ABSTRACT

One of the most tangible benefits of the public realm is the provision of affordable and efficient public transportation, particularly in large metropolitan areas. Low- and moderate-income households currently spend 60% of their income on housing and transportation, a disproportionately high figure that contributes to the increasing income inequality and wealth disparities in the U.S.

Transit advocates purport that greater access to public transit improves access to employment opportunities and services, and therefore improves economic mobility and reduces income inequality. However, few studies have demonstrated this effect empirically. This paper leverages emerging data on transit levels of service in major metropolitan areas in the U.S. to examine the link between robust public transportation (in terms of investment and accessibility) and decreased income inequality at the metropolitan level. It seeks to answer several policy-relevant questions, including whether metro areas that invest more in mass transit, improving mobility and accessibility to economic opportunities and reducing transportation costs, have higher household incomes and lower income inequality.

Our analysis of the 100 largest metropolitan areas shows a statistically significant correlation between access to a larger share of jobs within 45 minutes via transit and lower levels of inequality using the Gini coefficient. Results using metrics of economic mobility were mixed. These preliminary results will help inform future work related to transit access to employment opportunities and equity outcomes.

Keywords: transit access, equity, income inequality, economic mobility
Many factors drive income inequality: uneven educational attainment, the availability of low- and middle-skilled employment opportunities, and the cost of living, among others. Variation in human capital and local market conditions account for much of the difference between metropolitan areas; however, regional mobility of human capital must not be discounted. Urban planners and economic development practitioners have long struggled with the physical distances between job centers and affordable housing options (Cervero, 1989; Cervero & Duncan, 2006; Ihlanefeldt & Sjoquist, 1998). Access to affordable, reliable public transit options has the potential to increase economic opportunity for low- and moderate-income households. Given that moderate income households spend an average of 57 percent of their income on housing and transportation – 12 percentage points higher than the standard for affordability (Haas, Makarewicz, Benedict, Sanchez, & Dawkins, 2006) – we set out to determine whether and to what extent this is true. Specifically, we address the research question: 1) Do metropolitan areas that provide greater access to mass transit, improving mobility and accessibility to economic opportunities and reducing transportation costs, have lower income inequality?

Public transit (especially light and heavy rail) has often been viewed as an economic development tool, providing a service to employees, imbuing a city or region with prestige, and providing windfalls to property owners (Hensher, 1999; Pickrell, 1992). These roles for transit conflict with the need to provide mobility for those unable or unwilling to use an automobile. In many cases in U.S. history, transit deployment has been guided by the needs and desires of downtown business owners and suburban commuters rather than the low-income and carless population who depend on public transit to meet a wider range of trips than simply the commute (Sanchez, 2002; Taylor & Morris, 2015). In fact, only one quarter of low- and middle-skill jobs are transit accessible, or located within a 90-minute trip via transit, versus one-third of high-skill jobs (Tomer, Kneebone, Puentes, & Berube, 2011). Accordingly, transit systems are poorly designed to serve the population most in need. With income segregation, concentrated poverty, and suburban poverty on the rise, equitable transit access that links affordable housing and employment options is needed.

Transit and Income Segregation

Over time, public transportation has helped shape residential patterns. There are a number of theories as to how new modes of transportation help to form cities. In the 1960s, a dominant theory of residential choice was the Alonso-Muth model, which posited that high-wage workers choose to live as far away from the central city as possible given that income elasticity of housing demand is greater than that of marginal commuting costs (Gin & Sonstelie, 1992). A related theory of travel time budgets posits that individuals have a relatively fixed amount of time they are willing to spend traveling each day. As transportation technology improved and possible speeds increased, the city expanded accordingly, leading to widespread suburbanization (Muller, 2004). This theory helps explain how horse-drawn streetcars and later automobiles led to very different patterns of housing, with density decreasing and segregated land uses increasing over time.

