Spatial Mismatch: Understanding Differences in Income Mobility Between Cities

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ABSTRACT Why do some American cities appear to be havens of opportunity while others remain stratified? Recent studies illustrate large differences in intergenerational income mobility between American cities, especially for low-income individuals. These differences are difficult to explain through economic productivity alone – for example, some booming cities, like Atlanta, GA and Columbus, OH, exhibit low levels of income mobility. I argue that differences in city policy are at the root of disparities in income mobility. In particular, I examine the effect of accessible public transportation on income mobility. I make a case that physical separation from jobs perpetuates intergenerational poverty, and that effective public transportation alleviates this separation. I conduct my analysis in two parts: First, a national statistical study of urban intergenerational income mobility from 1980 to 1996, using public transit accessibility as an explanatory variable. Second, a case study of the politics of public transportation in Columbus using interviews and historical sources. Synthesizing these two parts, I argue that public transit's social efficacy depends on the structure of local institutions: In cities with fewer veto points for regional planning and greater municipal fiscal autonomy, local governments are more likely to prioritize democratic goals in transit planning over technocratic ones.

Introduction

A child born into the bottom quintile of income in Atlanta, Georgia is almost three times less likely to advance to the top quintile than his or her contemporary in San Jose, California (Chetty et. al., 2014). While we often use simple heuristics to understand class in America – urban verses rural, Southern versus Northern – facts like this show that there are stark differences in socioeconomic opportunity even between superficially similar, "thriving" cities. This is due in large part to the lasting effects of urban planning decisions, which shape not only the physical form of the city but also its accessibility to the working poor.

One particularly important aspect of urban planning is the provision of public transportation. For many low-income individuals, faced daily with the challenges of securing a reliable commute and searching for work, economic mobility is tied to physical mobility through the city. An equitable, extensive public transit network can alleviate the many costs that the working poor face in this regard. Additionally, public transit can guide the spatial growth of cities, countering the highway-led urban sprawl that many US cities have faced.

For this and many other reasons, the accessibility of public transit is an important determinant of economic mobility in large cities. In this paper, I present a rigorous national test of the effect of public transit accessibility on upward income mobility. Before that, however, I make a conceptual case for the importance of public transit to studies of structural poverty. Finally, I conclude with some policy implications that follow from my study. My goal is to situate urban planning – and public transit provision in particular – within the broader context of a national conversation about economic inequality.

Literature Review

Motivation: The Idea of Income Mobility

Few issues could be more relevant to contemporary public debate than income mobility. Inequality scholars like Thomas Piketty - whose 2007 study of the US with Emmanuel Saez and subsequent book Capital in the Twenty-First Century both garnered considerable media attention - have seen their work elevated from public obscurity to a major political talking point over the last several years. This echoes a conceptual shift among American economists, who have historically downplayed or chosen not to study distributional issues - a stance against which many high-profile scholars have begun to break rank with the discipline. Indeed, the now-famous "1% of the population controls 40% of the income" statistic around which the Occupy movement organized itself is commonly attributed to Nobel Prize winner Joseph Stiglitz, hardly a "heterodox" figure.

It is in this fraught environment that Raj Chetty, Emmanuel Saez, Nathaniel Hendren, and Patrick Kline published their "Equality of Opportunity

Project" papers, which provided the impetus for this study, in 2013. The Project comprises two papers, one of which addresses geographic differences in intergenerational income mobility across the United States, the other of which addresses long-term historical trends.

Income mobility, as a concept distinct from static equality, is of particular relevance to the US political conversation. Defenders of the U.S.'s uniquely skewed income distribution have often cited the wealth of opportunity available to its citizens as justification for its degree of income inequality (e.g. Mankiw, 2013). In fact this supposed tradeoff is illusory – Alan Krueger's (2012) famous "Great Gatsby curve" demonstrates that there is a strong positive correlation between equality and mobility – but it remains a potent rhetorical idea. That is why the Equality of Opportunity Project, which revealed vast disparities in income mobility within the US, struck a popular chord – it has been featured in the New York Times and cited by many city and state government leaders as a cause for concern. (ex. Reed, 2013)

Among Chetty et. al.'s most striking findings is a huge difference in mobility between the South and the rest of the nation: on average, individuals born into the bottom quartile of income in the southeastern states have only a 27%-38% chance of reaching a higher income level than their parents, a measure among the lowest in the nation (Chetty et. al. refer to this statistic as "absolute upward mobility", and I will henceforth do the same).

