Transit and Economic Resilience

Arthur C. Nelson (corresponding author)
Professor of Planning and Real Estate Development
College of Architecture, Planning and Landscape Architecture
University of Arizona
Tucson, Arizona 85719
520.621.4004
acnelson@email.arizona.edu

Matt Miller
Doctoral Student and Research Associate, Metropolitan Research Center
University of Utah
Salt Lake City, Utah 84112

Joanna P. Ganning
Executive Director, Metropolitan Research Center
University of Utah
Salt Lake City, Utah 84112

Philip Stoker
Doctoral Student and Research Associate, Metropolitan Research Center
University of Utah
Salt Lake City, Utah 84112

Jenny H. Liu
Assistant Professor
School of Urban Studies and Planning
Portland State University
Portland, Oregon 97201

Reid Ewing
Director, Metropolitan Research Center
University of Utah
Salt Lake City, Utah 84112

Words: 3934
Tables: 4
Figures: 1

Abstract

Do fixed-guideway transit systems facilitate resilience with metropolitan areas? There is little literature making this connection theoretically and none testing it empirically. Our paper helps close this gap in both respects. In evaluating metropolitan areas with light rail transit systems we find evidence that transit corridors on the whole performed better than control corridors during the recovery period of two recessions: that of the early 2000s and the so-called Great Recession. In particular, during the Great Recession transit corridors outperformed control corridors among many economic sectors. Outcomes were more impressive during recoveries from both the recession of the early 2000s and the Great Recession. We offer implications for the role of these forms of fixed-guideway transit on economic resiliency.

Introduction

re·sil·ient *adjective* \ri-ˈzil-yənt\

a. capable of withstanding shock

b. tending to recover from or adjust easily to misfortunate or change

Origin

Latin *resilient-*, *resiliens,* present participle of *resilire* to jump back, recoil …

First Known Use: 1674[1]

There seems to be an article of faith among transit proponents that transit systems, especially fixed-guideway ones, enable local economics to withstand economic shocks better than areas without these options; such transit systems may make local economies more resilient to shocks. Yet, there is scant literature making this connection theoretically and none testing it empirically. This paper helps close the gap in the field of transit and economic resilience.

We start with an overall review of resiliency as a concept, review recent literature applying the concept to transit, and adapting from the economic resiliency literature craft a theory of transit and economic resilience. We proceed with the application of our theory to all the light rail systems operating in the United States before and after the Great Recession, and in some cases just after the recession of the early 2000s. We offer implications for the role of these forms of fixed guideway transit on economic resiliency.

Resiliency

Martin-Breen and Anderies (2011) offer a sweeping review of the literature on the topic of resiliency. Here, we focus on some of the key elements in the evolution of the concept as applied to urban policy.

The earliest applications of the concept emanate from the field of “ecological resilience” (Holling 1973). It was used to describe the biological capacity of an ecosystem to adapt and thrive under adverse environmental conditions. Specifically, resilience was described as “the persistence of relationships within a system; a measure of the ability of systems to absorb changes of state variables, driving variables, and parameters, and still persist” (Holling 1973). Since then, this definition of resilience has been expanded to similar fields that emphasize the link between social and environmental systems (Berkes et al. 2003; Folke 2006; Walker and Salt

2006). As a result, a new term emerged: *Social-ecological resilience* and is defined as the amount of disturbance a system can absorb and still remain within *the same state*; the degree to which the system is capable of self-organization; and the degree to which the system can cope with change (Wilkinson et al. 2010). This definition is appropriate in an urban planning context, where the city, neighborhood, or metropolitan area is the system, and the disturbance may be any number of internal or external shocks.

