Transport Policy 74 (2019) 103–113

Contents lists available at ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

# The relationship between financial incentives provided by employers and commuters' decision to use transit: Results from the Atlanta Regional Household Travel Survey

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ARTICLE INFO

*Keywords:*
Atlanta Regional Household Travel Survey
Transit
Transit pass or parking
Transportation or travel demand management

ABSTRACT

Local employers can play an important role in the transportation or travel demand management (TDM) effort by influencing commuters' mode choice through financial incentives. Using the 2011 Atlanta Regional Household Travel Survey data, this paper analyzes the relationship between free or subsidized transit pass or parking provided by employers and commuters' decision to use transit in metro Atlanta. We find that employees who were provided free or subsidized transit pass had 156% higher odds to commute on transit, but employees who were provided free or subsidized parking had 71% lower odds to commute on transit, all else equal, compared to their counterparts. Hence, encouraging local employers to offer free or subsidized transit pass instead of free or subsidized parking to their employees would be an effective strategy to manage transportation or travel demand in metro Atlanta.

## 1. Introduction

Transportation-related financial incentives provided by employers could influence commuters' mode choice decision. The conventional wisdom is that employees seek to maximize utility by choosing the mode providing the highest utility and this utility typically depends on travel cost along with taste variables, usually represented by socio-demographic characteristics of individuals and/or households, and spatial configuration of land use and transport infrastructure at the origin and/or destination (Ben-Akiva and Lerman, 1985; Cervero, 2002; Domencich and McFadden, 1975; Ewing and Cervero, 2010; Kuzmyak et al., 2003; Limtanakool et al., 2006; Steg and Vlek, 1997). For instance, all else equal, if employees are provided free or subsidized transit pass, they are more likely to commute on transit, but when they are provided free or subsided parking at their workplace, they are more likely to drive alone.

Previous studies have analyzed factors influencing commuters' mode choice and reported that in addition to spatial configuration of land use and transport infrastructure at the origin and/or destination, commuters' mode choice – driving alone, carpooling, transit, walking, or biking – was also associated with transportation-related financial incentives, such as free or subsidized transit pass or parking provided by employers (Fujii and Kitamura, 2003; Hess, 2001; Lachapelle, 2017; Thogersen, 2009; Willson and Shoup, 1990; Wilson, 1992; Yang et al., 2015; Zhang et al., 2014). Also, studies have indicated that transportation-related financial incentives reduced the use of single occupancy vehicles during peak-hours (Ben-Elia and Ettema, 2011a, 2011b; Ettema et al., 2010; Rey et al., 2016). In this study, using data from the 2011 Atlanta Regional Household Travel survey, we analyze if there was a relationship between free or subsidized transit pass or parking provided by local employers and commuters' decision to use transit in metro Atlanta.

While talking about transit options in metro Atlanta, we need to go back to a 1950s study recognizing public transportation or transit as an integral part in metro Atlanta's future growth and economic expansion. By 1960, the study garnered enough traction and support leading to a proposal for a modernized transit system. In 1965, the Metropolitan Atlanta Rapid Transit Authority Act was commissioned creating, in the fall of 1968, what we know today as MARTA. MARTA now operates a network of bus routes linked to a rapid transit system consisting of 48 miles of rail track in almost exclusively in Fulton, Clayton, and Dekalb counties in the metro region (Metropolitan Atlanta Rapid Transit Authority, 2018). Some other counties in the region have their own transit systems (e.g., CobbLinc, Cherokee Area Transit Service, and Gwinnett County Transit) providing commute options to the public. Most recently, local leaders in the metro Atlanta region have agreed to develop a unified regional transit system serving its 13 counties, called the Atlanta-Region Transit Link Authority also known as ATL, to

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https://doi.org/10.1016/j.tranpol.2018.11.005
Received 3 November 2017; Received in revised form 16 November 2018; Accepted 18 November 2018
Available online 19 November 2018
0967-070X/ 

provide unified transit service to the public and making it more reliable and dependable (Georgia Regional Transportation Authority, 2018).

Excessive traffic congestion is a bane of urban lives in many metro areas including metro Atlanta because of various costs associated with excessive traffic congestion.[1] A recent study by a transportation analytics firm, INRIX, has ranked metro Atlanta the eighth most congested city in the world (INRIX, 2017).[2] Also, commute time in metro Atlanta is relatively longer than the national average – average commuter in metro Atlanta spends 30 minutes in driving compared to 26 minutes of the national average (Associated Press, 2015; Kneebone and Holmes, 2015). Further, average driver in metro Atlanta experienced 52 hours of delay compared to 42 hours of delay, on average, in the 10 most congested cities in the United States in 2014, costing $1130 per driver or $3.1 billion a year to the metro economy which is approximately one percent of roughly $300 billion metro Atlanta economy (Kanell and Stafford, 2015; Moskvitch, 2014; Schrank et al., 2015).[3]

Excessive traffic congestion may be viewed as a hidden tax for residents and business communities and residents in metro Atlanta are increasingly concerned about traffic congestion. For instance, residents in metro Atlanta, four years in a row since 2012, have ranked traffic congestion the biggest problem faced by residents (Atlanta Regional Commission, 2016a). This congestion cost could hinder growth of the local economy in various ways. As congestion trims disposable income on fuel, repairs, and maintenance, it could dampen the demand side of the local economy. It could also dampen the supply side through higher costs of productions and deliveries. If the state of traffic congestion continues to get worse, this can negatively impact the inflow of investment or capital into the region.[4] Hence, improving these metrics is critical to the economy and quality of life in metro Atlanta.

One way to mitigate traffic congestion is through the use of transportation or travel demand management (TDM) policies. TDM policies seek to reduce auto trips by increasing travel options or altering mode choice, providing incentives and more accurate and timely information on current traffic conditions to encourage and help individuals modify their travel behaviors or by reducing the physical need to travel (Ferguson, 2018; Steg and Vlek, 1997). Table 1 summarizes various forms of TDM policies used in various part of the world. The most common TDM policies include transit subsidy, road pricing (e.g., toll road), land-use planning encouraging shorter travel distances, park and ride schemes, and improved infrastructure for walking and biking (Steg and Vlek, 1997). TDM is also included in air quality management plans for environmental reasons and in regional transportation plans because of its cost effectiveness compared to other supply side solutions, such as expanding road networks. One subset of TDM strategies focuses on reducing the use of single occupancy, private vehicles and encouraging individuals to use transit through various incentives, disincentives or marketing tools (Gärling et al., 2002; Ferguson, 2018). For instance, along with other factors, subsidizing transit use and controlling parking access by increasing parking price or limiting parking quota may help change commuting mode.

As a part of TDM efforts in metro Atlanta, various initiatives have been implemented to address and mitigate congestion in metro areas. These initiatives range from transit-oriented development to transportation mobility options at the regional level. For instance, the TransFormation Alliance, a collaborative effort of community advocates, policy experts, transit providers and government agencies in metro Atlanta advocates transit-oriented development in the metro Atlanta region (TransFormation Alliance, 2018). Likewise, the Georgia Commute Options was created in 1996 with the goal of helping commuters, employers and property managers take advantage of commute alternatives. It advocates and promotes transit riding, ride sharing, telecommuting and other options to cut trip demand of single occupancy vehicles by using various financial incentives in the 20-county metro Atlanta region (Georgia Commute Options, 2018).

