WAITING FOR THE R TRAIN: PUBLIC TRANSPORTATION AND EMPLOYMENT

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1. Introduction

There has been substantial interest in public policy circles in recent years regarding strategies of "job creation" and fostering "job access." These terms are rarely provided with concrete definitions and are instead meant to capture an alleged capacity on the part of government to decrease unemployment, or increase the quality of jobs that are available to individuals. Making job opportunities more spatially accessible represents a plausible policy lever for government to improve employment outcomes amongst urban residents. If government improves transportation networks, the number of jobs available to a typical individual will be increased and this could improve the speed with which workers match to firms, and improve the quality of matches.

Job access is closely related to issues of urban sprawl and the theory of spatial mismatch; both of which consider spatial gaps between workers and jobs. For populations reliant on public transportation, the ability to access employment is closely tied to the usability and extent of the region's public transportation network. There is theoretical, and empirical evidence that populations with better access to jobs through public transportation networks enjoy lower rates of unemployment; however, properly identifying this relationship is complex because neighbourhood economic vitality and public transportation provision are codetermined. Locations that occupy geographically central locations, or have exogenously developed as centers of economic activity or affluence, will be more likely to see local public transit investment, due to the higher economic returns to transit infrastructure in such areas.

The effect of Hurricane Sandy on New York City's public

transportation infrastructure presents a natural experiment to investigate a causal relationship. Using the truly exogenous reduction in public transportation that occurred in particular neighbourhoods, this study will provide evidence for a causal relationship between public transportation access and local unemployment.

2. Related Research

This section will provide a basis for the current study in the foundational contribution of Kain (1968). Subsequently, this section will describe more recent and closely related works, particularly those that look specifically at public transportation access and employment outcomes within US metropolitan areas.

Spatial mismatch is a theory that seeks to explain why the unemployed became spatially concentrated in inner cities. In pre-war North America, a significant portion of urban economies were built upon industrial and manufacturing activities that took place in urban city centers. The low-skilled workers that were employed in these industries clustered in dense urban housing, allowing them easy access to low-skilled job opportunities. Post-war North American cities have been characterized by a decrease in manufacturing job opportunities in general, while remaining low-skilled jobs were largely relocated to the suburbs to take advantage of lower land prices. Because housing stock is long lived and locational choice is constricted by affordability, low-income, low-skilled populations generally remained in inner cities, even though their historic employment base had collapsed or moved away.

Kain (1968) represents the first effort in the literature to draw an empirical connection between location of housing and the propensity to be unemployed. Kain (1968) specifically attempted to explain the unusually high rates of unemployment that persisted in black neighbourhoods in the inner cities of Chicago and Detroit. While previous investigations had exclusively blamed job market discrimination for the gap in employment between white and black neighbourhoods, Kain (1968) suggested that the locational characteristics of these neighbourhoods with respect to job centers may also play a strong role in determining job market outcomes. By mapping the distribution of manufacturing jobs through time and noting that many predominantly black neighbourhoods remained

stationary through time, the study is able to relate the collapse of low-skilled job opportunities in inner cities to declines in employment outcomes for black residents located in the same areas.

An attempt to systematically test the spatial mismatch hypothesis came from Farley (1982). Farley (1982) presents empirical evidence that spatial dimensions of employment markets cause higher rates of unemployment amongst black populations, particularly in northern US metros. The study uses controlled regressions and estimated that 15% of the gap in white-black unemployment can be derived as a consequence of housing segregation and suburban employment location.

Ihlanfeldt and Sjoquist (1998) aims to provide a review of past investigations into spatial mismatch. The paper provides a discussion of the potential endogeneity which occurs when using household location as a predictor of employment outcomes: "The problem with this approach is that while job access may affect employment, employment may also affect the magnitude of the measure of job access." Ihlanfeldt and Sjoquist (1998) also provides a discussion of so-called mobility strategies, or those strategies which seek to use the transportation network to increase job access. Ihlanfeldt and Sjoquist (1998) considered the evidence to be inconclusive regarding the presence of a causal role of transportation access on employment.