Equally striking and less intuitive to a casual observer is the degree of heterogeneity between cities: among the 50 largest metropolitan areas, absolute upward mobility varies from 46.2% in Salt Lake City, Utah to 35.8% in Charlotte, North Carolina. Urban differences do not map neatly onto a North/South divide, either – among the 10 least mobile cities are 3 in Ohio, one in Indiana, and one in Wisconsin. It is these sorts of differences which this paper seeks to explain.

In this review, I will compare and contrast the prevailing explanations for disparities in income mobility found in the social sciences – particularly, the "individualist" explanations common in economics verses the "structuralist" arguments predominant in sociology. Then I will make a case for why geographic explanations of mobility – and access to transportation in particular – are a significant and relatively underexplored area of research.

The Nature of Opportunity

Explanations of income mobility can be divided, broadly, into two camps: Individualist and structuralist. Individualist explanations predominate in economics, particularly in neoclassical economics and its modern methodological successors. When considering the determinants of income, neoclassical economists tend to emphasize "human capital" factors like skills and professional training, as well as individuals' incentives or disincentives to work. This focus on personal qualities in isolation comes from neoclassical economics' grounding in marginalist theory, in which wages are a function of individual workers' productivity. This has led many scholars of the American economy to posit a "skills mismatch" as the cause of intergenerational poverty (ex. Handel, 2005), citing that traditional manual labor-heavy jobs have been increasingly obsolete by globalization and deindustrialization, and arguing that better training for workers (present and future) is the key to ending persistent inequality of opportunity.

However, many scholars of poverty outside of the discipline of economics argue that economists' focus on methodological individualism elides important differences social, geographic, and political contexts that affect income. These so-called structuralists argue that economics presupposes a fixed set of background conditions in these areas that bear little resemblance to reality. Structuralist arguments are more common in sociology and political science – in the US, the "Chicago school" of urban sociology in particular has produced a number of influential strucutralist scholars of poverty.

Chief among these scholars is William Julius Wilson, whose work at University of Chicago in the 70s helped make its sociology department a metonym for the urban studies discipline. In The Truly Disadvantaged, one of his many books on the persistence of black poverty and neighborhood segregation, Wilson popularized the term "spatial mismatch" to characterize how many urban black communities are separated from work by geographic and social distance, not just a lack of professional skills. Throughout his work, Wilson refers to the mid-century emergence of a predominately black urban "underclass" created through systematic discrimination in housing policy and lending practices. This paper and many of the works cited therein owe a great deal to Wilson's articulation of these problems.

The segregated residential patterns that Wilson describes have been well documented in the empirical literature. Jargowsky and Yang (2006) found that metropolitan areas that experienced a greater degree of suburbanization between the years 1990 and 2000 had a more persistent level of economic segregation. Kasarda (1993) also found that spatial concentration of poverty became greater from 1970 to 1990 on the national average, despite gains in a few Northeastern cities.

Likewise, Baum-Snow (2010) finds that there has been a population shift from cities to suburbs since the 1960s. However, he also observes that employment concentration is now greater in central cities than in the suburbs – in other words, the amount of jobs available in central cities has proportionately increased. Combining these two statistics, it becomes clear that fewer people today live and work in central cities, even as those areas become more productive. This suggests that the ability to commute long distances is becoming more important for workers, exacerbating spatial mismatch for those who neither have access to public transportation nor a reliable car.

Studies like this show that urban poverty can no longer be understood as a purely inner-city phenomenon, as in Wilson's time – Murphy (2007) points out that since the 90s, Census data has revealed an increase in suburban poverty, particularly in "inner-ring" suburbs proximate to cities. She points out that the phenomenon of suburban poverty has been largely overlooked by ethnographic and demographic studies, and stresses its importance to future poverty research.

While the nature of poverty may be shifting in some places, these papers all suggest that the social geography of cities – in particular, the concentration and separation of their poor – has a profound effect on job access and thus income mobility. In this area, there remains a disjuncture between economics and the rest of the social sciences. However, studies like Chetty et. al. have the potential to bridge this gap, as they allow social scientists to systematically test the claims made by sociologists and political scientists with a level of rigor and detail never before available.