Despite the availability of transit service in many locations in metro Atlanta and the fact that using transit can reduce traffic congestion, a small fraction, nearly 9 percent (5.87 percent every day and another 2.65 percent use once or twice a week) of the commuters used transit in metro Atlanta (Atlanta Regional Commission, 2011). Hence, the culture to drive alone seems to be the major cause of traffic congestion in metro Atlanta. Because of relatively strong job opportunities and affordable housing, population in metro Atlanta is growing and is expected continue to grow to over 8 million by 2040 (Atlanta Regional Commission, 2016b). This population growth along with the culture to drive alone is likely to increase traffic congestion in the region in absence of mitigation efforts and other supply side measures (e.g., expanding road network). In this regard, findings of this study would inform city planners and policy makers on the relationship between transportation-related financial incentives provided by local employers and commuters' mode choice in metro Atlanta. City planners and transportation planning agencies are expected using these findings, to inform their TDM policies. Also, these findings help local employers and business communities understand how their transportation related policies (e.g., free or subsidize transit pass or parking) may influence future of mobility in metro Atlanta. These findings may also be useful to the Georgia Commute Options in helping to reach out to certain demographic groups who are less likely to commute on transit despite its availability.

## 2. Theoretical framework

The basic analytical framework for mode choice comes from random utility model. The random utilities for individual $i$ are a set of latent variables $U_{i1}$, ……, $U_{iJ}$ defined as

$$U_{ij} = V_{ij} + \epsilon_{ij} \tag{1}$$

where $i =$ ,…., $N$ denotes individuals and $j = 1$, …., $J$ denotes alternatives (transit or else, in this case). Equation (1) consists of two parts: $V_{ij}$ is the deterministic component and $\epsilon_{ij}$ is the random component of the utility. The deterministic part of the utility is modeled as

$$V_{ij} = x_i' \beta_j \tag{2}$$

[1] According to a study conducted by the Harvard Center for Risk Analysis, traffic congestion in the 83 largest urban areas in the United States caused more than 2200 premature deaths in 2010 and added $18 billion to public health costs (Moskvitch, 2014).

[2] The INRIX Congestion Index (ICI) measures the impact of congestion on car commuters, by estimating the total number of hours the average commuter spends in congestion. It first estimates the percentage of time that drivers would spend in congestion at different parts of the day and week, and on different parts of the road network. These include peak, midday, evening and weekends, and highways into or out of the city compared to the inner-city road network. Based on trip volume at different points in time and location, and the relative size of cities, a weighted average known as the INRIX Congestion Index (ICI) is calculated (INRIX, 2017).

[3] A recent study by the safe-driving app Drivemode (2018) indicated that Atlanta drivers who take to the roadways between 4:00 p.m. and 5:00 p.m. spend more time in the car than commutes in almost every other big city except New York and Los Angeles in the United States.

[4] In a meeting with the Atlanta Business Community in 2007, Dennis Donovan, a principal at New Jersey-based world-wide site selection and corporate relocation firm spoke “When Fortune 500 companies contact me about where to relocate their companies, Atlanta is often a top choice because of its incredible strengths - the world's busiest airport, a rich talent pool, research universities that are the envy of the nation and good weather all year. Unfortunately, in too many cases those strengths are being overshadowed by one big weakness - traffic. We're just now starting to see Atlanta get knocked out of the running at the last minute when companies are picking new cities” (Metro Atlanta Chamber, 2007). Companies are increasingly concerned with congestion or mobility options in their decision to location selection. For instance, Amazon recently announced that easy access to major highways, a location within 45 min of an international airport and direct access to mass transit are among the company's requirements for HQ2 (Trubey, 2018).

**Table 1**
Various forms of transportation or travel demand management policies (Steg and Vlek, 1997).

| Transportation or travel demand management policies |
|---|
| Taxation of cars and fuel |
| Closure of city centers for car traffic |
| Road pricing |
| Parking control |
| Decreasing speed limits |
| Avoiding major new road infrastructure |
| Teleworking |
| Land use planning encouraging shorter travel distances |
| Traffic management reallocating space between modes and vehicles (e.g., bus and high occupancy vehicle lanes |
| Park and ride schemes |
| Improved public transport (e.g., frequency, comfort, retrievability of information about public transport, no price increases) |
| Improved infrastructure for walking and biking |
| Public information campaigns about the negative effects of driving |
| Social modelling where prominent public figures use alternative travel modes |

where $x_i$ is an $m$-dimensional vector of characteristics influencing commute model choice of individual $i$ and $\beta_j$ is an $m$-dimensional parameter vector associated with these characteristics (Wooldridge, 2010).

Employees, like consumers, act rationally and try to maximize their utility, specified in eq. (2) by choosing a commute mode (here, transit or else), yielding the highest utility (Domencich and McFadden, 1975). This utility typically depends on generalized cost also known as travel cost which includes the opportunity cost of travel time, out-of-pocket costs, spatial configuration of land use, transport infrastructure at the origin and/or destination and sociodemographic characteristics of commuters (Bohluli and Daneshgar, 2014; Chu and Polzin, 1998; Domencich and McFadden, 1975). Travel time consists of the time spent on a trip such as in-vehicle time, out-of-vehicle time, walking and waiting time. Likewise, out-of-pocket costs consists of all expenses associated with owning, operating and maintaining a vehicle. Hence, the amount paid for parking or transit pass and all tolls paid at toll booths are all out-of-pocket costs in travel demand analysis.

The literature on mode choice suggests spatial configuration of land use and transport infrastructure, such as land use diversity or mixed-use development, walkability, transit access and quality, destination accessibility and household or population density at origin and/or destination, are equally important in explaining mode-choice decision or travel behavior (Ewing and Cervero, 2001, 2010; Kuzmyak et al., 2003). For instance, transit use, in general, tends to be higher in areas proximity to transit infrastructure, with greater land use diversity or mixed-use development, greater walkability and transit access and quality, higher-density population or housing units (Taylor and Fink, 2003; Brown et al., 2003; Johnson, 2003; Limtanakool et al., 2006).

The literature also suggests a number of sociodemographic factors influencing mode choice including – age, gender, level of education, race/ethnicity, income and the status of having children in the household (Chen et al., 2008; Hamre and Buehler, 2014; Hess, 2001; Limtanakool et al., 2006; Schwanen and Mokhtarian, 2005). Access to vehicles, such as the numbers of vehicle in the household, may also influence mode choice (Hamre and Buehler, 2014; Loutzenheiser, 1997). Previous studies have indicated that trip characteristics such as distance between home and office may also influence commuters' mode choice (Hamre and Buehler, 2014; Hess, 2001; Vega and Reynolds-Feighan, 2009).