Thomas Sanchez furnishes the literature with US case studies looking directly at public transit characteristics – such as the nearness to a bus or subway stop, or transit service frequency – and relates high transportation access to lower levels of unemployment. Sanchez (1999) analyzes access to public transportation for poor black communities in Portland, Oregon and Atlanta, Georgia; finding that unemployment is higher for those residents who live more than 400 meters from a public transit node. Sanchez et al. (2004) looks at a wider sample of cities and finds transit access to be negatively related to the likelihood of a household being on government assistance.

Youth unemployment and its connection to public transit accessibility has been the topic of several papers (see Ellwood, 1986; Ihlanfeldt and Sjoquist, 1990; O'Regan and Quigley, 1996, 1998). Exclusively studying youth populations offers a partial solution to the identification problem because the location of a youth's home is more plausibly exogenous. If it is assumed that youth have no say in the

locational choice of the household then self-selection is not a problem. This is only a partial solution because even if it is assumed that youth have no direct influence over household locational choice and parents ignore the job market considerations of their children, it seems likely that socioeconomic biases may be common to both parents and children. Job market ability has been shown to be highly stable across familial generations (Clark, 2014); suggesting that the neighbourhood choice of parents may be naturally stratifying youth populations into neighbourhoods of differing employability characteristics.

Holzer et al. (2003) supplies a study that is closely related to the current paper in its attempt to overcome the identification problem through use of a natural experiment; pointing out, "No study has identified a clear exogenous source of variation in spatial access to employment opportunities." Holzer et al. (2003) uses the 1997 expansion of the San Francisco region's Bay Area Rapid Transit (BART) system as an exogenous shock to the labour pool available to firms located along the new BART route. Holzer et al. (2003) find that firms along the extension hired more minority residents from the inner city after the extension was completed, suggesting the new transit route was responsible for increasing job opportunities to inner city minority residents. The exogeneity assumption made by Holzer et al. (2003) is suspect because it ignores that the citing of transit infrastructure is codetermined with economic activity. The citing of the new BART line was not random, but was specifically located along a route where planners foresaw a future demand for commuting. Furthermore, exogeneity of the event assumes that the extension played no factor in firm locational choice in the years leading up to the actual opening of the new subway route. It is likely that firms choosing to locate on the new line will be predisposed to taking advantage of the inner city labour pool, because accessible labour is a natural consideration in firm locational choice. Therefore, the finding that firms along the subway extension hired a higher percentage of inner city minority workers cannot be simply attributed to increased mobility of inner city residents. A central contribution of the present paper will be to utilize an unplanned, and unforeseen variation in infrastructure to avoid these barriers to causal inference.

The aforementioned papers share the same barrier to

identification; namely, disentangling the endogenous relationship between localized economic development and the citing of public transit. In order to infer a causal impact of public transportation on neighbourhood employment, the effect of employment on transportation infrastructure construction must be removed. The remainder of this paper will explicitly address this confounding relationship.

3. Data

This paper relies on American Community Survey data, collected by the US Census Bureau. In order to identify trends through time, one-year estimates are used for years 2010 through 2013. The Public Use Microdata Sample (PUMS) provides annual individual level observations, including employment status, for a randomly selected 1% of the US population. Variables are taken directly from the Integrated Public Use Microdata Series (IPUMS) data products (Ruggles et al., 2014).

All individuals living outside of New York City are dropped from the sample. Only individuals in the labour force are retained for analysis; individuals under 16 years of age and those reporting to be not in the labour force are dropped. Of individuals at least 16 years of age and living in New York City, 60.6% are in the labour force. This creates a sample of 136,726 individual level observations, split roughly evenly across the four years observed.

The smallest identifiable geographic unit is the Public Use Microdata Area (PUMA); each PUMA contains at least 100,000 persons. PUMA boundaries are contiguous with New York City boundaries, covering the entire city.

Regressions also use the Federal Emergency Management Agency (FEMA) insurance payout data, which cover payouts to housing owners and renters under the Individuals and Households Program (IHP). Observations can be identified as resulting from damage caused by Hurricane Sandy, all payments resulting from other events are dropped. IHP data is used as a proxy for the intensity of local storm damage. FEMA reports these data at the Zip Code Tabulation Area (ZCTA). Data has been cross-walked to PUMAs using the Missouri Census Data Center's Geographic Correspondence Engine; providing an estimate for the average individual's FEMA

payout by PUMA.

