Overcoming Spatial Mismatch: Public Transportation's Relationship with Labor Force Participation Rates

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Previous research has indicated that access to public transportation makes travel easier, ameliorating the effects of *spatial mismatch* and thereby creating more opportunities for individuals with limited mobility due to disability or lack of car ownership. However, other research has indicated that public transportation has little to no effect on labor force participation rates. This paper aims to investigate the question: Does public transportation ridership affect cities' labor force participation rates? A simple random sample of thirty American cities was analyzed using an LS regression. The results show that although existing public transportation does not seem to correlate with LFP rates, public transportation may still be a useful way to reduce commute times and connect vulnerable populations to wider society.

The United States has a public transportation problem, lagging behind the rest of the developed world when it comes to accessible and extensive public transportation systems. Five percent of Americans use public transportation, compared to thirty-eight percent of Germans (Burrows et al., 2021; Public Transportation, 2016). Even when excluding America's sprawling suburbs, American cities' public transportation is far less extensive than their European counterparts. For example, in 2019 Chicago and Berlin, two cities of comparable size and population density, had 455.7 million and 1,604 million riders, respectively (CityTransit Data, 2022; CTA, 2022). Unsurprisingly, many people within the U.S. have expressed interest in expanding public transportation access throughout the U.S., including the Biden administration, which has made public transportation a key part of their agenda (The White House, 2022).

Public transportation is an umbrella term that encompasses many different forms of transportation such as busses, light rails, heavy rails, and underground metro systems. While all can be found within the U.S., many areas are left with limited access or even no access at all. Nevertheless, there are continual efforts to expand public transportation to new areas and to improve or expand existing public transportation systems. For example, in 2019, fifteen public transportation projects were completed in the U.S., including new light rails built in Phoenix, Arizona and new commuter rail lines built in Denver, Colorado (The Transport Politic, 2019). Both state and municipal leaders believe that public transportation is a good investment. The expansion of it can affect both neighborhoods and whole communities. Moreover, access to public transportation has been linked to employment rates, especially for groups that are dependent on public transportation (Tyndall, 2017). Low-income workers often live far from employment that suits their skill levels: they are spatially mismatched. Access to public transportation makes travel easier, ameliorating the effects of spatial mismatch and thereby creating more opportunities for individuals with limited mobility due to disability or lack of car ownership. Taking this into consideration, access to public transportation is disproportionately important for economically disadvantaged communities (Kneebone and Holmes 2015). This paper aims to investigates how public transportation ridership affect cities' labor force participation rates.

Literature Review: Spatial Mismatch and Urban Unemployment

In the United States, persistently high urban unemployment is a major issue facing both municipal and state governments. High rates of unemployment have been linked to increased crimes rates and higher likelihoods of drug and alcohol abuse (Raphael and Winter-Ebmer 2001; Henkel 2011). As such, reducing urban unemployment is a prime concern for governments. While there are many factors contributing to unemployment, one often-cited theory of why urban unemployment persists is the spatial mismatch hypothesis. According to this hypothesis, "proximity to employment can influence a range of economic and social outcomes" especially for "low-income and minority workers" (Kneebone and Holmes 2015). For instance, an individual would have a more difficult time consistently getting to a job that is 30 miles away from their residence than one that is three miles away. Additionally, the opportunity costs of a

long commute may prevent individuals from securing jobs they would otherwise be fit for. Longer commute times are associated with decreasing individual odds of employment, especially for young people (Bastiaanssen, Johnson, and Lucas 2020). Spatial mismatch can cause major employment disadvantages such as unemployment, longer unemployment spells, lower wages, and longer work commutes (Covington 2018). Moreover, the problem has gotten worse as jobs move away from urban centers. Kneebone and Holmes (2015) have found that "between 2000 and 2012, the number of job opportunities within a typical commute distance" has fallen by 7 percent. Research has also shown that there exists a significant racial disparity in the spatial mismatch. The number of jobs near the typical Hispanic or Black individual has fallen more steeply than for white individuals (Kneebone and Holmes 2015).