Given the opportunity cost of travel time, other out-of-pocket costs and all other factors affecting mode choice as discussed earlier, employees' decision to commute on transit also depends on cost of transit pass or parking. Accordingly, if free or subsidized transit pass is provided by employer, employees are expected to commute on transit, but if free or subsidized parking is provided, employees are expected to drive alone or expected not to commute on transit, all else equal.

## 3. Method

### 3.1. Data

This study uses household travel survey data from the Atlanta Regional Household Travel Survey (ARHTS) conducted in 2011 (Atlanta Regional Commission, 2011).[5] The Atlanta Regional Commission (ARC), in conjunction with the Georgia Department of Transportation (GDOT), conducts the regional household travel survey periodically to collect demographic and travel behavior characteristics of residents in the 20-county area of the metro Atlanta region. The survey is the primary input to update regional transportation forecasting and, to also, understand the potential impacts of socioeconomic shifts on mobility and traffic congestion. Understanding these patterns helps us better understand transportation infrastructure demands, future environment impacts and land development patterns and, most importantly, how all these are interrelated.

The Atlanta Regional Household Travel Survey uses a stratified random sampling approach where the survey universe is divided into smaller groups and a random sample was chosen within each group. In some cases, oversampling is done at certain geographic and demographic levels to capture the diversity of the population according to specific factors affecting travel behavior while meeting the county distribution goal. The survey also uses the global positioning system (GPS) to better understand trip characteristics from a subsample of households. The survey is pretested to refine the survey procedures, programs and materials.

The 2011 ARHTS had a goal to obtain demographic and trip characteristic data from a random sample of a minimum of 10,000 households including a subsample of 1000 households that would also provide GPS data. Data collection activities began in February 2011 and continued through October 2011, with a break during the summer, and included several stages; advance notification, reminder postcard, recruitment, placement of material, reminder call, travel data retrieval and data processing. The majority of the sampled households were initially contacted by an advance letter that introduced the household to the survey purposes and invited them to participate in the recruitment survey either by phone or online. Households that were not mailed an advanced letter were initially contacted by telephone. Once the household agreed to participate, key household and person-level information was collected. Eighty-five percent of the households completed the recruitment survey via telephone and the remaining 15 percent completed the recruitment survey online. All recruited households, including those participating in the GPS portion of the survey, were then mailed personalized diaries to report their travel (number of trips, travel locations, distance, etc.) for the assigned 24-h period. Out of 16,374 recruited households, a total of 10,278 households completed the survey, with an overall retrieval rate of nearly 63 percent. The survey also collected the latitudinal and longitudinal information of where the respondents live and work. To sum, the survey collected various information of nearly 26,000 persons, 21,000 vehicles and 94,000 trips associated with these households (Atlanta Regional Commission, 2011).

[5] Despite the availability of big-data, such as those collected by commercial forms using mobile apps or social media, we use conventional data to understand travel behavior in metro Atlanta for a number of reasons. First, some of the big data collected by commercial firms suffer from authenticity and credibility problems in data collection as these commercial firms, in general, neither adopt scientific data collection procedures such as random sampling method for data collection nor follow scientific data processing procedures to address biases. Hence, their data do not represent overall population. Second, these commercial big data providers do not have uniform methods collecting their data. For instance, they can change the sampling methods and processing algorithms at any time without any notice. Hence these data lacks compatibility over time. Third, although some big data are good in volume, they, in general, contain limited information for statistical and economic analyses. For instance, data collected by google map or waze, in general, does not include socioeconomic and demographic characteristics of users (Liu et al., 2015).

One section of the survey asked respondents about their employment status, the use of transit and transportation-related financial incentives provided by their employers. Particularly, respondents were asked to indicate if they are employed and how often they use transit to commute. The variable *transit* equals "1" if the employee commuted on transit at least once a week and "0" otherwise. Likewise, the variable *transit pass* equals "1" if the employee received a free or subsidized transit pass from the employer and "0" otherwise. Finally, the variable *parking* equals "1" if employee received free or subsidized parking at the workplace and "0" otherwise. Based on the latitudinal and longitudinal information on where the respondents live and work, we compute commute distance (distance between home and office, in miles) using the VINCENTLY program, built in Stata 14 (Nichols, 2007). The survey also collected socioeconomic and demographic information of the individuals, such as age, gender, race/ethnicity, level of education, income and number of children and number of vehicles in the household.

As we discussed earlier, spatial configuration of land use and transport infrastructures are equally important in explaining mode choice or travel behavior (Ewing and Cervero, 2001, 2010; Kuzmyak et al., 2003; Limtanakool et al., 2006). Accordingly, we account for land use or built environment (population per acre, land-use diversity, walkability and activity density) and transit measures (transit service frequency and jobs within 0.5 miles of fixed-guideway transit) at the residential and/or workplace census block group level, available from the United States Environmental Protection Agency (2017). To find the land use or built environment at residential area and/or workplace, we spatially join the OA/Smart Location Database and OA/Walkability Index dataset (https://geodata.epa.gov/arcgis/rest/services/OA) developed by the United States Environmental Protection Agency (2017), based on the 2010 census data, to the latitudinal and longitudinal information on where the respondents live and work, available from the ARHTS, using ArcGIS (Atlanta Regional Commission, 2011). The Smart Location Database includes over 90 different variables related to the built environment, accessibility, employment and a number of demographic characteristics for every Census 2010 block group in the United States (Ramsey and Bell, 2014). For more information about the Smart Location Database, please visit the webpage https://www.epa.gov/smartgrowth/smart-location-mapping#SLD. Similarly, the Walkability Index dataset characterizes every Census 2010 block group based on its relative walkability which depends on characteristics of built environment. For information about the methodology describing the process of creating Walkability Index, please visit the webpage at ftp://newftp.epa.gov/EPADataCommons/OP/WalkabilityIndex.zip.

### 3.2. Econometric model

Because we modeled the probability to commute on transit, $P(Transit)$ as a binary response ("1″ if employee commuted on transit at least a week and "0" otherwise), logistic regression is the most appropriate approach to model the transit choice (Wooldridge, 2010).[6] The logistic regression models the log odds of the outcome as a linear function of the predictor variables and can be specified as:

$$P(Transit) = \frac{\exp(\boldsymbol{x}'\boldsymbol{\beta})}{1 + \exp(\boldsymbol{x}'\boldsymbol{\beta})}$$

where $\boldsymbol{x}$ is a vector of explanatory variables (transportation-related financial incentives provided by employers – free or subsidized transit pass or parking, land use or built environment and transit measures (land use diversity, population per acre, transit service frequency, jobs within 0.5 miles of fixed-guideway transits, activity density and walkability) at the residential area and/or workplace census block group and socioeconomic and demographic characteristics of the individual as suggested by the literature on mode choice. The vector of explanatory variables (***x)*** also includes *industry-fixed effects* to account for industry-specific unobserved heterogeneities affecting commuters' mode choice. For instance, because of the nature of work, employees in construction industry tend to drive alone more often compared to those working in wholesale or retail industry. Finally, $\boldsymbol{\beta}$ is the vector of parameters to be estimated.