As appealing as the idea of resilience might be for urban planners and regional researchers, there is the distinct danger off "fuzziness" *(*Pendell et al. 2010*)*. One reason for the popularity of the term resilience, and the subsequent fuzziness, is the term's malleability; it can mean different things to different people (Christopherson et al. 2010). For instance, to engineers, resiliency is "the ability to store strain energy and deflect elastically under a load without breaking or being deformed" (Gordon 1978). Psychologists adopted the term resilience to describe patients who were able to overcome adverse conditions (Masten et al. 1990). In economics, resilience has been defined in terms of return to a fixed and narrowly defined equilibrium following a shock (as measured by employment, for example). In the social sciences the term regional resilience is associated and almost synonymous with regional adaptation (Christopherson et al. 2010).

For their part, Pendall, Foster and Colwell (2010) offer a sweeping view of resiliency as a concept from such disciplines as ecology, psychology, geography, political science and economics. Their review shows that while some literature characterizes resilience as a return to pre-shock conditions other literature offers a more complex approach wherein dynamic feedback loops make systems more or less resilient to stress.

Transit and Resiliency

According to Marshall (2012), the studies into transportation resilience have focused mostly on the ability of transportation systems to sustain target levels of service during a shock and/or the delay in returning to that service (see also Heaslip and Louisell 2009; 2010). There is a substantial and growing literature on transportation infrastructure resiliency with respect to climate change (see Cybulski 2013 for a review of the literature). Yet, there is no literature directly relating transit with economic resilience. When it comes to economic resiliency, Marshall's review of literature concludes that it has focused on spikes in gasoline prices (see also Briguglio, Cordina et al. 2005; Zheng, Garrick et al. 2010). Marshall is presently engaged in US DOT-sponsored research that explores "the varying impact of transit infrastructure and TODs on the ability of different households to be resilient to uncontrollable outside forces, such as rising gas prices." (Marshall 2012: 2)

A Theory of Transit and Economic Resilience

That there *should* be an association between transit and economic development has been established reasonably well in the literature. That there *is* may not yet be conclusive, though emerging evidence seems supportive. A key measure of economic effects is using the real estate market to estimate the premium the market is willing to pay for proximity to transit. Three recent papers have compiled literature providing a preponderance of evidence showing this for both residential and office development (Bartholomew and Ewing 2011; Petheram, Nelson et al. 2013; and Ko and Cao 2013).

Another key measure is how jobs are affected by transit investments. In their recent study of employment within 0.50 mile of transit stations serving 34 transit systems over the period 2002 through 2008, Belzer, Srivastava and Austin (2011) found that while jobs increase in the arts, entertainment, and recreation sector as well as the food and accommodation, and health care and social assistance sectors, they fell in the manufacturing sector. They also found that the public administration had the greatest share of jobs found near transit stations. Several other sectors also concentrated around transit stations such as professional, scientific, and technical services, and retail. On the other hand, as a whole the station areas experienced declining shares of jobs relative to their regions, with the exceptions jobs in the utilities, information, and the arts, entertainment, and recreation sectors. Indeed, data for 2008, the first full year of the Great Recession, indicated that most sectors within 0.50 mile of transit stations lost job share relative to their regions as a whole. They surmised that much of the metropolitan job growth continues to favor auto-oriented locations.

In short, while the relationship between transit and economic development measured in terms of value premiums is strong, the relationship with respect to jobs is not as clear. This paper will take a closer look at this nuance.

In measuring economic resilience, Pendall, Foster, and Cowell (2009) suggest two related approaches: “equilibrium analysis” which measures resilience as the time it takes to return to the level before a shock and “complex adaptation” adaptive systems which measures the ability of a system to adapt to stresses caused by the shock. Hill et al. (2012) refines measuring the first approach in terms of the time it takes to return to the rate of growth rate of output, employment, or population after a shock. For reasons noted below, we will focus on jobs as a key measure for resilience. On the other hand, while a quality location for warehousing may see employment recover to pre-recessionary levels, an increase in location quality might also result in that location transitioning to a higher-rent urban use.

While much of the literature on economic resilience focuses on measuring time-to-recovery, Briguglio et al. (2005; 2008) are more nuanced. To them, economic resilience refers to the ability to recover quickly from a shock and withstand the effect of a shock as it occurs (Briguglio et al. 2008: 4-5). In our view, their concepts can be reversed to measure the ability of an economy to withstand the shock as it occurs and then the amount of time it takes to recover from the shock.

