



Public transit fare structure and social vulnerability in Montreal, Canada



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ARTICLE INFO

Article history:

Received 27 July 2015

Received in revised form 5 December 2016

Accepted 12 December 2016

Keywords:

Transit fares
Monthly fares
Weekly fares
Low-income
Equity

ABSTRACT

Research on social equity pertaining to transportation typically addresses how residents in a region have access to desirable destinations. Nonetheless, little is known about how public transit fare structures relate to social equity concerns. Some transit agencies charge more for fewer rides—weekly fares often cost more per ride than unlimited monthly fares, though monthly fares cost more upfront. For some social groups, in particular low-income earners, purchasing monthly passes may place a burden on their budget, and influence them to buy weekly passes instead. In this study, we analyze transit fare purchases of total monthly, weekly, and three or more weekly passes during the month of September 2014 in Montreal, Canada. We discovered that fare vendors in neighborhoods with low median household income and/or with a high proportion of unemployed residents are predicted to sell more weekly fares than vendors in neighborhoods with high household income and low rates of unemployment. Monthly fare purchases were not dependent on income or unemployed residents. Moreover, using smartcard data to track individual fare cards, we found that recurring purchases of three or more weekly passes depend on income and unemployment, so neighborhoods with socially vulnerable individuals are predicted to have more riders purchasing multiple weekly fares than socially secure neighborhoods. Our findings indicate that individuals residing in marginalized neighborhoods are likely to spend more money on transit fares over the course of a month compared to those residing in wealthy neighborhoods. These findings raise concerns regarding the financial burden that the existing fare structure in the city of Montreal imposes, especially on low-income groups. The methodology and findings from this study provide insight for transport planners, particularly those concerned with providing an equitable public transit system.

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1. Introduction

A public transit network capable of moving many residents to diverse locations is an integral characteristic of any city. A large focus of public transit research deals with scheduling and operations or travel behavior and mode share, but fewer studies have investigated fare structures and purchasing. Moreover, from a social equity perspective, a growing body of literature has asked whether transit benefits and projects are distributed equitably in a region (Delbosc and Currie, 2011; Foth et al., 2013; Manaugh et al., 2015; Martens, 2012, 2017), but fewer studies have addressed the equity impacts of fare structures. Indeed, transit fares may form an important barrier for the working poor (Stolper and Rankin, 2016). One recent exam-

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ple of research on fare structures was a study in New York City, where researchers discovered that entries at subway stations in low-income census tracts were predominately from seven-day fare cards, while entries at stations in higher income census tracts were largely from monthly fare cards (Hickey et al., 2010). In New York City—as in many other cities—purchasing multiple weekly fares as a substitute for a monthly fare costs more in the long run since buying in bulk is cheaper. However, low-income earners may be unable to spend a large amount at one time for a monthly fare, opting instead to buy weekly fares that are cheaper in the short-term but costlier in the long-term (Schuerman, 2015; Stolper and Rankin, 2016).

In this paper, we investigate how purchases of different transit fare types may relate to social vulnerability, particularly income and unemployment, with implications for social equity. We studied purchases of transit fares using OPUS card transaction records, the transit fare smartcard of the transit agency of the Island of Montreal, Canada, the Société de transport de Montréal (STM) (STM, 2015). To shed light on the spatial and socioeconomic factors that underlie different types of fare purchases, we model the number of total monthly fares purchased, total weekly fares purchased, and the number of riders who purchased three or more weekly fares during September 2014. We hypothesize that some low-income earners and unemployed residents may be unable to purchase monthly passes because of the high upfront cost, and buy weekly passes as a substitute; while a weekly pass is less expensive upfront, buying three or more weekly passes over the course of the month is costlier (per ride). Based on our hypothesis, we expect to find concentrations of weekly fare transactions predominately in low-income neighborhoods, and we also predict that income will be a significant explanatory variable of three or more weekly fare sales that we hereafter refer to as recurring, repeated, or multiple weekly fare sales.