Since the logistic regression coefficients do not correspond to a linear relationship between the dependent and independent variables as in the ordinary least square model, we also compute odds ratios, which are exponentiation of the logistic regression coefficients, to help interpreting regression results. Heteroscedasticity-consistent robust standard errors are used to correct for potential bias arising from heteroscedastic residuals. *Wald chi2* is used to see overall significance of the regression model. The decision criteria for hypothesis testing is based on $p < 0.10$ (Wooldridge, 2010).

## 4. Results

### 4.1. Sample descriptions and summary statistics

Before running regression model, we did outlier analyses. Thirty-nine observations had age greater than 75 years, 90 observations had number of vehicles more than 6 and 10 observations had commute distance greater than 60 miles. Accordingly, we exclude those observations in the analysis. Table 2 describes the variables and Table 3 reports summary statistics. In the sample, nearly 9 percent of the sample commuted on transit at least once or twice a week (5.87 percent commuted nearly every day and another 2.65 percent commuted at least once or twice a week on transit). Twenty percent of the sample received free or subsidized transit pass and 87 percent received free or subsidized parking at their work. Regarding residential area characteristics, land use diversity score was 0.47 on the score between zero and one where the scores close to zero indicate less diverse and the scores close to one indicates more diverse, population per acre was 4.06, transit service frequency was 24, percentage of jobs within 0.5 miles of fixed-guideway transit was 0.04, activity density (housing and job per acre) was 4.14 and national walkability index was 8 on the score between 1 and 20. Likewise, land use diversity score of the workplace was 0.68 on the score between zero and one, transit service frequency was 90, and national walkability index score was 7 on the score between 1 and 20. Hence, land use was relatively diverse and transit service frequency was also higher in the workplaces compared to the residential areas. However, residential areas are more walkable compared to workplace.

Regarding sociodemographic characteristics, respondents, on average, was 46 years old; 51 percent of the sample were female; 72 percent were White; 63 percent had college degree or higher level of education; 26 percent had family income below $60,000 a year and 43 percent had children in the household.[7] Average individuals had 2 vehicles in the household. Commute distance of the average individuals

[6] Because of the availability of big-data, alternative modelling approach can provide better information about travel behavior. For instance, big data and machine learning can allow to observe mobility behavior on an unprecedented level of detail. However, there are a number of issues using machine learning in travel behavior analysis and modelling, including choice of appropriate methods for a given application, interpretability of modelling results as many methods are largely 'black boxes,' and the suitability of such methods for long-range forecasting application (He et al., 2018). Hence, we use conventional modelling approach to understand travel behavior in metro Atlanta.

[7] To indicate household income, respondents were provided the ranges: less than $10,000, $10,000 to $19,999, $20,000 to $29,000, ……, $50,000 to $59,000,……$150,000 or more in the survey. Since we use income as a control variable, we use a binary measure of income – *income below $60,000* a year with the intention to classify individuals above and below the median household income of $53,000 a year in the metro Atlanta region (Metro Atlanta Chamber, 2016). Likewise, there are multiple categories of race/ethnicity – white, Black or African-American, Asian, Native American, Alaskan Native, Pacific Islander, Native Hawaiian, Multiracial, Hispanic or Mexican, or other. Since we use race or ethnicity as a control variable, we use binary measure of race or ethnicity – *white* (Atlanta Regional Commission, 2011).

**Table 2**
Description of the variables.

| VARIABLES | Description |
|---|---|
| Transit use | Binary variable that equals "1" if the respondent commutes on transit at least once a week, and "0" otherwise. |
| Incentives from employers | |
| Transit pass | Binary variable that equals 1 if free or subsidized transit pass is provided to the respondent, and "0" otherwise. |
| Parking | Binary variable that equals "1" if free or subsidized parking is provided to the respondent, and "0" otherwise. |
| Residential area or workplace characteristics (census block group level) | |
| Land use diversity | Employment and household entropy calculation, where employment and occupied housing are both included in the entropy calculations. Higher scores indicate more diverse land use likelihood. |
| Population per acre | Gross population density (people/acre) on unprotected land |
| Transit service frequency | Aggregate frequency of transit service within 0.25 miles of block group boundary per hour during evening peak period |
| Jobs within 0.5 miles of fixed-guideway transits, % | Proportion of employment within ½ mile of fixed-guideway transit stop. |
| Activity density (housing + jobs per acre) | Gross activity density (employment and housing units) on unprotected land. Higher scores indicate more activity density likelihood. |
| National Walkability Index | Walkability score of a census tract relative to all other tracts. Higher scores indicate more walk trip likelihood |
| Socio-demographic characteristics | |
| Age | Age of the respondent, in year. |
| Female | Binary variable that equals "1" if the respondent is female, and "0" otherwise. |
| White | Binary variable that equals "1" if the respondent is White, and "0" otherwise. |
| College degree or more | Binary variable that equals "1" if the respondent has college degree (completed college degree) or higher level of education, and "0" otherwise. |
| Income below $60,000 | Binary variable that equals "1" if the respondent has household income below $60,000 a year, and "0" otherwise. |
| Children in household | Binary variable that equals "1" if the respondent has children in the household, and "0" otherwise. |
| Number of vehicle | Number of vehicles in the household. |
| Commute distance, miles | Distance between home and workplace, miles. |

Source: Atlanta Regional Commission (2011); United States Environmental Protection Agency (2017); Ramsey and Bell (2014).

**Table 3**
Summary statistics (n = 6576).

| VARIABLES | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Transit use | 0.09 | 0.28 | 0 | 1 |
| Incentives from employers | | | | |
| Transit pass | 0.20 | 0.40 | 0 | 1 |
| Parking | 0.87 | 0.34 | 0 | 1 |
| Residential area characteristics | | | | |
| Land use diversity at home census block group | 0.47 | 0.23 | 0 | 1 |
| Population per acre at home census block group | 4.06 | 4.41 | 0.05 | 83 |
| Transit service frequency at home census block group | 24.36 | 51.52 | 0 | 578 |
| Jobs within 0.5 miles of fixed-guideway transits at home census block group, % | 0.04 | 0.15 | 0 | 1 |
| Activity density (housing + jobs per acre) at home census block group | 4.14 | 10.78 | 0.04 | 174 |
| National Walkability Index at home census block group | 8.38 | 3.64 | 1.5 | 19 |
| Workplace characteristics | | | | |
| Land use diversity at workplace census block group | 0.68 | 0.18 | 0 | 1 |
| Transit service frequency at workplace census block group | 89.93 | 133 | 0 | 578 |
| National Walkability Index at workplace census block group | 7.49 | 2.62 | 1 | 17 |
| Socio-demographic characteristics | | | | |
| Age | 46 | 12 | 16 | 80 |
| Female | 0.51 | 0.50 | 0 | 1 |
| White | 0.72 | 0.45 | 0 | 1 |
| College degree or more | 0.63 | 0.48 | 0 | 1 |
| Income below 60,000 | 0.26 | 0.44 | 0 | 1 |
| Children in household | 0.43 | 0.50 | 0 | 1 |
| Numbers of vehicle in household | 2.25 | 0.88 | 0 | 4 |
| Commute distance, miles | 11.70 | 8.98 | 0.10 | 58 |

was nearly 12 miles. As we see, certain demographic groups (e.g., relatively older people, Whites and people with more income) are over represented in the sample, which could lead to bias and incorrect estimates (Pfeffermann, 1996). To mitigate this bias, the regression analysis uses survey weights based on the 2010 Census (Atlanta Regional Commission, 2011).