Regarding the best way to ameliorate the adversary effects of spatial mismatching, the literature has reached no consensus. Covington (2018) has found that both access to automobiles and access to public transportation can reduce the effects of spatial mismatch. By analyzing the racial disparity of spatial mismatch, it was found that "automobiles provide the strongest positive employment benefit" (Covington 2018). Through a meta-analysis of other studies, Bastiaanssen, Johnson, and Lucas (2020) found that automobile ownership can help people gain employment. However, the relationship between automobile ownership and employment may be subject to potential endogeneity since the dependent variable affects the independent variable. This is because the cost of an automobile may be prohibitively high for low-income individuals. While access to a car can increase employment opportunities, "a job also provides the financial means for a car, which may bias study results" (Bastiaanssen, Johnson, and Lucas 2020). Hence, access to public transportation can help to fill the gaps left by automobile accessibility, which explains why low-income and minority individuals are more reliant on public transportation. Additionally, public transportation has advantages compared to automobiles when it comes to carbon emissions; automobiles emit 0.96 pounds CO2 per passenger mile while public transit emits an average of 0.45 pounds CO2 per passenger mile (Hodges 2010). Public transportation is also an effective way to combat road congestion, thereby reducing commute times for automobile users.

Public Transportation and Employment Rates

While the relationship between employment opportunities and transportation access is well established, it is worth taking a closer look at how public transportation specifically affects employment opportunities. Access to public transportation has been shown to be "a significant factor in determining average rates of labor participation within" Portland, Oregon, and Atlanta, Georgia (Sanchez 1999). These results were found by comparing labor participation rates for individuals living within walking distance of transit stops to labor participation rates for individuals not living within walking distance of transit stops. Sanchez used geographic information systems (GIS) to estimate the distances between residents and transit stops. A quarter mile was considered the maximum distance an individual would typically be willing to walk. Sanchez recommends increasing accessibility to transit stops. However, it may prove difficult to provide "efficient service amidst increasing automobile dependency and dispersed land-use patterns" (Sanchez 1999). Car use negates the necessity for public transportation and low-density development affects the cost effectiveness of public transportation.

Despite the poor overall state of American public transportation, new projects are often completed. In 2013, "more than 10 billion passenger trips were taken on public transit systems in the United States," the highest level since 1965 (Toms and Song 2016). While there has been an increase in public transportation use, not all areas are serviced equitably. Some demographics, specifically low-income people, disabled people, and minorities, tend to rely more on public transportation. Toms and Song find a needs gap characterized by a divergence between where the public transportation supply is and where the demand is. Using GIS, the Louisville Metro region was analyzed for transit demand and for the level of service. The results of their analysis confirm that there exists a "mismatch between public transit supply and social needs existed in Metro Louisville area" (Toms and Song 2016). The identification of these so-called "transit deserts" can help municipal governments better understand where to invest resources.

Extreme weather also provides a unique opportunity to examine the effect that public transportation has on unemployment. Superstorm Sandy, which hit New York City in October 2012, temporarily reduced public transportation access. Such an exogenous shock imparts close looks at the relationship between public transportation access and local unemployment. Specifically, the R train was temporarily shut down for drainage and repairs. The closure lasted a little over a year, lasting from August 2013 to September 2014. The closure of the R train "created significant commuting delays for workers who lived along the R Train route in Brooklyn and worked in Manhattan" (Tyndall 2017). This may have made it difficult for individuals to retain employment and may have limited opportunities for

Variable	Definition	Data Source	Hypothesis
Independent Variable			
LaborForcePR	Each city's labor force participation rate	US Census	
Dependent Variables			
City	Name of City	US Census	
State	Name of each city's State	US Census	
MayorPolAffiliation	Each city's government political affiliation. 0-R, 1-D, 2-N	Ballotpedia	
GvtType	Each city's government type. 0-Strong Mayor, 1-Council Manager, 2-Other	US Census	
Budget	Each city's annual budget	US Census	
Budget_pc	Budget per capita		(+)
Population	Each city's population	US Census	
PopDensity	Each city's population density	US Census	(+)
CommuteTime	Average travel time to place of work in minutes	US Census	(-)
%under18	Percent of the population under 18 years old	US Census	(-)
%over65	Percent of the population under 65 years old	US Census	(-)
%white	Percent of the population that is white	US Census	(-)
%disabled	Percent of the population under 65 that is disabled	US Census	(-)
AvgWkdyRidership	The average number of weekday riders on all a city's transit services	APTA	(+)
NewPubTransport	The number of new public transportation projects completed since 2009	The Transport Politic	(+)

Table 1: Variable Definitions and Data Sources

those searching for jobs. Tyndall (2017) used a difference-in-difference approach to analyze the impact the R Train closure had on employment. This method allowed for regional trends in employment to be controlled for. The study found that the closure of the R train caused difficulties for individuals in keeping jobs and finding new ones, showing that "public transportation access plays a meaningful role in setting the level of local unemployment" (Tyndall 2017). However, this study focuses on New York City which stands apart from other American cities when it comes to public transportation. There is evidence from other cities that contradicts the evidence from NYC.