The paper begins with a review of the relevant literature on transport equity and transit fares. Next, we provide background on the Montreal context and transit fare structure of the STM, Montreal's main transit provider. Third, we describe our dataset, methods, and modeling approach. Fourth, we explain our models and findings. Lastly, we discuss our findings and potential policy relevance.

2. Literature review

An emerging body of literature has brought social equity concerns to the forefront of many disciplines, including land use and transportation planning (Geurs et al., 2009; Martens, 2012). Nevertheless, in many instances, what equity entails is murky including equity in transportation planning (Manauagh et al., 2015) and the definition of equity itself (Taylor and Norton, 2009). Generally, equity in reference to planning, as espoused by Krumholz and Forester (1990), means allocating more resources to those who have the least. This idea would propose ensuring that socially vulnerable populations, who are typically bound to transit (APTA, 2007), have a larger share of transportation-related benefits, such as accessibility to jobs by transit (Foth et al., 2013) or access to transit itself (Delbosc and Currie, 2011; Wasfi et al., 2013; Welch, 2013), than individuals with more transport options, like a private vehicle. With regard to transit fares, an equitable scheme consistent with Krumholz and Forester (1990) thesis would be one where low-income individuals pay less, while individuals who can afford to pay more will pay a greater fare (Aggarwala, 2012).

Many different fare schemes are used by transit agencies with varying impacts on social equity. In North American cities, many transit agencies charge flat fares for city bus and subway services (Cervero, 1981), regardless of distance traveled or mode. Since low-income residents tend to live in central city neighborhoods well-served by transit (Glaeser et al., 2008), these residents likely travel shorter distances and thus are poorly served by flat fares. On the other hand, commuter rail tends to be zonal in fare structure and is mostly used by affluent white-collar workers (Taylor and Morris, 2015). These schemes also apply to Montreal, where one flat fare is used for city buses and metros, but commuter rail fares are zonal. Recent work using spatial modeling to examine a switch from flat to distance-based fares found that this switch is advantageous for minority and low-income riders in Wasatch Front, Utah (Farber et al., 2014). In addition to considering fares based on distance or time of day, different fares types, such as monthly unlimited or weekly unlimited passes are also used by many agencies. The price-per-ride of a monthly pass is usually less expensive than weekly or daily single fares.

With varying fare schemes, demand for transit can be managed. For example, longer trips in Beijing are most affected by fare increases (Wang et al., 2015), while in New York City, estimated ridership loss is less for increases in unlimited monthly fares compared to weekly fare increases (Hickey, 2005), implying that sensitivity of ridership depends on fare structure and type. By evaluating several scenarios of Alameda-Contra Costa Transit, California, Nuworsoo et al. (2009) found that vulnerable riders, including low-income riders, youth, and minorities would be penalized more by scenarios that would increase flat fares per ride due to more transfers and more trips compared to affluent riders who could afford to purchase a monthly pass. In contrast to agencies with flat fares or costlier fares for fewer rides, in Washington, D.C., distance and peak trips determine transit fares, and per ride, weekly fares cost the same as monthly fares (WMATA, 2015). Washington's approach to charging lower fares during off-peak hours could address some equity concerns (Taylor and Norton, 2009). To specifically address vulnerable populations who depend on transit, transit agencies in San Francisco, Seattle, and Calgary, for example, have programs for subsidized transit passes for low-income riders (SFMTA, n.d.; Transit, 2015; Transit, 2015).

Nevertheless, few studies have considered the factors underlying transit fare purchases. By estimating travel demand in Athens, Greece, researchers uncovered that the fare type can influence ridership, and this varies by mode as well as fare price (Gkritza et al., 2011). While that study used some sociodemographic indicators, namely income and immigrant status, to determine their association with fare purchases, detailed demographics were lacking. This is likely due to the inability to

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