### 4.2. Regression results

Table 4 reports the logistic regression coefficients and corresponding odd ratios. The *Wald chi2* is 626.04 with *p-value* 0.00, indicating that the regression model, overall, is statistically significant to explain the dependent variable. The variables *parking* and *transit pass* both are significant in the model. The odds ratios suggest that employees who had received free or subsidized transit pass had 156% higher odds to commute on transit, all else equal, compared to those who had not received free or subsidized transit pass. However, employees who had received free or subsidized parking had 71% lower odds to commute on transit, all else equal, compared to those who had not received free or subsidized parking.[8]

The land use diversity variable at the home census block group is negatively significant though it is not significant at the workplace census block group. Transit service frequency at the home census block group and workplace census block group both are positively significant in the model. Other residential area characteristics including jobs within 0.5 miles of fixed-guideway transit and walkability are positively significant to explain employees' decision to use transit. Regarding sociodemographic controls, the variables *age*, *female*, *white*, *college degree or more*, *children in household* and *numbers of vehicle in household* are all negatively significant, but the variable *commute distance* is positively significant in explaining commuters' decision to use transit. One additional year of age was associated with 1% lower odds to commute on transit, all else equal. Likewise, female had 20% lower odds, White had 55% lower odds, individuals with college degree or higher level of education had 44% lower odds and individuals with children in the household had 25% lower odds to commute on transit, all else equal, compared to their respective counterparts. One additional vehicle in the household was associated with 48% lower odds, but one additional mile increase in commute distance was associated with 3% higher odds to commute on transit, all else equal.

[8] In general, the relationship between a factor increase and the percentage change is (f-1) × 100% (Buis, 2016). Hence, an odds ratio of 2.56 corresponds to a (2.56 - 1) × 100% = 156% change in odds, or 156% higher odds. Likewise, an odds ratio of 0.29 corresponds to a (0.29–1) × 100% = −71% change in odds or 71% lower odds.

**Table 4**
Employees' decision to commute on transit in metro Atlanta (n = 6576).

| VARIABLES | Coefficients | Odds ratio |
|---|---|---|
| Incentives from employers | | |
| Transit pass | 0.936*** | 2.551*** |
| | (0.140) | (0.358) |
| Parking | −1.255*** | 0.285*** |
| | (0.155) | (0.044) |
| Residential area characteristics | | |
| Land use diversity at home census block group | −1.023*** | 0.360*** |
| | (0.379) | (0.136) |
| Population per acre at home census block group | −0.021 | 0.979 |
| | (0.017) | (0.017) |
| Transit service frequency at home census block group | 0.004*** | 1.004*** |
| | (0.001) | (0.001) |
| Jobs within 0.5 miles of fixed-guideway transit at home census block group, % | 1.803*** | 6.066*** |
| | (0.388) | (2.355) |
| Activity density (housing + job per acre) at home census block group | −0.011 | 0.989 |
| | (0.008) | (0.008) |
| National Walkability Index score at home census block group | 0.088*** | 1.092*** |
| | (0.031) | (0.034) |
| Workplace characteristics | | |
| Land use diversity at workplace census block group | 0.634 | 1.884 |
| | (0.406) | (0.766) |
| Transit service frequency at workplace census block group | 0.003*** | 1.003*** |
| | (0.000) | (0.000) |
| National Walkability Index score at workplace census block group | 0.037 | 1.038 |
| | (0.028) | (0.029) |
| Socio-demographic characteristics | | |
| Age | −0.012** | 0.988** |
| | (0.006) | (0.006) |
| Female | −0.224* | 0.799* |
| | (0.135) | (0.108) |
| White | −0.805*** | 0.447*** |
| | (0.130) | (0.058) |
| College degree or more | −0.573*** | 0.564*** |
| | (0.150) | (0.085) |
| Income below $60,000 | −0.073 | 0.930 |
| | (0.156) | (0.145) |
| Children in household | −0.290** | 0.748** |
| | (0.144) | (0.107) |
| Numbers of vehicle in household | −0.653*** | 0.520*** |
| | (0.093) | (0.048) |
| Commute distance, miles | 0.029*** | 1.030*** |
| | (0.008) | (0.008) |
| Constant | −0.558 | |
| | (0.596) | |
| Wald chi2 | 626.04 | |
| Prob > chi2 | 0.00 | |

Note: Logistic regression estimates; heteroscedasticity-consistent robust standard errors in parentheses; ***, **, and * denote significance at $\alpha$ = 0.01, 0.05, and < 0.1 levels, respectively.

### 4.3. Exploring mediating effects

Tables 5 and 6 explore mediating effects between financial incentives provided by employers and employees' decision to commute on transit using employees' sociodemographic characteristics and spatial configuration of land use and transport infrastructure at their home or workplace. The findings suggest that Whites or individuals with college degree or higher level of education who had received free or subsidized transit pass had higher odds to commute on transit (Table 5) although Whites or individuals with college degree or higher level of education, in general, had lower odds to commute on transit (Table 4). Increasing numbers of vehicle in the households of individuals who had received free or subsidized transit pass had higher odds to commute on transit but increasing numbers of vehicle in the households of individuals who had received free or subsidized parking had lower odds to commute on transit, all else equal. Increasing commute distance to those individuals who had received free or subsidized transit pass had higher odds to commute on transit but increasing commute distance to those who had received free or subsidized parking had lower odds to commute on transit.

Although individuals who had received free or subsidized parking had lower odds to commute on transit, individual who lived in walkable neighborhoods (census block) had higher odds to commute on transit despite the availability of free or subsidized parking at their workplace (Table 6).

## 5. Discussion

Because of population growth and limited funding opportunities to expand roadways, there is a growing need to manage transportation or travel demand. As we mentioned earlier, transportation or travel demand management (TDM) policies focus on changing or reducing travel demand, particularly during the peak commute hours, rather than increasing roadway capacity. In this effort, local employers can play a vital role to help change or reduce travel demand of their employees. Accordingly, many promising TDM programs emphasize coordination with local employers on a number of measures such as transit pass subsidies, car or van pooling programs, flexible work schedules, teleworking options and parking management (Steg and Vlek, 1997). Our findings also suggest that providing free or subsidized transit pass to employees may increase their odds to commute on transit.