Briguglio et al. also saw a role for public policy in facilitating resilience by ameliorating adverse effects of economic shocks. In our view, transit may be one such policy. In terms of transit and economic resilience, we thus theorize that transit will dampen adverse outcomes associated with an economic shock and facilitate a speedier recovery. One way in which to further measure these outcomes is to compare transit corridors with control corridors before, during and after an economic shock. This is illustrated in Figure 1.

INSERT FIGURE 1 ABOUT HERE

We apply our theory to an empirical analysis described next.

Research Question

Based on our theory, fixed-guideway transit corridors, such as light rail transit (LRT) should retain if not capture a higher share of jobs than control corridors within the same metropolitan area during and after economic shocks. Our research question is simple:

Do LRT corridors capture proportionately more jobs than control corridors during and after economic shocks?

We mean the term "capture" to mean the share of total jobs and jobs within 2-digit NAICS sectors that are within 0.25 and between 0.25 and 0.50 mile of transit or control corridors.

Research Design

We use a quasi-experimental, interrupted time series research design with treatment (transit) and control (nontransit) corridors applied over several time periods and applied to LRT systems operating within those time frames. Below we review our data, study periods, transit and control corridors, and method.

Data

Our data come from the Longitudinal Employer-Household Dynamics (LEHD) program which is part of the Center for Economic Studies at the U.S. Census Bureau.[2] For all LRT systems studied, 2-digit NAICS data are available annually at the census block level.

Study Periods

We have three discrete time periods for analysis extending from the tail end of the early 2000s recession through the recovery period of the Great Recession.

2002-2007 covers the period from the very end of the Dot Com recession of the early 2000s to the year before the Great Recession of 2008-2009. This is the "first recovery" period. Based on our theory, transit corridors should capture a higher rate of metropolitan jobs than control corridors. The metropolitan areas with LRT systems operating during this period include Dallas, Denver, Portland, Sacramento, Salt Lake City and San Diego.

2007-2009 covers the period of the Great Recession. This is the "shock" period. According to our theory, transit corridors should retain if not capture a higher rate of metropolitan jobs than control corridors. The metropolitan areas with LRT systems operating during this period include all those noted above plus Charlotte, Houston and the Twin Cities.[3]

2009-2011 covers the period after the Great Recession. This is the "second recovery" period. Based on our theory, transit corridors should capture a higher rate of metropolitan jobs than control corridors. All LRT systems operating since 2007 area included in this analysis.

Transit and Control Corridors Described

This section describes the criteria for selecting existing transit and control corridors, and then describes the corridor selected for analysis and its comparable corridor.

Many of the metropolitan areas analyzed have only as single light rail corridor, dictating the selection. For metropolitan areas with more corridors, ones that began operation between 2002 and 2011 were preferred. When no such corridor was available, corridors between regional-scale use such as airports were avoided as representing major confounders.

For comparable corridors, the emphasis was placed on creating corridors viable as transit corridors. This meant that corridors were contiguous and followed a continuous existing right-of-way that was viable as a transit corridor. Availability of right-of-way was the primary concern, and this dictated either existing major roads or existing railway right-of-way. For the former, highways and major arterials were preferred. For the latter, this meant the majority of right-of-way needed to follow an existing rail corridor.

For the Dallas DART system, the Red line was used as a transit corridor. The 29.3-mile light rail corridor opened in 1996, and runs from Parker road in Plano to Westmoreland. The comparable corridor follows an existing railroad corridor (one of the few not used for later DART lines).

For the Denver, the RTD light rail's Southwest Corridor was used as the transit corridor. It is a a 8.7 mile corridor stretching from downtown Denver to Littleton. For a comparable corridor, the Northwest corridor, an existing rail corridor stretching from Denver Union station to Broomfield was used.