Why Location Matters

There are a number of reasons why geographic location could affect income mobility. Most common in the literature are "neighborhood effects" like school quality, crime rates, prevalence of single parents, and a lack of supportive community institutions (a dearth of "social capital", to use Robert Putnam's term). Chetty et. al. find that all of these factors explain a significant portion of difference in income mobility. The traditional spatial mismatch hypothesis, popularized by Wilson in When Work Disappears, builds on these explanations. It posits that youth in low-income neighborhoods suffer from a lack of positive social roles to which they can aspire, and are not socialized into the "soft skills" of communication and professionalism necessary for working life.

What I test for in this paper is not precisely Wilson's spatial mismatch hypothesis, but is informed by it. I am concerned with the effect that access to reliable public transit has on upward income mobility. There is a strong intuitive case that in many cities low-income workers simply lack the means to get to work, and this is supported by qualitative studies like Boschmann (2011). Lack of access to transportation could also create social distance and increase the opportunity cost of a number of important activities (as discussed later), so it is a relevant issue for a number of theoretical explanations.

To illustrate why studying transit accessibility is critical, consider the empirical literature on the spatial mismatch hypothesis, which is often ambiguous or conflicting. Hellerstein et. al. (2009) provide a good summary of the controversy: It is difficult to parse out the effect of spatial mismatch from the effects of hiring discrimination. As low-income urban communities in the US tend to be disproportionately black, these two phenomena are easily conflated. Many statistical strategies have been used to isolate the effect of spatial mismatch, but Hellerstein et. al. take a different approach: They stratify their sample by race before testing the spatial mismatch hypothesis. They find that the issue is not a simple lack of nearby jobs in low-income black communities; rather, it is that these jobs tend to be disproportionately held by whites, even when controlling for skill levels. When the sample is restricted to black respondents, the conventional spatial mismatch hypothesis appears to hold. This suggests a picture of racial inequality more complex than spatial mismatch or hiring discrimination alone – instead, the latter plays into the former.

This knowledge can help explain why place-based policy interventions like the Moving to Opportunity study (Katz et. al., 2001) and enterprise zones (Peters

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and Fisher, 2002) have appeared to have muted or nonexistent effects - while spatial mismatch may be a real phenomenon, it cannot be understood outside of larger patterns of discrimination. Looking at access to public transit is enlightening, then, as it is not only a determinant of social mobility in its own right but also a symptom of racial discrimination in urban planning and private development.

There are many mechanisms through which public transit accessibility can affect income mobility - it matters for more than just commutes. Harrison and Hill (1979) find that low-skilled "secondary sector" jobs tend to be considerably more cyclical than high-skilled "primary sector" jobs and subject to higher turnover. For this reason, low-income individuals (employed predominately in the secondary sector) face greater and more frequent search costs from looking for work, and these costs could be exacerbated through lack of access to reliable transportation. As they write, "Institutional obstacles to the free movement of workers from the secondary to the primary labor market seem to be deeply ingrained in American economic life."

Most of the empirical work on how public transit affects work access has been through case studies of particular cities rather than national surveys. For instance, Gao and Johnson (2009) use an econometric model of travel demand in Sacramento, California to estimate the potential welfare gains from expanding car ownership and making public transit more efficient. They find that while both interventions would increase low-income residents' welfare, public transit improvement would have broader benefits in terms of job accessibility and utility gains. Key to Gao and Johnston's findings is the fact that Sacramento's public transit system services both low-income and job-rich, high-income neighborhoods; this equitable access is a critical variable in my study.

Similarly, Sanchez (1999) compares the public transit systems of Portland and Atlanta and estimates the effect of transit accessibility on employment for both cities. Portland and Atlanta are interesting cases for the purposes of my study, as they not only lie on opposite ends of the income mobility spectrum, but have very different urban forms, political arrangements and racial compositions. Sanchez uses census block groups as his unit of analysis, and regresses unemployment statistics for each block on multiple measures of transit accessibility, as well as standard demographic covariates like racial composition and percentage of single parents. Sanchez includes three measures of transit accessibility: Service frequency, walking distance to the nearest transit stop, and a more sophisticated "gravity-based" measure of accessibility, in which a block is scored on its average distance from other blocks with service-sector employers, exponentially weighted. (The relative merits of these different measures, and how they might be synthesized, will be discussed in the methodology section.)