In some cases, financial incentives alone may not work enough to change commuters' mode choice. Some people tend to perceive that transit, in general, are unsafe and unreliable and hence, they are less likely to commute on transit. Also, they tend to oppose the expansion of transit for the reasons that it would make their neighborhoods unsafe to live (Jaffe, 2014).[9] The demographics of the transit riders in major cities in the United States may be taken as an example of how various demographic groups perceive transit. For instance, 92 percent of the bus riders are nonwhites in Los Angeles and 78 percent of the transit (MARTA bus or train) riders in Atlanta are African-Americans (Hess, 2012). Our findings also suggest that Whites had lower odds to commute on transit compared to nonwhites (e.g., Blacks or African-Americans, Hispanics or Latinos or Asians). However, Whites who had received free or subsidized transit pass had greater odds to commute on transit.

Female, elderly people, educated people (having college degree or higher level of education) and individuals with children had lower odds to commute on transit in metro Atlanta compared to their respective counterparts. However, educated people who had received free or subsidized transit pass had higher odds to commute on transit. Hence, providing free or subsidized transit pass to educated people may increase their odds to commute on transit. Previous studies have indicated that some demographic groups such as female, elderly people and people with children tend to perceive transit, in general, unsafe or inconvenient (Loukaitou-Sideris, 2014; Peck, 2010). Brown, Werner and Kim (2003) argue that females in general do more domestic chores in conjunction with their commutes, such as grocery or shopping and chauffeuring children, making transit less convenient. The majority of educated or elderly people live in suburbs which are, in general, not well connected with transit in metro Atlanta (Atlanta Magazine, 2012).[10] For instance, suburb counties such as Hall, Walton, Newton, Spalding and Carroll have the highest densities of senior residents (age 65+) in the 20-county metro Atlanta region (Atlanta Regional Commission, 2016c). Likewise, compared to rural or urban areas, many

[9] Gwinnett County rejected joining MARTA back in 1990 for the reason that expansion of MARTA train will export criminals from the city to the suburbs. Here is a perception of one Atlanta resident quoted in the Atlanta Journal Constitution in 1997: "Having MARTA [rail] increases the chances of crime. The criminals can get off the train and break into your home and get back onto the train. I don't think that's as likely to happen on buses, where they have to walk past the driver to get on board" (Jaffe, 2014).

[10] According to American Association of Retired Persons (2012), fifth-six percent of Americans aged 65 and older live in suburbs in the United States.

**Table 5**
Employees' decision to commute on transit in metro Atlanta and mediating effects (socio-demographic characteristics; n = 6576).

| VARIABLES | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Transit pass | 1.682*** | 0.968*** | 0.717*** | 0.634*** | 0.840*** | −0.003 | 0.414* |
| | (0.569) | (0.188) | (0.189) | (0.233) | (0.171) | (0.318) | (0.237) |
| Parking | −1.657*** | −1.317*** | −1.130*** | −1.045*** | −0.995 *** | −0.493 | −0.777*** |
| | (0.561) | (0.203) | (0.200) | (0.239) | (0.180) | (0.326) | (0.244) |
| Land use diversity at home census block group | −1.054*** | −1.022*** | −0.997*** | −1.012*** | −1.017 *** | −1.040*** | −1.102*** |
| | (0.380) | (0.379) | (0.378) | (0.380) | (0.371) | (0.378) | (0.381) |
| Population per acre at home census block group | −0.023 | −0.021 | −0.021 | −0.021 | −0.022 | −0.021 | −0.019 |
| | (0.017) | (0.017) | (0.017) | (0.017) | (0.017) | (0.016) | (0.016) |
| Transit service frequency at home census block group | 0.004*** | 0.004*** | 0.004*** | 0.004*** | 0.004*** | 0.004*** | 0.004*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Jobs within 0.5 miles of fixed-guideway transit at home census block group, % | 1.790*** | 1.801*** | 1.826*** | 1.819*** | 1.795*** | 1.785*** | 1.780*** |
| | (0.388) | (0.389) | (0.389) | (0.394) | (0.385) | (0.381) | (0.388) |
| Activity density (housing + job per acre) at home census block group | −0.011 | −0.011 | −0.011 | −0.011 | −0.0108 | −0.009 | −0.010 |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.007) | (0.008) | (0.008) |
| National Walkability Index score at home census block group | 0.090*** | 0.088*** | 0.084*** | 0.090*** | 0.0869*** | 0.087*** | 0.097*** |
| | (0.031) | (0.031) | (0.031) | (0.031) | (0.031) | (0.031) | (0.031) |
| Land use diversity at workplace census block group | 0.616 | 0.638 | 0.651 | 0.651 | 0.626 | 0.726* | 0.681* |
| | (0.406) | (0.407) | (0.405) | (0.406) | (0.409) | (0.404) | (0.405) |
| Transit service frequency at workplace census block group | 0.003*** | 0.003*** | 0.003*** | 0.003*** | 0.003*** | 0.003*** | 0.003*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.000) | (0.000) |
| National Walkability Index score at workplace census block group | 0.038 | 0.036 | 0.037 | 0.037 | 0.035 | 0.036 | 0.034 |
| | (0.028) | (0.027) | (0.028) | (0.028) | (0.027) | (0.028) | (0.028) |
| Age | −0.014 | −0.012** | −0.011** | −0.012** | −0.012** | −0.014** | −0.013** |
| | (0.011) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| Female | −0.221 | −0.288 | −0.220 | −0.211 | −0.216 | −0.217 | −0.217 |
| | (0.136) | (0.263) | (0.135) | (0.134) | (0.135) | (0.135) | (0.135) |
| White | −0.809*** | −0.805*** | −0.786*** | −0.808*** | −0.814*** | −0.770*** | −0.810*** |
| | (0.130) | (0.130) | (0.258) | (0.130) | (0.130) | (0.129) | (0.131) |
| College degree or more | −0.579*** | −0.576*** | −0.568*** | −0.484* | −0.574*** | −0.601*** | −0.556*** |
| | (0.150) | (0.150) | (0.150) | (0.285) | (0.149) | (0.153) | (0.152) |
| Income below $60,000 | −0.090 | −0.074 | −0.074 | −0.068 | −0.088 | −0.073 | −0.074 |
| | (0.156) | (0.156) | (0.156) | (0.156) | (0.156) | (0.159) | (0.158) |
| Children in household | −0.293** | −0.293** | −0.296** | −0.299** | 0.110 | −0.310** | −0.312** |
| | (0.144) | (0.144) | (0.143) | (0.144) | (0.266) | (0.144) | (0.144) |
| Numbers of vehicle in household | −0.652*** | −0.654*** | −0.645*** | −0.656*** | −0.660*** | −0.548*** | −0.661*** |
| | (0.093) | (0.093) | (0.092) | (0.093) | (0.092) | (0.177) | (0.093) |
| Commute distance, miles | 0.029*** | 0.029*** | 0.029*** | 0.031*** | 0.027*** | 0.027*** | 0.044*** |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) | (0.014) |
| Transit pass × age | −0.018 | | | | | | |
| | (0.012) | | | | | | |
| Parking × age | 0.010 | | | | | | |
| | (0.012) | | | | | | |
| Transit pass × female | | −0.060 | | | | | |
| | | (0.260) | | | | | |
| Parking × female | | 0.118 | | | | | |
| | | (0.278) | | | | | |
| Transit pass × white | | | 0.577** | | | | |
| | | | (0.255) | | | | |
| Parking × white | | | −0.335 | | | | |
| | | | (0.266) | | | | |
| Transit pass × college degree or more | | | | 0.501* | | | |
| | | | | (0.288) | | | |
| Parking × college degree or more | | | | −0.337 | | | |
| | | | | (0.293) | | | |
| Transit pass × children in household | | | | | 0.237 | | |
| | | | | | (0.278) | | |
| Parking × children in household | | | | | −0.699 | | |
| | | | | | (0.286) | | |
| Transit pass × numbers of vehicle in household | | | | | | 0.548*** | |
| | | | | | | (0.175) | |
| Parking × numbers of vehicle in household | | | | | | −0.443** | |
| | | | | | | (0.175) | |
| Transit pass × commute distance, miles | | | | | | | 0.042*** |
| | | | | | | | (0.015) |
| Parking × commute distance, miles | | | | | | | −0.038*** |
| | | | | | | | (0.015) |
| Constant | −0.452 | −0.518 | −0.590 | −0.690 | −0.620 | −0.665 | −0.763 |
| | (0.771) | (0.603) | (0.599) | (0.621) | (0.594) | (0.654) | (0.609) |
| Wald chi2 | 630.87 | 636.03 | 660.88 | 610.17 | 633.17 | 597.15 | 647.95 |
| Prob > chi2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Note: Logistic regression estimates; heteroscedasticity-consistent robust standard errors in parentheses; ***, **, and * denote significance at $\alpha = 0.01$, 0.05, and < 0.1 levels, respectively.