For the Portland MAX system, the yellow line corridor was used, running between Expo center and Portland State University. It is 5.8 miles long, and began operations in 2005. The comparable corridor is a parallel path to the yellow line, on the east side of I-5, along Albina Avenue, and then along Martin Luther King Boulevard for a similar length.

For the Sacramento Regional Transit light rail, the Southern extension to the Blue line was used. The section is about 5.5 miles long, and began operations in 2003. The analysis portion runs from the southern beltway to Meadowview Road. The comparable corridor was a Southern Pacific railroad corridor running parallel to the line, characterized by similar types of land uses.

For the Salt Lake TRAX system, the 400 South University line was used, running from downtown to the University of Utah. For a comparable corridor, 2100 South, a comparable arterial that also links into the rest of the TRAX system was used.

For the San Diego Trolley, the Mission Valley East extension to the Green line was used. It stretches from Mission San Diego to La Mesa, and began operations in 2005. It stretches 19.4 miles. As a comparable corridor, a corridor origination in Mission San Diego northward along I-5, and then east to Mira Mesa was used. Both corridors run parallel to freeway corridors for much of their length.

For the Charlotte Metro area LYNX light rail, running along the South Boulevard between I-485 and downtown Charlotte. It is a 9.6 mile corridor that began operations in 2007. For a comparable corridor, the planned blue line extension It extends along an existing railroad corridor from downtown Charlotte to UNC Charlotte.

For the Houston METRORail light rail line, the Red line, a 6.7 mile corridor stretching from the University of Houston to the Reliant Park (Astrodome) in the south, along surface streets. For a comparable corridor, a route running along existing arterial roads was used. It ran from the Houston CBD to the Galleria, along Gray Street, Westheimer Road, and Post Oak Boulevard.

For the Minneapolis-St. Paul metropolitan area, 8.8 miles of the Hiawatha corridor (now part of the METRO transit Blue line) from downtown Minneapolis to the Minneapolis-St. Paul International Airport was used. The corridor began operations in 2004. The comparable corridor follows a portion of the proposed Southwest Corridor light rail, originating in Minneapolis along the existing railroad corridor toward St. Louis Park, then towards Hopkins, ending at Shady Oak road.

Method

Given that the employment capture rate and change in rate over time is our principal concern we choose descriptive and location quotient (LQ) analytic approaches. Descriptive statistics are used to compare share of total jobs in transit and control corridors for 2002, 2007, 2009 and 2011, and changes in shares between them between each successive year (2002 to 2007, 2007 to 2009, and 2009 to 2011). This provides us with an overall perspective of the extent to which transit corridors perform as well as, better than, or worse than control corridors.

Secondly, we use LQ analysis to decompose changes in shares of jobs between transit and control corridors during the same time period. This has the advantage of identifying economic sectors that are attracted to, or repelled by, transit corridors during economic shocks and recovery.

LQs are calculated as the share of jobs in one economic sector compared to (divided by) all jobs in that small area as the numerator, compared to (divided by) the share of all jobs in a larger area compared to (divided by) all jobs in that area as the denominator.[4] They are an efficient way to assess concentrated a particular economic sector is in a region compared to other sectors, and compared to other parts of the same region such as transit and control corridors in our study.

LQs for economic sectors quantifying how "concentrated" the sector is in the smaller area compared to the larger one. Because they can be measured at any given point in time, changes in LQs can identify emerging or lagging economic activity in a specific sector of a smaller area relative the larger one, again in our case transit and control corridors compared to the metropolitan area as a whole. As such, LQs can be considered a measure of the capture rate in a given sector so that LQs >1.0 indicate local advantage in attracting jobs. Over time, as LQs rise or fall, analysis can detect growing or declining attractiveness of the smaller area. In our case, if transit corridor LQs rise in some sectors over time such would indicate growing attractiveness of the corridor for new economic activity.

Also in our LQ analysis, we note whether the transit corridor LQ has increased between study periods, indicating that jobs would be concentrating along the transit corridor relative to metropolitan trends over time.