Sanchez finds that in Portland, only the walking distance measure has a significant relationship with employment, and the size of that relationship is small. Even this significance vanishes when the sample is limited to majority non-white census blocks. However, in Atlanta, he finds that all of the measures of accessibility except service frequency have a large, significant relationship with employment. What's more, he finds that bus accessibility has a much greater effect than rail accessibility in both cities, consistent with the majority of literature on this topic. He attributes the difference in findings between cities to the fact that in Portland, there is little variation in transit accessibility between census tracts (that is, transit access is relatively equitable), while in Atlanta there are large disparities between communities. As will be discussed in this study, the divergent development of public transit in these two cities can be explained in large part by their distinct bases of local political power.

In contrast to the studies above, Blumenberg and Manville (2004) is a direct challenge to Wilson's spatial mismatch thesis. Blumenberg and Manville are critical of the theory because they claim that it considers mere distance from jobs rather than accessibility of jobs – in many regions, as they test for in the paper, auto users face significantly shorter commutes than public transit users. They call this phenomenon "modal mismatch", and cite as its cause barriers to car ownership for low-income residents, like reliability and asset value limitations imposed on welfare recipients. They are skeptical of the effects of public transit expansion on employment, and point out that the same patterns of discrimination that have lead to residential segregation have also lead to the systematic under-serving of low-income groups by public transit. These admonitions are important to keep in mind for any study of how public transit affects the least advantaged.

Transit and Urban Sprawl

Blumenberg and Manville's paper is a reminder that transit issues should be considered in the broader social, economic and political context of urban development. The urban sprawl of an area, in particular, could have a great effect on the accessibility of jobs. There is clearly a connection between the nature of transportation (highway-led or public transit-led) and sprawl, but in what direction does causality run?

A common explanation for urban expansion (or lack thereof) is zoning laws, which restrict the supply and type of housing. A leading exponent of this view is Economist writer Ryan Avent, who writes in his book The Gated City that "America has made its most productive locations ever less accessible" through legislative constraints on new construction. This view can help explain differences in housing prices between cities, which no doubt affect the living patterns of low-income individuals. The racially discriminatory nature of many cities' zoning laws, as explored in detail by Massey and Denton (1993), is also of great importance to this study. However, zoning laws alone cannot explain differences in the amount of sprawl between cities – other public policies are part of the story as well.

Baum-Snow (2010), mentioned earlier, ties sprawl to highway-led growth. He uses the amount of planned highways in 1960 as an instrument to explain employment decentralization and commuting patterns in 2000. He finds that expansion of the highway system has led to an outflow of residents from central cities, consistent with qualitative accounts of highway-oriented development like Jackson's.

However, some economists contend that physical barriers to construction matter more than any public policy. For instance, Saiz (2010) finds that the amount of buildable land in an area strongly affects the elasticity of its housing supply. In addition, he argues that legislative constraints on housing are in fact endogenous to physical constraints – they are simply a means for residents to protect the rents they have already acquired. Most importantly for this paper, he concludes that a lack of physical constraints on building leads to a greater degree of urban sprawl. This suggests, contra both Baum-Snow and Avent, that the initial geographic endowments of a city matter more for its expansion than any public policy could.

To untangle the direction of causality between transportation and land use, Levinson and Chen (2005) use a Markov chain model to study the co-evolution of highway networks and housing in the Twin Cities area from 1958 to 1990. They divide a map of the area into regular cells and classify each cell by its predominant use – employment, residential, mixed-use or agriculture –as well as its connection to the highway system. This yields 20 different types of cells. They then create a "transition matrix" for every type of cell, which estimates how likely it will be for a given type of cell to change into any other given type over the time period (in this case, a decade). They find that highway construction had an effect on the initial growth of the city, tending to make unpopulated agricultural areas into populated ones. However, they also find that the direction of causality is less clear for areas that are already urbanized.

In sum, the literature from economics suggests that public policy, especially the choice between highway- and public transit-led growth, affects urban sprawl. This is critical for my thesis, because if differences in transit accessibility were a mere byproduct of geography then there would not be many interesting policy implications to be drawn. However, the literature shows that accessibility is very much the product of human decisions, and that city development is historically contingent.

Regression and Interpretation

Methodology

Drawing from these sources and others, I posit that public transit access is a large factor in explaining differences in upward mobility between American cities. Furthermore, I believe that Chetty et. al.'s dataset allows this hypothesis to be tested in a more comprehensive and rigorous way than ever before, thanks to its scale, accuracy and longitudinal nature.