Summary statistics for the entire sample of New York City workers is provided in Table 1.

4. Hurricane Sandy and the R Train

Hurricane Sandy made landfall in New York City on October 29th, 2012. Amongst instances of infrastructure damage across the region, the storm resulted in the flooding of the Montague Street Tunnel, which lies beneath the East River and connects Brooklyn to Manhattan (shown in Figure 1). The Montague Street Tunnel is primarily used by the R Train subway, which represents the major public transit connection linking neighbourhoods on the western edge of Brooklyn to Manhattan. After the hurricane, R Train service was immediately interrupted due to the flooding of the Montague Street Tunnel. Over the subsequent two months the tunnel was drained and repaired, reopening for R Train service on December 21st, 2012. In the months after the tunnel reopened it was determined by the Metropolitan Transportation Authority (MTA), who operates the tunnel, that additional repairs were needed as a result of the flooding. It was announced to the public on June 5th, 2013 that a long-term closure would be necessary. The tunnel was subsequently closed for repairs between August 2nd, 2013 and September 14th, 2014.

Figure 1. Areas Affected by R Train Service Disruption

During closure the R Train was split into two routes, divided by the East River.

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, potentially putting strain on their ability to maintain employment. Additionally, unemployed individuals living along the Brooklyn R Train route would likely have altered their job search strategy in response to the altered transit service. In particular, unemployed workers may have reduced the geographic scope of their search, as major Manhattan job centers that were previously within commuting distance were no longer viable options because they could not be reached in a reasonable commuting time. This point is central to the identification strategy: the removal of R train service for Brooklyn represents an exogenous shock to job prospects for particular residents. If it is true that public transportation access has a causal impact on job market outcomes, then a sudden and unexpected reduction in public transportation service should result in reduced job market success for the residents of impacted neighbourhoods. Indeed, this is what this paper finds.

5. Methodology

This study utilizes a difference-in-difference approach to identify the impact the R Train closure had on employment outcomes for affected neighbourhoods. All neighbourhoods within New York City are subjected to some of the same national and regional forces that shape employment outcomes, as job markets expand and contract trough time. A difference-in-difference approach allows for the estimation of how employment outcomes changed in the affected neighbourhoods, while controlling for employment trends through time, as well as fixed characteristics that may differentiate the affected and unaffected neighbourhoods. To improve precision of estimation, borough fixed effects are used in all regressions, to capture localized employment effects.

For the four years of observations used in analysis, only 2013 is considered as having been ‘treated’ by the closure of the R Train. The R Train was closed for a five-month period in 2013, whereas it was closed for less than two months in 2012. The effect of the extended 2013 closure on employment should have the greatest magnitude and

so is the topic of empirical investigation. Estimation will rely on representing the 2013 closure as a negative shock to employment prospects. Any impacts of the 2012 closure are controlled for by the difference-in-difference design and so pose no barrier to identification.

Three PUMAs are identified that are primarily reliant on the R Train in order to reach job centers in Manhattan and beyond; they are, Community Districts 6, 7, and 10 (see Figure 1), all of which are in western Brooklyn. Although PUMAs represent a course geographic unit, this study is fortunate that these three PUMAs align very closely to the neighbourhoods one would hypothesize to be heavily reliant on the R Train.

In testing the impacts the tunnel closure had on these neighbourhoods, it is useful to confirm that these areas were not disproportionately affected by the direct impacts of Hurricane Sandy, otherwise the observed negative employment effects may be simply attributable to general damage from the storm. FEMA provides data on insurance payouts under the Individuals and Households Program that were paid in response to damage brought about by Hurricane Sandy. This provides a reasonable proxy for comparing damage between PUMAs. The average individual in New York City received $69 in FEMA assistance under IHP, while the average individual in the treatment neighbourhoods received only $15. The destruction of local businesses or homes would seem to be a plausible path by which storm damage could affect the treatment neighbourhoods adversely. It appears that if anything, the treatment neighbourhoods received less damage than was typical. An exception to this average is the coastal neighbourhood of Red Hook in Community District 6, which suffered significant damage to building stock as a result of the hurricane. Red Hook residents only comprise 2.7% of the total population of treated PUMAs; furthermore, results are robust if Community District 6 is considered as a control rather than treatment neighbourhood. To guard against the potential direct impacts of storm damage on local economic conditions, the average FEMA payout within the individual's PUMA is controlled for in regressions.