However, for our analysis, we compare the ratio of LQs between transit (numerator) and control (denominator) corridors at the end-year of a study period to the begin-year of that period. This generates a measure of relative strength or weakness of transit corridors in attracting growth with specific sectors over each time period, relative to control corridors. LQ change ratios >1.0 indicate transit corridors are gaining share over control corridors while LQ change ratios <1.0 indicate the reverse.

Our LQ analysis is based on the 2-digit 20-sector NAICS sector definitions, aggregated to eight larger sectors. The NAICS reports jobs some sectors (such as agriculture and mining) are not relevant for our purposes while others (such as construction) is also excluded because it does not have many workers occupying space on a permanent basis. We further still the relevant sectors to eight groups as shown in Table 1.

For each study period we report results for the first 0.25 mile and then the second 0.25 mile from the centerline of the transit or control corridor. That is, we compile job data for each census block whose centroid falls within one or the other of those buffers.

Results

We report overall results for the descriptive comparisons first, followed by results from LQ analysis.

Descriptive Results

Table 2 reports results from the descriptive analysis. Calculations are based on the ratio of job change from an earlier period to a later period for transit corridors divided by the same for control corridors. In effect, figures great than 1.0 indicate increasing share of metropolitan area jobs in transit corridors relative to control corridors. From this table, we can see that within the first 0.25 mile of the centerline of a corridor, transit corridors in half or more of all cases, and weighted over all systems, shows transit corridors to have performed better than their controls. Specifically of interest to us, transit corridors were decidedly more resilient in weathering the economic shock of the Great Recession in nearly all the metropolitan areas as well as overall within the first 0.25 mile, and in about half the metropolitan areas as well as overall over the next 0.25 mile. However, during the first and second recovery periods over the second 0.25 mile, control corridors performed better.

Location Quotient Results

The advantage of location quotient analysis is that it can detect economic development attraction (and repelling) over time with respect to key factors such as transit systems. The advantage in comparing the rate of change between LQs between transit and control corridors over our study periods is that we can detect relative changes in the attractive of transit corridors over control corridors. A ratio of change of LQs >1.0 indicates the transit corridor is performing better than the control corridor for that specific sector. Table 3 reports change in LQs for transit compared to control corridors for the first 0.25 mile for each of our study periods while Table 4 reports results over the next 0.25 mile.

During the first recovery period, we find evidence of transit corridor resiliency with respect to the control corridor and the overall metropolitan area, with the second 0.25 mile band actually having more positive LQ (>1.0) changes for specific sectors that the first band, even though share of total employment fared less well as seen in Table 2. Numerically, however, the number of jobs affected is small. (Jobs are not reported for reasons of brevity.)

We find similar trends for the Great Recession and second recovery; that is, there is evidence that transit corridors on the whole performed better than control corridors and the metropolitan area as a whole. During the Great Recession, transit corridors over the first 0.25 mile band outperformed control corridors in half the sectors (manufacturing, retail/lodging, office, and education) and outperformed metropolitan areas in three of them (the same excluding manufacturing). Outcomes were more impressive during the second recovery as transit corridors were more resilient than control corridors in all but three sectors (nonmanufacturing industries, office and health) and they were more resilient than metropolitan areas as a whole in all but two sectors (nonmanufacturing industries and office). Over the next 0.25 mile results are less impressive for transit corridors during the Great Recession as well as the second recovery.

Implications

We view our analysis as only preliminary. For one thing, the concept of measuring economic resilience in terms of transit systems is new. Second, we measured entire transit corridors which, while necessary for comparability with control corridors, could over-estimate resiliency outcomes when restricted to just areas around transit stations. Though we also note that at least one analyst (Canepa 2007) implicitly argues for transit corridor as opposed to transit station area planning. Though ours may be the first work of its kind to attempt to measure and find some evidence for a relationship between transit and economic resilience, we also call for more rigorous research to improve measurement and expand the analysis across other transit modes.