Chetty et. al. do not use states or counties as their unit of analysis – instead, they use a constructed area called the "commuting zone", created by Tolbert and Sizer (1996). Commuting zones (henceforth CZs) are meant to delineate areas by where the majority of the population works, and can be considered an extension of the "standard metropolitan statistical area" methodology used by the Census Bureau to the entire United States, including rural areas. Tolbert and Sizer draw the boundaries of CZs by using hierarchical clustering

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analysis on Census data of individuals' commuting patterns. CZs are uniquely suitable for this paper, as I am concerned with transportation, so I follow Chetty et. al.'s example and use them as my geographic unit of analysis.

To establish a relationship between transit accessibility and income mobility, I regress Chetty et. al. (2014)'s measure of absolute mobility against data on transit accessibility from Berube et. al. (2011) and a number of relevant controls. I then test this model for robustness to regional fixed effects and different specifications of accessibility.

I hypothesize that an increase in the accessibility of public transit (as measured below) will lead to an increase in upward mobility for low-income individuals, all else being equal. After presenting the output of my regressions in Stata, I will present an interpretation, and then conclude with some policy implications for city planners drawn from the results.

Data

Data on income mobility comes from Chetty et. al. (2014)'s national study of intergenerational mobility, as discussed earlier. Chetty et. al.'s data on parent and child income comes from dis-identified federal tax returns. Their measure is pre-tax, post-transfer and adjusted for cost of living using the CPI. In their paper on geographic differences, parents' income is taken from 1980 to '82, and their adult children's income from '96 to '00. This cohort of children was around 30 years old when their income was measured – Chetty et. al. establish that this is a robust, stable measure of their lifetime income through adding data from subsequent years to their specification.

As mentioned, Chetty et. al. construct two measures of income mobility from their tax return data – "relative" and "absolute" mobility. The former measures the difference in rank outcomes between children from bottom-income families vs. those from top-income families. This has ambiguous normative implications, as an increase in relative mobility – that is, a narrowing of the gap – could just as easily come from worsening outcomes for the rich as improving outcomes for the poor. (That said, the majority of difference in relative mobility between areas in Chetty's data comes from the lower- and middle-class; the rich appear to uniformly well-off.) Absolute mobility, in contrast, measures the expected rank outcome for children born into the 25th percentile of income. Given that I am concerned foremost with the outcomes of low-income individuals, I use absolute mobility in my specification.

A final note on Chetty et. al.'s methodology: In constructing their CZ-level mobility estimates (the only level of data I have access to), they count individuals by their area of birth, not the area they end up in as adults. This decision likely stems from Chetty et. al.'s methodological focus on childhood effects (like school quality) in explaining mobility. This seems problematic for my purposes, as public transit access is just as likely to have a beneficial effect on adults as children, if not more likely. Yet if an individual moves from the country to the city as a young adult, they will not be counted toward the city in Chetty's data, leading to the potential underestimation of the effects of public transit on mobility. While this is a valid concern, Chetty et. al. check their data for robustness to migration by restricting their sample to non-movers, and find a strong correlation between their baseline mobility estimate and the restricted estimate (despite endogenous selection of non-movers). This means, in spite of the migration issue, I am comfortable using Chetty et. al.'s data for my regression.

Data on public transit accessibility comes from Berube et. al. (2011)'s study for the Brookings Institution. They study the transit systems of the 100 largest metropolitan areas of the United States. They construct three different measures of accessibility for each area – coverage, service frequency, and job access. In all cases, data on the extent of transit networks was taken from local transit agencies between 2009 and 2011. "Coverage" measures the percentage of census tracts within ¾ of a mile of a transit stop, this being considered a reasonable upper limit on commuters' acceptable walking distance. "Service frequency" measures the average time a commuter must wait for transit service during rush hour, averaged across all census tracts. Finally, "job access" measures the share of jobs than can be reached within 90 minutes using public transit, again averaged across all census tracts. Since these three metrics measure distinct aspects of accessibility, I include all of them in my regression.

For each metric, Berube et. al. provide four different versions. One is for all census tracts in the city, and the other three restrict the sample to low-, middle-, and high-average-income tracts, where low-income tracts have an average household income below 80% of the metropolitan area's median (AMI), middle-income tracts are between 80% and 120% of AMI , and high-income tracts are above 120% of AMI. I am primarily interested in the low-income metrics, given my focus on absolute upward mobility, but I test my regression for robustness to using the universal metrics instead.