In the post-automobile world, U.S. central cities increasingly housed a disproportionate share of impoverished households, with 19.9 percent of the total population living in poverty living in central cities in 2000 (Glaeser, Kahn, & Rappaport, 2008). Glaeser et al. explain that access to public transportation is one reason for this concentration, as households in poverty are more likely to rely on time-intensive but low cost modes of transportation. Access to public transportation is a significant constraint on housing options for recipients of subsidized housing through housing choice vouchers, therefore many households receiving vouchers tend to locate in dense, urban areas, often spaces of concentrated poverty (Graves, 2015).

However, at least from the early 2000s, and continuing to the present, amenities in central cities have again flourished and urban crime rates have declined, bringing affluent households back into central cities, displacing the poor. The Alonso-Muth theory is undermined by this increase
in upper-income households moving to urban areas, or “re-gentrification” of the urban core, which began as early as the 1970s (Gin & Sonstelie, 1992). In addition, earlier suburbanization can more likely be explained by the ubiquity of the automobile and subsidization of an automobile-oriented lifestyle through the creation of the interstate highway system, the introduction of government-backed mortgages in Federal Housing Administration (FHA) lending, and other trends (Dreier, Mollenkopf, & Swanson, 2014; Jackson, 1985; Schwartz, 2010). The dominance of the automobile over more efficient and once-popular modes of transit has led to additional theories, such as Snell’s conspiracy (St. Clair, 1981), which attributed the decline in the streetcar as a mode of public transit to the systematic dismantling of streetcar systems by General Motors, Standard Oil, and other automobile stakeholders.

Until quite recently, public transit ridership has been in decline and transit agencies have become dependent on downtown commuters and transit dependents (those who are physically or economically unable to own and operate a vehicle) (Garrett & Taylor, 1999). However, there has been somewhat of a reversal in recent years. In 2014, U.S. residents took 10.8 billion trips on public transportation, which amounts to the highest annual number of transit trips taken in 58 years (American Public Transportation Association, 2015), although per capita ridership has actually been flat or declining given increases in population (King, Manville, & Smart, 2014).

Benefits of Transit for Low-Income Households

Automobile dependence and suburban sprawl in U.S. metropolitan areas has led to a shift in the location of employment centers into suburban areas that are often inaccessible by transit, particularly in the case of entry-level low-skilled jobs. Research on this so-called spatial mismatch between job and home has highlighted the effects of mobility on the ability to identify job openings, secure employment, and maintain employment. Studies have clearly demonstrated that the absence of transit in suburban areas has led to reduced employment accessibility for transit dependent populations, in particular African-Americans (Grengs, 2010; Ihlanfeldt & Sjoquist, 1998; Taylor & Ong, 1995). In Portland and Atlanta, controlling for neighborhood and household characteristics, job skills, education levels, and job proximity factors, access to public transit was found to increase employment participation (Sanchez, 1999). Additionally, greater access to transit was associated with higher unemployment among neighborhoods in New York City (Kaufman, Moss, Hernandez, & Tyndall, 2015). Furthermore, areas with less sprawl and shorter commutes have significantly higher rates of upward economic mobility (Chetty, Hendren, Kline, & Saez, 2014).

In addition to economic benefits, public transit access provides various benefits for public health. These include increased physical activity, improved air quality, and a reduced chance of automobile injury and fatality, among others (Frumpkin, Frank, & Jackson, 2004). There are also social benefits. Public transit can be integrated with existing streets or placed underground and does not require the massive demolition of the urban fabric that was characteristic of highway construction (Dimento & Ellis, 2015). This preserves communities and their social connections. However, development spurred by transit has also been a cause of displacement of low-income households, particularly in the San Francisco Bay Area (Golub, Marcantonio, & Sanchez, 2013; Self, 2003)

Transit Policy and Investment

The prioritization of funding for mass transit in the U.S. does not adequately reflect the potential benefits of transit investments. For instance, 23 states prohibit the use of gasoline tax revenues for public transportation by constitutional amendment, a move that greatly limits the economic competitiveness of metropolitan areas in those states, as transit access is increasingly important for attracting a talented workforce as well as employers (McAndrew, Levine, & Davis, 2016).
Transit is often funded through regressive taxation (generally sales taxes) that disadvantages low-income populations and may be designed with a bias towards white, middle-income commuters, as in the Atlanta region in the 1970s (Dajani & Egan, 1974). Despite these limitations, Dajani and Egan (1974) found that the Atlanta system produced income redistribution effects through time savings, reduced vehicle costs, and fewer accidents experienced by low-income households.