As discussed in the previous section, 2013 brought a substantial reduction in transit service for the treated neighbourhoods. Therefore observations that are both located in the three Brooklyn PUMAs

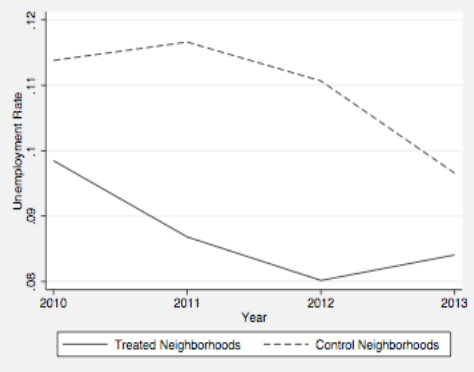
identified along the R Train and were recorded in 2013 are referred to as the treatment group. Defined in this way, there are 2,082 treatment observations, within a sample of 136,726.

In previous investigations into the impact of new infrastructure on employment, endogeneity poses a significant problem to identification. The citing of new public transportation infrastructure is not at all exogenous to local conditions. The methodology presented here overcomes codetermination between economic conditions and transportation infrastructure by exploiting random variation in infrastructure. There is no possibility that Hurricane Sandy's impact on the Montague Street Tunnel was planned or predicted, meaning local economic conditions are orthogonal to this variation.

6. Results

The impact of the R Train disruption on the treatment neighbourhoods can be glimpsed in Figure 2. Between 2010 and 2012 the rate of unemployment decreased significantly within the treatment neighbourhoods, falling from 9.8% to 8.0%. Employment in the remainder of New York City was relatively stable over this period, falling slightly from 11.4% to 11.1%. This trend was starkly reversed in 2013, wherein the neighbourhoods along the Brooklyn R Train saw a rise in unemployment (8.0% to 8.4%) while in other New York City neighbourhoods unemployment fell substantially (11.1% to 9.7%). This departure in outcomes in 2013 is suggestive that job market conditions changed in the treatment neighbourhoods in 2013, making employment more difficult to secure or

Figure 2. Unemployment Rate: Treated and Control Neighbourhoods



maintain.

By exploiting the truly exogenous impact of Hurricane Sandy, while controlling for local and time dependent variation through a difference-in-difference framework, regressions can provide an unbiased estimate of the impact the R Train had on employment conditions for the neighbourhoods studied. This section will outline strong empirical evidence demonstrating that the absence of R Train service harmed employment outcomes for affected neighbourhoods. This represents the unique contribution of this paper to the literature; identifying a reduction in localized employment directly attributable to a discreet reduction in public transit access.

To improve the ease of coefficient interpretation and in accordance with Angrist (2001) and Angrist and Pischke (2009) OLS is used throughout this study rather than an estimation method specific to limited-dependent variables. Table 2 provides a regression for the full sample of New York City workers. As economic conditions improved following the financial crisis of 2008, the probability of unemployment amongst New York City workers fell, this is captured by the year fixed effects that show the probability of being unemployed decreasing across the four years studied. In 2013, the probability of unemployment for a worker in New York City was 1.9 percentage points lower than it was in 2010 (model 1). Models 2 and 3 add relevant demographic characteristics and the PUMA level variation in local storm damage. Although the included controls are surely important to precise identification, their interpretations are not of particular interest because many of the controls are codetermined. For example, the partial effect of having a college degree on employment, after the effect of income has already been removed, is not easily interpretable. The central result, indicating the impact of living in the treatment neighbourhoods in 2013, is highly robust to the inclusion of any of these controls.

After controls are in place, the estimated effect on an individual attributable to living adjacent to the R Train in 2013 is an increase in the probability of being unemployed of 1.4 percentage points (Table 2). The result is highly statistically significant, as well as representing a large effect in practical terms. This finding is completely consistent with a spatial mismatch hypothesis, in which isolated populations suffer from inferior employment outcomes due to an inability to

physically access jobs. This observed effect cannot be explained by the codetermination of transit location and economic activity, demonstrating a causal connection between transit provision and neighbourhood employment outcomes.