Berube et. al use standard metropolitan statistical areas (SMSAs) as their unit of analysis, rather than CZs like Chetty et. al. Fortunately, the two groupings map closely to one another – For CZs that intersect MSAs, the correlation between CZ-level and MSA-level mobility statistics is greater than 0.9. For that reason, I can safely combine the two datasets. However, a few transit systems that are treated as separate in Berube et. al. are covered by one CZ – in these cases, I average the accessibility metrics of the systems together, weighted by population, before combining the dataset.

Merged pairs and triads include Akron/Cleveland, New Haven/Bridgeport/Hartford, Ogden/Salt Lake City, Oxnard/Riverside/Los Angeles, Rochester/Buffalo, Stockton/San Francisco, and Worcester/Boston. Many of these cases are large cities paired with "satellite" communities that send more than a quarter of their workers to the main city (Berube et. al), so it is methodologically inconsequential for my purposes to merge them. After merging, n = 91.

Control variables include the fraction of black residents, racial segregation and income segregation indices, the fraction of residents with a commute < 15 minutes, local government expenditure per capita, and median household income. These variables are all taken from Chetty et. al.'s dataset, and details on their sources and construction can be found in Chetty et. al.'s documentation. I also include the percentage of Democratic votes cast in 1980 Presidential election as a proxy for the political ideology of each commuting zone during the time when parent income data was measured.

The commute time measure (meant to be a proxy for urban sprawl) is worth discussing in greater detail, as at first glance it may appear to measure essentially the same thing as Berube et. al.'s accessibility measures. However, commute time is not collinear with any of Berube et. al.'s measures, and this is because the two metrics are largely distinct – commute time captures both private automobile and public transit, and does not distinguish between local income strata as Berube et. al. does. As such, there is justification for including both in my regression. Berube et. al.'s accessibility measures should then capture the effect of access disparities (my variable of interest) after controlling for the effect of traffic congestion, slow rail systems, etc. That said, my results ultimately show that access disparities are necessarily tied to the factor of urban sprawl, as will be discussed in detail later. The two issues can never be fully separated empirically or theoretically.

Specification and Results

I estimate a regression of the form:

Relative mobility = β0 + β1**Job access** + β2**Coverage** + β3**Service frequency** + β**X**

Where X is a vector of the control variables listed above. I test four different specifications of this model: With and without regional fixed effects and low-income vs. universal accessibility measures. For the regional fixed effects models, I code each observation by its official Census Bureau region: Northeast, Midwest, South, or West. This accounts for any differences between regions that are not specified in the model. I use clustered standard errors for the fixed effects model due to likely autocorrelation between geographically proximate observations. In all models, I weight observations by population to correct for heteroskedasticity. Note that all models are robust to restricting the accessibility measure to only one of the three variables ("jobaccess", "coverage", or "servfreq" alone) – multicollinearity is not an issue. The results are reported in the following tables.

Figure 1: Regional FE, low-income accessibility measures

	AM, 80-82 Cohort
%black	-15.480
	(5.35)*
Racial segregation index	-5.640
	(1.53)
Income segregation	7.304
	(0.33)
Fraction with commute <15min	-11.530
	(1.07)
HH income per capita	-0.000
	(0.40)
Local gvt. expenditure PC	0.743
	(1.40)
jobaccesslow	1.365
	(0.61)
coveragelow	4.209
	(4.66)*
servfreqlow	0.022
	(0.43)
%Votes Democrat, 1980 presidential election	-0.018
	(0.35)
Constant	41.922
	(6.04)**
R2	0.66
N	91

* p<0.05; ** p<0.01

Figure 2: Simple OLS, low-income accessibility measures

	AM, 80-82 Cohort
%black	-17.401
	(4.15)**
Racial segregation index	-4.809
	(1.45)
Income segregation	7.206
	(0.44)
Fraction with commute <15min	-11.578
	(1.54)
HH income per capita	0.000
	(0.17)
Local gvt. expenditure PC	0.442
	(1.01)
jobaccesslow	1.739
	(0.70)
coveragelow	6.927
	(3.21)**
servfreqlow	0.043
	(0.90)
%Votes Democrat, 1980 presidential election	0.034
	(0.84)
Constant	37.052
	(8.08)**
R2	0.56
N	91

* p<0.05; ** p<0.01

Figure 3: Regional FE, universal accessibility measures

	AM, 80-82 Cohort
%black	-14.376
	(5.64)*
Racial segregation index	-6.642
	(1.93)
Income segregation	12.824
	(0.55)
Fraction with commute <15min	-6.332
	(0.50)
HH income per capita	-0.000
	(0.19)
Local gvt. expenditure PC	0.383
	(0.87)
jobaccessall	1.491
	(0.45)
coverageall	5.680
	(3.92)*
servfreqall	0.012
	(0.35)
%Votes Democrat, 1980 presidential election	-0.014
	(0.32)
Constant	40.701
	(5.40)*
R2	0.70
N	91