Despite the evidence that public transportation access affects employment opportunities, there is some evidence to the contrary. Bollinger and Ihlanfeldt (1997) analyze the impact that Atlanta's MARTA rail line had on local employment. The MARTA line is useful because Atlanta's municipal government took no other actions to improve employment in the area, thereby enabling the effects of the rail line to be isolated (Bollinger and Ihlanfeldt 1997). The study used a simultaneous model

to measure both changes in population and employment. The results of their study found that the MARTA rail line had "neither a positive nor a negative impact on total population and total employment in station areas" (Bollinger and Ihlanfeldt 1997). However, they note that the composition of employment shifted towards more public sector jobs.

Sample

This study involves a sample of America's most populous municipalities. The sample used in this study was drawn from a list of America's 100 most populous cities. Important decisions on public transportation are mostly made at the city or municipal level. Furthermore, populous cities tend to have larger budgets and more public services. Hence, they are more likely to have public transportation systems. Moreover, research on the spatial mismatch hypothesis tends to focus on cities that have some form of public transportation. Simple random sampling was used to select 30 cities from the list of 100 so that there was no selection bias.

There are several major characteristics pertaining to the sample. Basic information, such as the state the city is in is useful for categorizing cities. Additionally, the political affiliation of the mayor in each city provides another possible factor affecting public transportation investment. The type of government is also a variable as it affects how much power a mayor has. There are strong mayors, council-manager, and other types of government. Demographic information such as population, population density, age, race, and ability are important for evaluating how cities compositions correlate to public transportation. Economic and geographic information such as the municipal budget, budget per capita, and population density are important to this study. It will also evaluate the relationship between the number of new public transportation projects completed and labor force participation rates. The study will limit the number of public transportation projects completed by only selecting projects completed after 2009.

Variables, Data Sources, and Hypotheses

All the variables that are used in this study are shown in Table 1. The data was obtained through secondary sources, primarily the U.S. Census Bureau. Data on the political affiliation of city mayors was obtained via Ballotpedia while data concerning the number of new public transportation projects completed since 2009 was obtained from The Transport Politic, a free online database containing data on public transportation.

The dependent variable used in this study is the labor force participation rate. The labor force participation rate is the percentage of adults over age 16 who are currently employed or actively seeking employment. It is a useful metric for measuring the number of people who are engaged in the economy and has some advantages over unemployment rate. The advantages are that labor force participation rate captures the whole population. This allows for a more holistic view of a city's overall economic wellbeing. Spatial mismatch – a key element of this study – often leads to chronic underemployment in urban areas (Kneebone and Holmes 2015). Long-term underemployment may lead some individuals to stop seeking a job altogether. Labor force participation rate, as opposed to unemployment rate, incudes these people.

There are several independent variables considered in this study. Mayor political affiliation may affect how likely city governments are to invest in new public transportation projects. To complement the data on mayoral political affiliation, the government type is also included. This is because some cities have strong mayors while others have strong city councils. Depending on which type, the mayors influence on city spending can be stronger or weaker. The annual budget of each city is also included in the data. This is because the budget may influence how much money cities are willing to invest in new public transportation projects. It is hypothesized that there is a direct positive relationship between budget size and new projects completed.

Each city's population and population density are included in the data. It is hypothesized that there is a direct positive relationship between population density and new projects completed. This is because population density affects how cost effective and viable new public transportation projects would be. Higher population density also may increase employment opportunities thereby increasing labor force participation rate.

Commute time is a significant factor in determining employment opportunities (Bastiaanssen, Johnson, and Lucas 2020). Therefore, it is included in this dataset. It is hypothesized that there is an inverse relationship between commute time and labor force participation rate. This means that as commute times increase, labor force participation rate decreases.

Additionally, demographic factors are included in the dataset. The percent of the population under 18 and over 65 seems to have an inverse relationship to labor force participation rate (i.e., the more of them there are, the lower the participation rate). This is because these demographics tend to be in education or in retirement. The percent of the population that is white is also included since chronic underemployment tends to affect white populations less. Moreover, non-white people, people under 18, and people over 65 tend to be more reliant on public transportation (Toms and Song 2016).

