have a commuter rail system run by a separate agency that has distance-based fares. However, it generally does not serve the same markets as CTA heavy-rail service.

Since 2000 the CTA has increased its fares four times on January 1 of 2004, 2006 and 2009, and January 14, 2013. Table 1 shows the principal adult fares. The fare increases of 2004 and 2006 primarily targeted cash fares and did not change the prices for single fares and period passes paid by electronic fare media. This was at a time when the CTA was introducing electronic ticketing and wanted to encourage people to switch to this form of payment. The fare increase of 2009 eliminated the single-ride discount given to holders of the stored value

Table 1
Principal adult rail fares.

	Before 2004	2004	2006	2009	2013
Single Ride – Cash	$1.50	$1.75	$2.00	Discontinued[a]	Discontinued
Single Ride – Stored value Card	$1.36	$1.59	$1.59	$2.25	$2.25
1-day Pass	$5	$5	$5	$5.75	$10
7-day Pass	$20	$20	$20	$23	$33
30-day Pass	$75	$75	$75	$86	$100

Note:
[a] Passengers can still purchase a stored-value ticket for a single ride from a vending machine at stations.