* p<0.05; ** p<0.01

Figure 4: Simple OLS, universal accessibility measures

	AM, 80-82 Cohort
%black	-15.431
	(3.81)**
Racial segregation index	-4.979
	(1.60)
Income segregation	14.332
	(0.96)
Fraction with commute <15min	-5.305
	(0.70)
HH income per capita	0.000
	(0.69)
Local gvt. expenditure PC	-0.098
	(0.23)
jobaccessall	1.628
	(0.66)
coverageall	6.783
	(3.37)**
servfreqall	0.035
	(0.85)
%Votes Democrat, 1980 presidential election	0.041
	(1.11)
Constant	36.470
	(7.70)**
R2	0.59
N	91

* p<0.05; ** p<0.01

Interpretation

These results are broadly supportive of my hypothesis. Across all specifications, the "coverage" measure of accessibility has a large positive coefficient and is significant at p>.05. This suggests that, all else equal, cities that provide public transit to a greater proportion of residents tend to be more socially mobile.

However, there is another, less intuitive result: the "service frequency" and "job access" metrics are nowhere close to statistically significant, and have negligibly small coefficients. Given that all three variables purportedly measure accessibility, this is surprising. If anything, intuition suggests that job access should be more important than mere coverage; per Blumenberg and Manville (2004), the greatest physical barrier to employment that low-income city dwellers face would seem to be finding a way to get to work on time. What explains these contradictory findings?

There are two potential explanations. First, the service frequency and job access metrics are subordinate to the coverage metric; that is, they are only calculated for census tracts that are already considered "covered" (aka within ¾ of a mile of a transit stop). This means that the majority of significant variation is captured by the coverage metric. To put it another way: For most people, the issue does not appear to be whether they can catch the bus or train to work on time - rather, it is whether they have access to transit at all.

Second, the way in which Berube et. al. calculate their job access metric may skew the results. In the data provided, they do not differentiate between types of jobs; rather, they look at all employers within a 90 minute commute. Given that low-skilled service-sector jobs tend to be in the suburbs (cf. Jackson (1985), Kasarda (1993), Jargowsky and Yang (2006), and many others), this measure may overestimate the amount of attainable jobs that low-income individuals can reach via transit. Indeed, Berube et. al. note this disparity in their paper: "About one-quarter of jobs in low- and middle-skill industries are accessible via transit within 90 minutes for the typical metropolitan commuter, compared to one-third of jobs in high-skill industries." However, they do not provide detailed city-by-city data with which to test this explanation. This would be a fruitful area for further research.

A final caveat in interpreting these results: Since my sample only includes cities with a transit system, there is likely selection bias on the dependent variable. This makes results difficult to generalize beyond the sample. To correct for this bias, two-stage Heckman estimation could be used, in which a probit model for the likelihood of a city developing a transit system is first estimated, and then the result of this equation is incorporated into the income mobility OLS model. This use of Heckman correction is only valid if an exclusion restriction for the probit model can be found– in this case, a variable that is correlated with developing a transit system but not with income mobility. (cf. Bushway et. al. 2007) Use of historical instruments is common for this sort of problem in econometrics, ex. Baum-Snow (2010), which uses planned highways as an instrument for built highways, and Ananat (2011), which uses railroad tracks as an instrument for segregation.

Finding such a variable for my data is outside the scope of this paper, but is another interesting subject for follow-up papers. Bus and commuter rail networks have often developed along the path of early streetcar routes, so the historical extent of streetcar routes may be a strong instrument in this case. There is precedent for this – Brooks (2014) uses streetcar networks as an instrument for modern urban sprawl.

Note that Heckman correction would assume that all cities have the potential to develop a transit system – in other words, that having a transit network is a latent variable. Consider the most well-known use of Heckman correction, wage equations: It is assumed that there is some "reservation wage" (determined by personal characteristics) below which an individual will choose not to work. Selection bias caused by non-workers can then be treated as a case of omitted variable bias where the omitted variable is the reservation wage. However, it is not clear that there is anything analogous to the reservation wage in my case – it is odd to think that there is some threshold value beyond which a city chooses to develop a transit network. A better solution may be to use traditional two-stage least squares with streetcar extent (or whichever historical variable I find) as an instrument for transit accessibility in the first stage. In either case this is a promising route for further research.