Variable	Observation	Mean	SD	Minimum	Maximum
Independent Variable					
LaborForcePR	30	0.654	0.036	0.595	0.741
Dependent Variables					
Democratic Mayor	30	0.679	0.476	0	1
Council-manager	30	0.464	0.508	0	1
Budget (millions)	30	1,966	2,434	401	9,700
Budget_pc	30	2839	2057	1036	11099
Population	30	701,298	810,277	227,470	3,898,747
PopDensity	30	5510.01	4880.42	171.20	17179.20
%under18	30	0.219	0.042	0.134	0.329
%over65	30	0.132	0.029	0.093	0.244
%white	30	0.585	0.147	0.336	0.880
%disabled	30	0.085	0.026	0.033	0.158
%inpoverty	30	16.939	5.477	6.800	5.477
CommuteTime	30	25.60	5.23	18.60	37.20
NewPubTransport	30	2.39	3.37	0.00	13.00
AvgWdyRidership	30	149.01	242.30	0.10	809.30

Table 2: Descriptive Statistics

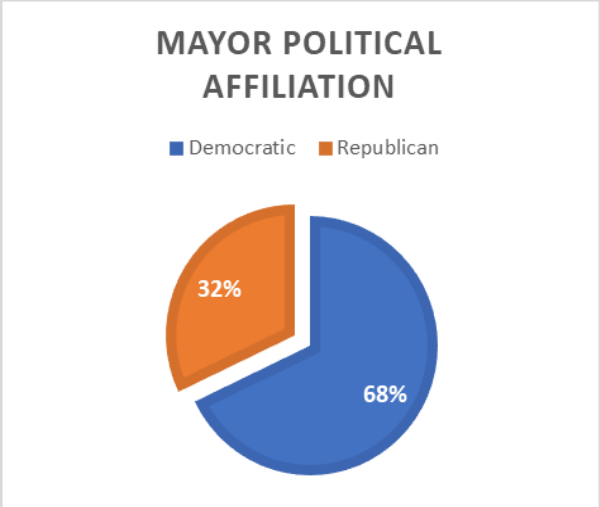
Therefore, these groups would likely disproportionately benefit from new public transportation projects.

Finally, the main independent variable is the number of new public transportation projects completed. This data suggests that there is a direct positive relationship between the number of new projects completed and labor force participation rate. This is because past studies have shown that increased access to public transportation can increase the labor force participation rate (Sanchez 1999).

Table 2 contains descriptive statistics that describe this study's independent and dependent variables. The average labor force participation (LFP) rate of 30 cities in the sample is 65.4%. The data showed a standard deviation of 3.6%, showing that most cities have LFP rates between 60% and 70%. The lowest LFP rate was Cleveland, Ohio with 59.5% and the highest was Minneapolis, Minnesota with 74.1%. Frequency statistics showed that about two third of city mayors were Democrats and about half of city government forms has strong mayors.

A close analysis of the dependent variables reveals many interesting things. For instance, the average budget per capita was $2,839 with a standard deviation of $2,057, revealing that budget per capita can range significantly. However, the lowest in the sample was Bakersfield, California with $1,036 and the highest was San Francisco, with $11,099. The median of the data is $2,246, revealing that most cities have budgets per capita close to $2,000. Very wealthy cities, like San Francisco, are an exception to the norm. The average population density is 5,510.01 people per square mile with a standard deviation of 4,880.42 people/mi^2 and the median is 3,365.1 people/mi^2. The lowest is Anchorage, Alaska with 171.20 people/mi^2 and the highest is San Francisco with 17,179.20 people/mi^2. The average commute time was 25.6 minutes, ranging from 18.6 to 37.2 minutes. The average weekday ridership is 149,000 people per day, with the lowest being Anchorage with 100 people per weekday and the highest being Los Angeles with 809,000 people per day. Figure 2 shows the frequency of cities that did not build new public transportation between 2009 and 2021, that built one to five new projects, and cities that built over five new public transportation projects.