In addition to fare revenue and various state and local funding sources, federal funding for urban mass transit is available. In 1973, the Federal Aid Highway Act allowed local governments to substitute transit infrastructure for withdrawn interstate construction for the first time (Weiner, 2008). In 2015, the Fixing America’s Surface Transportation (FAST) act was passed, which allocated $61 billion for various public transit programs over four years. The Federal Transit Administration (FTA) provides various grants and financing arrangements, including the Job Access and Reverse Commutes (JARC) Program, which specifically provides transportation for low-income employees and job seekers to suburban job centers.

Transit and Equity

Given the importance of transit to low-income households and for creating safer and healthier communities, investments in public transportation would seem to be a natural investment at the local or regional scale. However, the neomaterialist interpretation of income inequality shows that the larger the gap in earnings, the less likely the wealthy are to gain from expenditures on public goods such as transit. Wealthy elites are more likely to benefit from a reduction in taxes in order to seek alternatives in the private marketplace, such as a chauffeur (Sapolsky, 2005).

Recently, as neighborhood preferences have shifted towards urban amenities and spaces, rapid transit station density has been shown to be associated with higher-income households than bus stop density and may even have a gentrifying effect on neighborhoods based on a study of New York City (Barton & Gibbons, 2015). The gentrifying effect was also found in an earlier study of 14 major cities that expanded their rail service into urban, walkable communities (as opposed to suburban “park and ride” stations) between 1970 and 2000 (Kahn, 2007).

In recent years there have been efforts to address this trend in cities such as Los Angeles and Atlanta, where affordable housing set-asides have been put in place near transit stations to ensure that low-income households have better access to transit. At the federal level, transit equity and environmental justice issues have gained increasing attention. In December 2015, a federal Advisory Committee on Transportation Equity (ACTE) was convened by the Secretary of Transportation. The Ladders of Opportunity program within DOT seeks to connect underserved communities with employment opportunities and foster transportation projects that strengthen rather than divide communities.

METHODOLOGY

In order to understand the link between transit accessibility and equity outcomes, we chose to study metropolitan regions, as many transportation decisions are undertaken at this level and these regions function as labor sheds for commuters. Choosing a unit of analysis (urbanized zone, county, or metropolitan area) proved difficult given the varying reaches of transit systems within metropolitan regions. For example, Atlanta’s rapid transit system only serves three of the 29 counties in the metropolitan region. However, metropolitan areas were most desirable due to the availability of new and novel transit accessibility data and the ability for regional coordination at the level of the metropolitan planning organization. We chose 2012 Metropolitan Statistical Area (MSA) boundaries to conform to the available transit accessibility data.

For the dependent variables of income inequality and economic mobility, we chose three measures of households at the metropolitan level. For income inequality, we chose the Gini coefficient reported by the Census American Community Survey (ACS). For mobility, we chose
absolute and relative mobility as reported by the Equality of Opportunity Project (Chetty et al., 2014). The Equality of Opportunity Project measures intergenerational mobility using federal income tax records spanning 1996-2012 and assigns observed mobility to the MSA where the child grew up, regardless of where she settles as an adult.

The Gini coefficient of household income similarly measures the dispersion of income using pair-wise comparisons of households. The index ranges from 0 (perfectly equal, or all households earn the same income) to 1 (perfectly unequal, or one households is the only earner). Higher values indicate greater income inequality. A limitation of the Gini index is its oversensitivity to changes in the middle-income categories and relative insensitivity to changes in low-income and high-income households (Glassman, 2016).

**Figure 1: Gini coefficient of income inequality**

Source: 2012 Census ACS
As shown in Figure 2, nationally, the Gini coefficient has been increasing steadily from 1967 to 2015.