In summary, transit accessibility has a large, statistically significant effect on income mobility. However, it appears that the key aspect of accessibility is whether or not individuals can walk to a transit stop, rather than frequency of service or distance from jobs. This suggests that individuals without access to transit either live on the outskirts of or are systematically excluded from public infrastructure.

Conclusion

Scope Conditions and Future Directions

A couple of strong conclusions can be drawn from this study. First, the significance of the "coverage" measure suggests that ways to improve the accessibility of public transit to underserved communities is an important area for policy research. Second, the robustness of this regression to regional fixed effects suggests that the benefits of public transit are not confined to relatively egalitarian coastal cities; rather, transit accessibility is a goal that all large US cities can pursue.

However, there is still much room for improvement and future research in this area. A clear next step would be to test my hypothesis on a more granular level, narrowing the unit of analysis to census tracts or even individuals. This could allow more sophisticated tests of causality and would provide a more sophisticated picture of the geography of inequality in each city.

Additionally, it would be informative to expand the scope of the sample. Currently, limitations on the standardized transit accessibility data that is publically available meant that I had to restrict my sample to the 100 largest metropolitan areas. However, using GIS software and route data available from transit agencies' websites, it would be feasible to replicate Berube et. al.'s accessibility estimation procedure for a greater number of cities. Extending the sample to smaller cities would help with the selection bias issue that I currently face.

As discussed in the previous section, incorporating some form of instrumental variable estimation could also help with the identification problem. This is a relatively easy way that the study could be improved without having to obtain an entirely new dataset, and there is precedent for it in the literature on urban developed, as mentioned.

Improving the detail and rigor of the model would not only allow me to get closer to causal identification, but could allow for more detailed policy recommendations. Even in its current form, however, several clear normative implications follow from my research.

Policy Implications

First, it is evident that any discussion of how to improve transit accessibility must be bracketed by the fact that cities face differing geographic constraints on urban expansion. Connecting communities via transit in the flat, sprawling Atlanta metro area is necessarily a much more difficult task than in the naturally limited environment of New York City. However, even within the background conditions on growth imposed by geography there is significant room for influence from public policy. As Jackson (1985), Baum-Snow (2010), Levinson and Chen (2005) and many others have shown, modal choice of transportation significantly effects urban expansion. When city officials choose to invest in highway networks rather than intra-city public transit, there are first-order welfare consequences for the least advantaged.

Recognizing this, some progressively-minded cities, like Portland, have instituted self-imposed constraints on growth via zoning policy and transit-oriented development (TOD), which makes the expansion of the public transit system a priority in new land use planning. These sorts of changes are self-reinforcing, as transit systems with larger ridership rates tend to enjoy greater political support, and thus more funding (Boshken, 2002).

Another implication that emerges from my research concerns the choice between rail and bus systems for new transit development. While commuter rail projects tend to be high-profile, politically advantageous affairs, the majority of literature on the subject suggests that they are less equitable than bus systems (Wolch et. al., 2004). As rail systems are fixed by nature and require a significant capital investment, they can easily become subjects of patronage (Reed, 1990) .Their routes tend to favor affluent bedroom communities – who enjoy greater political and financial influence – over the low-income neighborhoods that could use access to transportation the most. For this reason, buses appear to be a more effective mode of transit from an equity standpoint (not to mention a budget standpoint).

Finally, the fact that the most significant difference between transit systems appears to be not frequency of service or connection to employers, but rather the extent of coverage, has clear policy implications. Instead of focusing on how to make existing public transit routes more efficient, planners should consider first how to extend transit access to underserved communities. This is the main reason bus systems are favorable to rail systems in terms of social effectiveness.

Summary

Spatial analysis can shed light on inequality in ways that traditional labor economics elides. My finding that transit coverage has a large, statistically significant relationship with income mobility is evidence that this is a topic worthy of further research, both in theory and in policy.

Furthermore, my findings suggest that city planners can and should make social efficacy a goal of public transportation, as it has a demonstrable effect on upward income mobility. However, there is a need for more detailed studies in order to explore individual-level causality as well as more accurately map the geography of public transit accessibility.

As the world's population becomes increasingly urbanized, studies of local economic conditions become more and more relevant. Urban economics can offer a valuable perspective on how to better design cities to reduce the burdens of inequality and increase access to work for all.

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