**Table 6**
Employees' decision to commute on transit in metro Atlanta and mediating effects (built environment; n = 6576).

| VARIABLES | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Transit pass | 0.960*** | 0.939*** | 0.998*** | 1.152*** | 0.958*** |
| | (0.310) | (0.167) | (0.149) | (0.341) | (0.191) |
| Parking | −1.634*** | −1.417*** | −1.294*** | −2.189*** | −1.441*** |
| | (0.320) | (0.186) | (0.164) | (0.364) | (0.221) |
| Land use diversity at home census block group | −1.585*** | −0.988*** | −1.032*** | −1.017*** | −1.013*** |
| | (0.563) | (0.379) | (0.379) | (0.375) | (0.379) |
| Population per acre at home census block group | −0.021 | −0.021 | −0.021 | −0.021 | −0.021 |
| | (0.017) | (0.017) | (0.016) | (0.016) | (0.017) |
| Transit service frequency at home census block group | 0.004*** | 0.002 | 0.004*** | 0.004*** | 0.004*** |
| | (0.001) | (0.002) | (0.001) | (0.001) | (0.001) |
| Jobs within 0.5 miles of fixed-guideway transit at home census block group, % | 1.790*** | 1.786*** | 1.733*** | 1.762*** | 1.795*** |
| | (0.387) | (0.385) | (0.553) | (0.377) | (0.387) |
| Activity density (housing + job per acre) at home census block group | −0.011 | −0.011 | −0.010 | −0.011 | −0.011 |
| | (0.008) | (0.007) | (0.008) | (0.007) | (0.008) |
| National Walkability Index score at home census block group | 0.088*** | 0.086*** | 0.089*** | 0.031 | 0.087*** |
| | (0.031) | (0.031) | (0.031) | (0.040) | (0.031) |
| Land use diversity at workplace census block group | 0.626 | 0.647 | 0.655 | 0.657 | 0.648 |
| | (0.407) | (0.407) | (0.407) | (0.407) | (0.408) |
| Transit service frequency at workplace census block group | 0.003*** | 0.003*** | 0.003*** | 0.003*** | 0.003*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) |
| National Walkability Index score at workplace census block group | 0.037 | 0.037 | 0.038 | 0.036 | 0.039 |
| | (0.028) | (0.028) | (0.028) | (0.028) | (0.028) |
| Age | −0.012** | −0.012** | −0.012** | −0.012** | −0.012** |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| Female | −0.231* | −0.227* | −0.225* | −0.236* | −0.222 |
| | (0.135) | (0.135) | (0.135) | (0.134) | (0.135) |
| White | −0.803*** | −0.801*** | −0.802*** | −0.782*** | −0.807*** |
| | (0.130) | (0.130) | (0.130) | (0.130) | (0.131) |
| College degree or more | −0.572*** | −0.574*** | −0.579*** | −0.581*** | −0.569*** |
| | (0.151) | (0.150) | (0.151) | (0.150) | (0.150) |
| Income below $60,000 | −0.074 | −0.077 | −0.064 | −0.071 | −0.071 |
| | (0.156) | (0.156) | (0.156) | (0.157) | (0.156) |
| Children in household | −0.290** | −0.304** | −0.298** | −0.301** | −0.294** |
| | (0.144) | (0.144) | (0.144) | (0.144) | (0.143) |
| Numbers of vehicle in household | −0.653*** | −0.654*** | −0.654*** | −0.654*** | −0.652*** |
| | (0.093) | (0.093) | (0.093) | (0.093) | (0.093) |
| Commute distance, miles | 0.029*** | 0.028*** | 0.029*** | 0.026*** | 0.029*** |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| Transit pass × land use diversity at home census block group | −0.054 | | | | |
| | (0.560) | | | | |
| Parking × land use diversity at home census block group | 0.818 | | | | |
| | (0.578) | | | | |
| Transit pass × transit service frequency at home census block group | | 0.000 | | | |
| | | (0.002) | | | |
| Parking × transit service frequency at home census block group | | 0.003 | | | |
| | | (0.002) | | | |
| Transit pass × jobs within 0.5 miles of fixed-guideway transit at home census block group, % | | | −0.725 | | |
| | | | (0.562) | | |
| Parking × jobs within 0.5 miles of fixed-guideway transit at home census block group, % | | | 0.404 | | |
| | | | (0.550) | | |
| Transit pass × National Walkability Index score at home census block group | | | | −0.021 | |
| | | | | (0.031) | |
| Parking × National Walkability Index score at home census block group | | | | 0.094*** | |
| | | | | (0.033) | |
| Transit pass × transit service frequency at workplace census block group | | | | | −0.000 |
| | | | | | (0.001) |
| Parking × transit service frequency at workplace census block group | | | | | 0.001 |
| | | | | | (0.001) |
| Constant | −0.281 | −0.392 | −0.522 | 0.111 | −0.445 |
| | (0.644) | (0.605) | (0.599) | (0.661) | (0.610) |
| Wald chi2 | 628.81 | 637.62 | 626.97 | 625.27 | 641.88 |
| Prob > chi2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Note: Logistic regression estimates; heteroscedasticity-consistent robust standard errors in parentheses; ***, **, and * denote significance at $\alpha$ = 0.01, 0.05, and < 0.1 levels, respectively.