**Figure 2: National Gini coefficient of income inequality, 1967-2015**

![National Gini coefficient of income inequality, 1967-2015]


Chetty et al. (2014) define absolute upward mobility as the measure of the mean income rank of children with parents ranked in the bottom half of the income distribution. In no metropolitan area is the average rank above 50, meaning that parents earning less than the median area income are unlikely to produce children that earn more than the median income, or that intergenerational mobility is, on average, unlikely. As shown in Figure 3, metropolitan areas of the south and Midwest have the lowest rates of upward mobility for children.

**Figure 3: Absolute mobility: mean child rank for parents at the 25th percentile**

![Absolute mobility: mean child rank for parents at the 25th percentile]

*Source: Chetty et al. (2014)*
A second metric used by Chetty et al. (2014) is relative mobility, or how much intergenerational mobility occurs in low-income families relative to high-income families within a given area. This is calculated regressing the rank of children on the rank of each child’s parents (rank-rank slope). This measure may also be thought of as the difference in outcomes for children of the bottom quintile and top quintile of earners. The difference in outcome of the child from the richest and poorest family is 100 times this coefficient.

**Figure 4: Relative mobility: rank-rank slopes**

Several metrics of transit accessibility were considered. Of the 929 metropolitan and micropolitan areas in the U.S., 184 have transit systems with valid transit information based on the U.S. Environmental Protection Agency’s Smart Location Mapping database. The Brookings Institution provides similar metrics for the 100 largest metropolitan areas. The EPA’s database provided challenges in aggregating block group level data to the metropolitan scale. Therefore, our accessibility metric comes from the Brookings Institution’s Missed Opportunity: Transit and Jobs in Metropolitan America report (Tomer et al., 2011), which measures the share of jobs in each MSA accessible by transit to the average worker. Brookings uses 2010 Nielsen databases and schedules from 371 transit operators to calculate transit accessibility in 100 MSAs. These were the primary sources of transit accessibility data used for this study. Other data sources included the Census American Community Survey, the Land of Opportunity database, and the National Transit Database.
RESULTS

The measures of income inequality and economic mobility generally produced expected correlation results with the measure of transit accessibility chosen for the analysis, the average share of jobs accessible within 45 minutes by transit. As shown in Table 1, the Gini coefficient had a statistically significant negative relationship with transit access to jobs, meaning transit access is associated with a lower level of income inequality at the metropolitan level. The correlation between transit access to jobs and relative economic mobility was not significant at the 95 percent confidence level; however, the correlation with absolute mobility was significant and positive, indicating that transit access to jobs is associated with a greater probability that a child moves up from the lowest half of the income distribution. As a comparison, correlations are also displayed for an alternative metric of transit investment, transit operating expenses per capita. The relationship between income inequality and expenditures per capita was positive, unexpectedly, although the relationship with absolute mobility was also positive, as expected. Interestingly, transit expenditures are associated with higher levels of income inequality and absolute mobility, which may be driven by the higher costs of running older, less technologically advanced yet more established transit systems in legacy cities.

Table 1: Bivariate correlations between transit variables and income inequality and economic mobility variables

<table>
<thead>
<tr>
<th>Average share of jobs accessible within 45 minutes by transit</th>
<th>Transit operating expenses per capita</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gini coefficient</strong></td>
<td><strong>0.194</strong></td>
</tr>
<tr>
<td><strong>Relative mobility</strong></td>
<td><strong>0.210</strong></td>
</tr>
<tr>
<td><strong>Absolute mobility</strong></td>
<td><strong>0.348</strong></td>
</tr>
<tr>
<td><strong>-0.261</strong></td>
<td><strong>-0.083</strong></td>
</tr>
</tbody>
</table>

** Significant at the 0.01 level
* Significant at the 0.05 level

Figure 5: Transit accessibility: average share of jobs accessible within 45 minutes via transit

Source: Tomer et al. (2011)
In order to better understand the relationship shown in the correlations above, the two measures that displayed the most significant correlations with transit access to jobs were examined, the Gini coefficient and absolute mobility. For both the Gini coefficient and absolute mobility measures, quartiles were created for the 100 metropolitan areas in the sample. As shown in Figure 6, the metros with the most equal distribution of income have, on average, three percentage points higher of a share of jobs accessible within 45 minutes by transit than those metros with the least equal distribution of income.