Neighbourhood level effects on employment can be attributed to a reduction in neighbourhood connectivity. However, neighbourhood self-selection may still exist, which presents a barrier to inferring a causal effect on individual workers. If households are able to participate in neighbourhood sorting in response to the R Train closure between the time when the hurricane damaged the Montague Street Tunnel (October 29th, 2012), and the end of 2013 (marking the last day in which 2013 ACS data may have been collected) then particular households could be self-selecting into neighbourhoods based on the R Train closure. The potential for shifts in latent ability characteristics that are not controlled for prevents the translation of clear neighbourhood level effects to individual level impacts.

Relocating to a new neighbourhood is a costly and time-consuming event for a household. The exogenous and discreet occurrence of R Train service interruption creates an unprecedented natural experiment in which a large-scale public transportation service was eliminated without warning. The lack of warning for transit disruption suggests households would not necessarily have time to relocate in response, providing an opportunity to look for a causal impact of job access on employment.

If the employment effect found in the current study is in fact a result of the loss of R Train service, this impact should be larger amongst those who are most dependent on public transit. The ACS asks respondents how many vehicles are kept at the household, and are available to the household member. The sample is split in two: those with no vehicles available at all, and those with at least one. 57.7% of the workforce has access to at least one vehicle. After controlling for socioeconomic characteristics and local storm damage, individuals with access to a car were found to experience a statistically significant increase in unemployment of 0.7 percentage points as a result of the transit disruption, while individuals without access to a car were found to suffer a much larger increase of 2.2 percentage points. This finding strengthens the causal argument by drawing a clear line in the data between job access through the public

transit system and employment outcomes.

7. Conclusion

The advent of Hurricane Sandy flooding the Montague Street Tunnel represents a unique natural experiment for investigating the impact of job accessibility through public transportation on employment outcomes. There is compelling evidence that a sudden decrease in public transportation triggered a significant hardship for the job market prospects of affected workers. This finding should strengthen the body of literature that suggests expanding transportation to high unemployment areas can be a tool to decrease local unemployment. Public transit allocation and neighbourhood economic conditions are to an extent codetermined, but exogenous changes in public transit have significant and large effects on neighbourhood employment outcomes.

Household locational choice is not exclusively determined by current employment, nor employment prospects. Locational choice is instead the result of a complex decision function of which one element is employment. It is therefore not sensible to invoke an overriding theory of spatial equilibrium with respect to jobs. Workers may be compelled by finances, family ties or community networks to remain in a neighbourhood even if it does not perfectly suit their needs for job access or mobility. This reality opens policy space for efficiency gains through extending transit to neighbourhoods with poor job accessibility. Establishing a deeper understanding of the extent and speed with which communities relocate in response to transit alterations would be a fertile area for future research.

This study finds strong evidence that public transportation access plays a meaningful role in setting the level of local unemployment. During contemplation of public transportation projects the localized employment effects are rarely explicitly considered; however, the impact appears to be large.

References

Angrist JD (2001) Estimation of limited dependent variable models with dummy endogenous regressors. Journal of business & economic statistics, 19(1): 2-16.

Angrist JD and Pischke, JS (2009) *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press.

Clark G (2014) *The Son Also Rises: Surnames and the History of Social Mobility*. Princeton University Press.

Ellwood DT (1986) The spatial mismatch hypothesis: Are there teenage jobs missing in the ghetto? In: Freeman RB and Holzer HJ (eds) *The Black Youth Employment Crisis*. University of Chicago Press, pp. 147–190.

Farley JE (1982) Black male unemployment in U.S. metropolitan areas: The role of black central city segregation and job decentralization. Journal of Urban Affairs 4(3): 19–34.

Holzer HJ (1991) The spatial mismatch hypothesis: What has the evidence shown? Urban Studies 28(1): 105–122.

Holzer HJ, Quigley JM and Raphael S (2003) Public transit and the spatial distribution of minority employment: Evidence from a natural experiment. Journal of Policy Analysis and Management 22(3): 415–441.

Hughes MA and Madden JF (1991) Residential segregation and the economic status of black workers: New evidence for an old debate. Journal of Urban Economics 29(1): 28–49.