suburbs in metro Atlanta had experienced the greatest increase in population with college degree or higher level of education between 2010 and 2015 (Atlanta Regional Commission, 2017a). In this regard, it is important to increase connectivity between major employment centers and suburbs where people live through transit expansion. One such program addressing this concern is the Atlanta Regional Commission's Livable Centers Initiative (LCI) program. Incentivizing local communities and municipalities to re-envision their communities as vibrant, walkable places offering increased mobility options, encouraging healthy lifestyles and providing improved access to job and services by offering grants to promote mixed-use, multipurpose development for mixed-income residential neighborhoods, employment, retail and recreation options. The program has reenergized economic development, reduced vehicle miles traveled per capita, decreased the number of vehicles on the road and assisted communities with reimagining their public spaces and optics concerning transit (Atlanta Regional Commission, 2018). The metro Atlanta region needs to expand such program to increase connectivity between residential areas and employment centers. Likewise, the coverage of ATL, the recently created unified transit system serving 13 counties in the region should be expanded beyond the 13 counties and cover other surrounding and adjacent counties. Also, outreaching the targeted demographic groups through various social and media outlets may help change their perceptions about transit. As elderly people and people with children had lower odds to commute on transit, it may indicate that transit in metro Atlanta is not friendly or efficient enough to these demographic groups. Hence, designing transit policies by addressing the needs of these demographic groups might help encourage them to use transit.

The measures of land use and transit service at residential area and/or workplace are also important in mode choice. For instance, the odds to commute on transit was greater in areas with greater walkability, higher transit service frequency or greater concentration of jobs (jobs within 0.5 miles of fixed-guideway transit). Since the interaction between parking and National Walkability Index score at home census block group is positive and significant, making neighborhoods more walkable may increase the odds to commute on transit despite the availability of free or subsidized parking at workplace. Likewise, increasing transit service frequency would help expand ridership of transit. Although mix use development or more diverse land use tends to make neighborhood walkable and encourages transit use (Ewing and Cervero, 2010; Stevens, 2017), the measure of land use diversity at the home census block was negatively associated with the odds to commute on transit in metro Atlanta. This contrast in finding could be because mix-use development in metro Atlanta covers less than four percent of metro Atlanta's land area (Atlanta Regional Commission, 2018). Also, there is spatial mismatch between location of the workers and the jobs (Chapman and Larry, 2011). For instance, the low-income workers are primarily concentrated on the southern portion of I-20, and in Clayton and Spalding counties where as the low-income jobs are evenly dispersed throughout the region (Atlanta Regional Commission, 2017b). Many of these locations do not have unified transit service to connect residential areas with employment centers. Accordingly, the number of super commuters (those who spend 90 minutes or more on commute every day) has increased quickly in metro Atlanta. For instance, between 2005 and 2018, the percent of metro Atlanta resident who were super commuters has increased by 11.5 percentage point, from 3.5 percent to 14 percent (Apartment List, 2018).

Our findings suggest that those who commute longer distance had greater odds to use transit. Since the interaction between transit pass and commute distance is positive and significant, providing free or subsidized transit pass to those who commute longer distance may increase their odds to commute on transit. These findings are not surprising given that transit is relatively cheaper and safer (e.g., low crash rates), compared to driving alone (Litman, 2014). According to the American Public Transportation Association (2016), average individuals who ride transit instead of driving alone can save, on average, more than $769 a month in the United States. Likewise, fatality rate per billion passenger-miles was 7.28 for car or light truck driver or passenger, compared to below 0.45 for transit riders (e.g., 0.43 for commuter rail and Amtrak, 0.24 for urban mass transit rail (subway or light rail), and 0.11 for the bus (transit, intercity, school, charter) between 2000 and 2009 in the U.S (Savage, 2013). But an increase in the number of vehicle in household decreases the odds to commute on transit, a finding consistent to Chakrabarti (2017) who reported that car ownership or the lack of access to vehicle explained the choice of transit to a large extent in Los Angeles. Since the interaction between transit pass and numbers of vehicle in the household is positive and significant, providing free or subsidized transit pass to individuals having multiple vehicles in their household may increase their odds to commute on transit in metro Atlanta.

## 6. Conclusion

Using the 2011 Atlanta Regional Household Travel Survey, we find statistically significant relationship between transportation-related financial incentives provided by employers and commuters' decision to ride transit in metro Atlanta. We also identify a number of sociodemographic characteristics influencing transit riding in metro Atlanta. Although some of the findings appear to be confirmatory rather than completely new, this study is the first in analyzing the relationship between transportation-related financial incentives provided by employers and commuters' decision to use transit in metro Atlanta. The central policy implication of this study is that future transportation or travel demand management policies should be designed in coordination with local employers. As far as possible, local employers should be encouraged to offer free or subsidized transit passes instead of free or subsidized parking at the workplace. Since some demographic groups are less likely to commute on transit, it is important that the Georgia Commute Options should reach-out to these demographic groups to influence their mode choice through its marketing tools. From the policy perspective, lobbying for free or subsidized transit passes to employees may be an effective way to manage transportation or travel demand in metro Atlanta.

From the modelling perspective, since commuters' mode choice is significantly associated with transportation-related financial incentives provided by their employers, future analysis of travel mode choice should account for these financial incentives along with land use or built environment and transit measures at origin, and/or destination and sociodemographic characteristics of the commuters. Since the odds to use transit was significantly higher in walkable communities or the communities with greater frequency of transit service, incorporating walkability in land use planning and increasing transit service frequency might encourage people using transit.

City planning agencies may also influence commuters' mode choice decision through zoning regulation. In this regard, local planning agencies should illustrate the importance of striking the right balance between land use decisions and transportation investments by concentrating growth in areas that already have infrastructure couple with aggressive investment in transportation infrastructure improving upon many measures of congestion. This results in more focused growth in existing areas with significant infrastructure investment currently established or targeted in already developed areas and maximizes accessibility while minimizing congestion and consumption of natural resources. A policy of this nature will accommodate future population and job growth while improving multiple congestion mitigation factors and preserving environment, air quality, recreation and other benefits of undeveloped lands and open space.

Two caveats of this study should be noted. First, free and subsidized transportation-related incentives (transit pass or parking) from employers could impact commuters' mode choice differently. For instance, compared to subsidized transit pass or parking, free transit pass or parking from employers could have stronger impact on commuters' mode choice. Likewise, highly subsidized transit pass or parking could have different impact on commuters' mode choice decision, compared to less subsidized transit pass or parking. However, because of the lack of information on whether transit pass or parking received by employees was free or subsidized, we treat both categories the same way. We recommend that future studies should account for these differences while analyzing the relationship between transportation-related financial incentives provided by employers and commuters' decision to ride transit. Second, econometric analyses like ours analyze the strength of the relationship between variables for the “average” individual. Hence, the results may not be generalizable to specific individuals.

## Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of Atlanta Regional Commission.

## Acknowledgements

We thank David Giguere at Atlanta Regional Commission for his help on geospatial analysis, and two anonymous reviewers and editor for their useful comments and suggestions. All remaining errors are our own.

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