**Figure 6: Mean value of job share accessible by transit by Gini coefficient quartiles**

As shown in Figure 7, the metros with the highest probability that a child with parents in the bottom half of income earners income will earn above a median income have, on average, a three percentage points higher share of jobs accessible within 45 minutes by transit than those metros that are the least economically mobile.

**Figure 7: Mean value of job share accessible by transit by absolute mobility quartiles**

The correlations and quartile values suggested that a relationship may exist between transit access to jobs and income inequality and economic mobility. In order to further explore these relationships, predictive modeling was initiated. Given the small number of observations (100), the number of independent variables in the model were held to as few as possible. While many social, economic, and demographic factors were considered, we chose only a few meaningful variables, including the critical dependent variable of the share of jobs accessible to the average worker within 45 minutes via transit, and the control variables population density, median household income, percent of the population over 25 years old with a bachelor’s degree, percent
of the population that is African-American, and percent of households that own their homes. All data were sourced from the U.S. Census American Community Survey (ACS), other than the metrics for transit accessibility, income inequality, and economic mobility discussed above. Descriptive statistics for the model variables are shown in Table 2.

Table 2: Descriptive statistics (N=100)

<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average share of jobs accessible within 45 minutes via transit</td>
<td>1.3%</td>
<td>22.2%</td>
<td>7.2%</td>
<td>3.8%</td>
</tr>
<tr>
<td>Relative mobility</td>
<td>0.18</td>
<td>0.43</td>
<td>0.34</td>
<td>0.06</td>
</tr>
<tr>
<td>Absolute mobility</td>
<td>33.73</td>
<td>49.16</td>
<td>40.81</td>
<td>2.99</td>
</tr>
<tr>
<td>Population density (per mi²)</td>
<td>54</td>
<td>2,865</td>
<td>563</td>
<td>489</td>
</tr>
<tr>
<td>Median household income</td>
<td>$33,761</td>
<td>$90,737</td>
<td>$53,699</td>
<td>$9,752</td>
</tr>
<tr>
<td>Percent population with a bachelor's degree or higher</td>
<td>15.3%</td>
<td>48.2%</td>
<td>30.5%</td>
<td>6.5%</td>
</tr>
<tr>
<td>Percent African-American</td>
<td>0.5%</td>
<td>48.3%</td>
<td>13.0%</td>
<td>10.2%</td>
</tr>
<tr>
<td>Homeownership rate</td>
<td>48.4%</td>
<td>74.8%</td>
<td>64.0%</td>
<td>4.9%</td>
</tr>
</tbody>
</table>

Three models were constructed with three separate dependent variables: the Gini coefficient to measure income inequality, and the relative and absolute economic mobility measures. For the Gini coefficient and the relative mobility measure, the variables were transformed to capture greater variation using the log of the odds ratio: ln (x/(1−x)).

As shown in Table 3, results were mixed among the three models. All three models demonstrated reasonably strong explanatory power, with model 3 (predicting absolute mobility) producing the strongest adjusted r² value (0.660). The transit accessibility measure, share of jobs accessible within 45 minutes via transit, was significant at a 95 percent confidence level in model 1 (predicting Gini coefficient) and model 2 (predicting relative mobility). In model 3 (predicting absolute mobility), its significance was below the 95 percent confidence level. The relationship between transit access and the Gini coefficient of income inequality was negative, indicating that transit access reduces income inequality. Median household income also had a negative effect on income inequality, while population density, percent African-American, and, interestingly, percent of the population with a bachelor’s degree had a positive effect on income inequality. For models 2 and 3 (predicting economic mobility), median household income had a positive impact on economic mobility. Again, share of the population with a bachelor’s degree had an unexpectedly negative impact on mobility, along with percent of the population that is African-American.