The regression analysis revealed several areas of statistically significant correlation. There was weak significance for %under18. This indicates that for every one percent increase in the %under18 increases, the LFP rate decreases by 0.451 percent. Furthermore, %inPoverty, population density, and commute time all showed moderate significance. For everyone percent increase in %inPoverty, the LFP rate decreased by 0.004 percent. This is expected, as poverty may make it difficult for people to find jobs suitable to them. As population density increases by one percent, labor force participation increased by 7.02E-06 percent. This may be because denser cities can help individuals overcome spatial mismatching, thereby enabling them to find jobs. Similarly, as commute times increased by one minute,



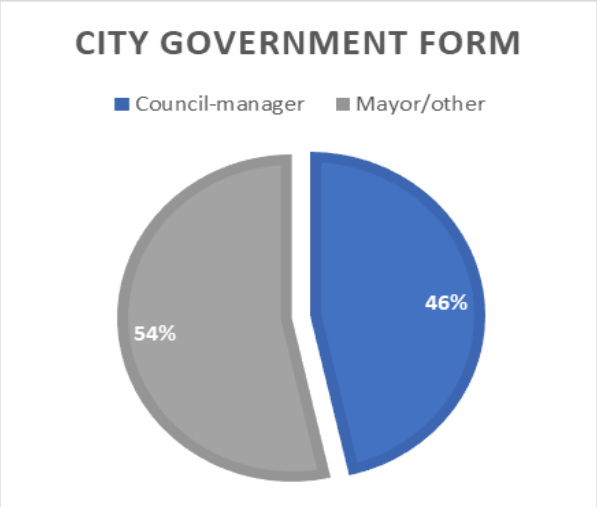


Figure 1: Frequency Data

the LFP rate decrease by 0.005 percent. This reveals that longer commute times shut some people out from looking for or obtaining employment. The %over65 variable showed the strongest significance. For everyone percent increase in %over65, the LFP rate decreased by 0.946 percent. This follows expectations, people over age 65 tend to retire and no longer seek employment.

Conclusion

Data analysis indicates that labor force participation rate is correlated with several variables. Following the spatial mismatch hypothesis, longer commute times and less dense urban environments result in lower LFP rates. This link may reflect a gap between city residents and jobs that may suit them. Higher rates of residents who were under-18 and over-65 also correlated with lower LFP rates, as did higher rates of poverty. There was no significant relationship found between current public transportation ridership and LFP rates.

These results show that although existing public transportation does not seem to correlate with LFP rates, public transportation may still be a useful way to reduce commute times and connect vulnerable populations to wider society. Low-income individuals are more likely to be reliant on public transportation. Since, unlike cars, public transportation is spatially fixed, the riders are limited in where they can go. Riders must go extra distances to get to and from transport stops. Hence, people reliant in public transportation have further elongated commutes. This is reflected in the significant correlation between population density, commute times and %inPoverty and LFP rate. Denser areas mean shorter distances between transport stops and destinations. This lowers commute times and opens more jobs to people, especially low-income individuals who rely on public transportation. The other two significant variables, people under-18 and over-65, are significant due to

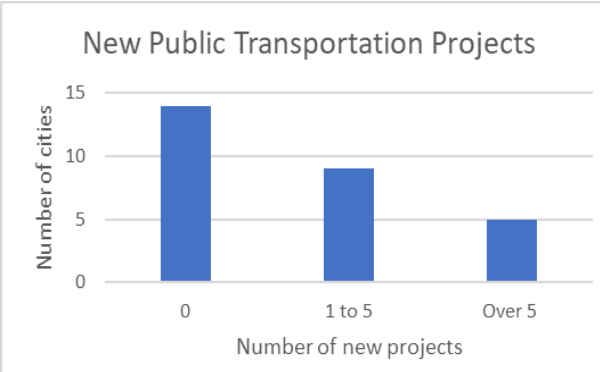


Figure 2: Frequencies of New Projects

Dependent Variable	Coefficient	Standard Error
Budget pc	0.000	0.000
CommuteTime	-0.005**	0.002
%under18	-0.451*	0.236
%over65	-0.946***	0.273
%white	0.032	0.049
NewPubTransport	0.003	0.003
PopDensity (1000s)	0.007**	0.005
Pop(1,000)	0.000	0.000
AvgWkdyRidership	0.000	0.000
%Disabled	0.377	0.276
%InPoverty	-0.004**	0.001

Table 3: OLS Regression Estimates

their societal status' as too young or too old for full employment. Nevertheless, these two groups tend to be more dependent on public transportation to get around.

City governments looking to increase LFP rates through the amelioration of spatial mismatch should focus on aiding those that are most reliant on public transportation. More robust public transportation systems can reduce commute times, enabling low-income individuals to seek out new job opportunities. Moreover, public transportation can help people under-18 and over-65, which, besides promoting a social good, can allow these groups to spend money in different areas, thus contributing to the economy.

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