Ihlanfeldt KR and Sjoquist DL (1990). Job accessibility and racial differences in youth employment rates. The American Economic Review 80(1): 267–276.

Ihlanfeldt KR and Sjoquist DL (1998) The spatial mismatch hypothesis: A review of recent studies and their implications for welfare reform. Housing Policy Debate 9(4): 849–892.

Kain JF (1968) Housing segregation, negro employment, and metropolitan decentralization. The Quarterly Journal of Economics 82(2): 175–197.

Kain JF (1992) The spatial mismatch hypothesis: Three decades later. Housing Policy Debate 3(2): 371–460.

O'Regan KM and Quigley JM (1996) Teenage employment and the spatial isolation of minority and poverty households. The Journal of

Human Resources 31(3): 692–702.

O'Regan KM and Quigley JM (1998) Where youth live: Economic effects of urban space on employment prospects. Urban Studies 35(7): 1187–1205.

Ruggles S, Alexander JT, Genadek K, Goeken R, Schroeder MB and Sobek M (2014) Integrated public use microdata series: Version 5.0 [machine-readable database]. Minneapolis: University of Minnesota.

Sanchez TW (1999) The connection between public transit and employment: The cases of Portland and Atlanta. Journal of the American Planning Association 65(3): 284–296.

Sanchez TW, Shen Q, and Peng ZR (2004) Transit mobility, jobs access and low-income labour participation in us metropolitan areas. Urban Studies 41(7): 1313–1331.

Tables

Table 1: Summary Statistics

Variable	Mean	Std. Dev.
Unemployed	0.108	0.31
Adjacent to Brooklyn R Train in 2013	0.015	0.122
Adjacent to Brooklyn R Train	0.06	0.237
Year: 2010	0.243	0.429
Year: 2011	0.248	0.432
Year: 2012	0.253	0.435
Year: 2013	0.256	0.436
Age	41.433	13.821
Log of Annual Income	9.964	2.297
Access to a Vehicle	0.577	0.494
High School Graduate or GED	0.864	0.343
Some College Completed	0.648	0.478
College Graduate	0.405	0.491
Master's or Professional Degree	0.163	0.37
PhD	0.016	0.125
White	0.496	0.5
Black	0.25	0.433
Hispanic	0.23	0.421
Asian	0.156	0.363
Average Neighbourhood IHP Payment ($100s)	0.694	1.903
Obs.	136726	

Table 2: Probability of Being Unemployed: Full Workforce

	(1)	(2)	(3)
Adjacent to Brooklyn R Train	.013**	.015**	.014**
in 2013	(0.002)	(0.002)	(0.002)
Adjacent to Brooklyn R Train	-.028**	-.004**	.005**
	(0.0005)	(0.001)	(0.002)
Year: 2011	0.0003	-.008**	-.008**
	(0.004)	(0.002)	(0.002)
Year: 2012	-.006**	-.012**	-.012**
	(0.002)	(0.002)	(0.002)
Year: 2013	-.019**	-.019**	-.019**
	(0.003)	(0.003)	(0.003)
Age		.003**	.003**
		(0.0005)	(0.0005)
Age (Squared)		-.00002**	-.00002**
		(4.99e-6)	(4.61e-6)
Log of Annual Income		-.086**	-.087**
		(0.002)	(0.002)
Access to a Vehicle		-0.002	-0.003
		(0.004)	(0.003)
High School Graduate		0.008	0.002
		(0.005)	(0.005)
Some College Completed		.014**	.013**
		(0.003)	(0.003)
College Graduate		.013**	.015**
		(0.002)	(0.003)
Master's Degree		.007*	0.006
		(0.003)	(0.004)
PhD		-0.003	-0.002
		(0.004)	(0.005)
White			.008**
			(0.0003)
Black			.019**
			(0.004)
Hispanic			-.012**
			(0.003)
Asian			-.022**
			(0.003)
IHP Payment ($100s)			.0009**
			(0.0003)
Const.	.116**	.879**	.878**
	(0.002)	(0.030)	(0.030)
Obs.	136726	136726	136726
R^2	0.0009	0.376	0.378

Significance Levels: * : 5% ** : 1% | Robust standard errors shown in parentheses