Table 3: Model results

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Model 1: Log odds ratio Gini</th>
<th>Model 3: Log odds ratio relative mobility</th>
<th>Model 4: Absolute mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>β 0.234 Sig. 0.000</td>
<td>β 0.00 ** Sig. 0.00 **</td>
<td></td>
</tr>
<tr>
<td>Share of jobs accessible within 45 minutes via transit</td>
<td>-0.195 0.032* Sig. 0.0045 Sig. 0.119 0.078</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population density</td>
<td>0.421 0.000 ** Sig. 0.166 Sig. 0.075 0.302</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median household income</td>
<td>-0.598 0.000 ** Sig. -0.315 Sig. 0.587 0.000 **</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% population with a bachelor’s degree</td>
<td>0.422 0.004 ** Sig. 0.217 Sig. 0.089 -0.337 0.003 **</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% African-American</td>
<td>0.192 0.029 * Sig. 0.591 Sig. 0.000 ** -0.595 0.000 **</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homeowner-ship rate</td>
<td>-0.190 0.038 * Sig. 0.365 Sig. 0.000 ** Sig. 0.045 0.502</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted r²</td>
<td>0.382 Sig. 0.552 Sig. 0.660</td>
<td></td>
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</tbody>
</table>
DISCUSSION

What should we make of these somewhat conflicting and even unexpected results? Given the results above, it is not clear that transit accessibility to jobs (as a whole) results in lower income inequality and economic mobility, although the data show that transit access has a negative effect on income inequality as measured by the Gini coefficient and a positive effect on relative economic mobility. There are several reasons this may be. First, this is a simplified model, meant to produce initial and exploratory results. From this starting point, additional lines of inquiry have been opened. For example, which types and mix of jobs are accessible to transit in these metro areas? Tomer et al. (2012) found that low-skill jobs are less accessible via transit as a whole. Given the goal of improving access to employment opportunities for low-income populations, this finding is troubling. Future work may focus on the accessibility of a balanced mix of jobs to transit or access to low- and middle-skill jobs in particular.

Second, in the housing domain, a link between transit and decreased housing affordability and gentrification near new and expanded rail lines has been established (Kahn, 2007). According to Kahn, new stations in walkable areas led to greater neighborhood gentrification for stations built between 1970 and 2000 in some but not all regions, based on data from 14 U.S. metropolitan areas. Gentrification tended to occur in more densely populated and centralized cities (Kahn, 2007). The strength of local housing markets is another potential factor in land redevelopment and the displacement of low-income households. Thus, regional public transportation planning must consider the respective local dynamics of transit and real estate prices, particularly around rail stations. Preserving and creating affordable housing near transit (often dubbed Equitable Transit Oriented Development or eTOD) benefits the region by reducing transportation costs for low-income households and providing a consistent ridership for the transit system.

Modes of transit other than rail should not be discounted in expanding or creating public transportation systems. Many reports have suggested prioritizing the expansion of bus rapid transit (BRT) over fixed-rail modes for maximum speed and efficiency (Kaufman et al., 2015). In Los Angeles, the extension of new light rail lines has brought drops in bus ridership, as bus users have switched to the more efficient rail mode (Broverman, 2017). Unlike fixed rail, bus routes and resources can easily be re-routed. Recently, ridesharing mobile apps have been used to better connect users to transit stations. While the technology is still emerging, it is timely to ask whether we are approaching a new paradigm in the provision of transportation with driverless cars and autonomous vehicles. If so, we must also consider equitable access in designing and deploying these systems in order to promote economic mobility.

From a policy perspective, expanding transit to promote economic mobility and alleviate income inequality is likely to produce uneven results. Rather, the questions should center on whom transit systems will serve and which jobs can be accessed. Households of all income levels and jobs of all skill levels should be accessible, with a particular focus on providing opportunities for low-income populations, who tend to be dependent on transit, and low-skill jobs, which are less likely to be served by transit. Given the valuable health and social benefits that transit provides, systems must be designed with equity in mind.