References

P. Martin-Breen and J. M. Anderies (2011). *Resiliency: A Literature Review*. New York, NY: Rockefeller Foundation.

F. Berkes and J. Colding, et al., (Eds.) 2003. *Navigating socialecological systems: Building resilience for complexity and change*. Cambridge, UK: Cambridge University Press.

K. Chapple, and W. T. Lester. 2010. The resilient regional labour market? The US case. *Cambridge Journal of Regions, Economy and Society*, 3, pp 171-175.

S. Christopherson, J. Michie and P. Tyler. 2010. Regional resilience: theoretical and empirical perspectives. Cambridge Journal of Regions, Economy and Society 3, pp 3-10

C. Folke. 2006. “Resilience: !e emergence of a perspective for social-ecological systems analyses.” *Global Environmental Change-Human and Policy Dimensions* 163: 253-267.

J. Gordon. (1978). Structures. Harmondsworth, UK: Penguin Books.
Holling, C., S. 1973. Resilience and Stability of Ecological Systems. Annual Review of Ecology and Systematics, Vol 4, pp 1-23

A. S. Masten, K. Best, N. Garmezy. 1990. Resilience and development: contributions from the study of children who overcome adversity. Development and Psychopathology Vol 2 (4), pp 425-444

R. Pendell, K. Foster and M. Cowell. (2010) Resilience and Regions: Building Understanding of the Metaphor. Cambridge Journal of Regions, Economy, and Society,

B. Walker and D. Salt. 2006. *Resilience Thinking: Sustaining Ecosystems and People in a Changing World*. Island Press, New York.

C. Wilkinson, L. Porter and J. Colding. 2010. Metropolitan Planning and Resilience Thinking: A Practitioner's Perspective. *Critical Planning* (Summer)

L. Briguglio, G. Cordina, et al. (2005). *Conceptualizing and Measuring Economic Resilience*. Malta: University of Malta.

W. Marshall. (2012). *Building a Framework for Transportation Resiliency and Evaluating the Resiliency Benefits of Light Rail Transit in Denver, Colorado*. Mountain-Plains Consortium proposal number MPC-361. Denver, CO: University of Colorado.

K. Heaslip and W. Louisell. (2009). *A Methodology to Evaluate Transportation Resiliency for Regional Networks.* Transportation Research Board, Washington, D.C.

K. Heaslip and W. Louisell. (2010). *A Sketch Level Method for Assessing Transportation Network Resiliency to Natural Disasters and Man-Made Events*. Transportation Research Board, Washington, D.C.

J. D. Cybulski. (2013) *Transportation Infrastructure Resiliency: A Review of Transportation Infrastructure Resiliency in Light of Future Impacts of Climate Change*. Boston, MA: Volpe Center.

J. Zheng, N. W. Garrick, et al. (2010). *Quantifying the Economic Domain of Transportation Sustainability*. Washington, DC: Transportation Research Board.

L. Briguglio, G. Cordina, N. Farrugia, and S. Vella. (2008) *Economic Vulnerability and Resilience: Concepts and Measurements*. New York, NY: United Nations University.

K. Bartholomew and R. Ewing (2011) Hedonic price effects of pedestrian- and transit-oriented development. *Journal of Planning Literature*, 26(1): 18-34.

S. J. Petheram, A. C. Nelson, M. Miller and R. Ewing (2013). Using the Real Estate Market to Establish Light Rail Station Catchment Areas: Case Study of Attached Residential Property Values in Salt Lake County with respect to Light Rail Station Distance. *Transportation Research Record*.

K. Ko and X. Cao (2013). The Impact of Hiawatha Light Rail on Commercial and Industrial Property Values in Minneapolis. *Journal of Public Transportation*, 16(1): 47-66.

E. Hill, T. St. Clair, H. Wial, H. Wolman, P. Atkins, P. Blumenthal, S. Ficenec, and A. Friedhoff. (2012) Economic Shocks and Regional Economic Resilience. In N. Pindus, M. Weir, H. Wial and H. Wolman, eds. *Building Resilient Regions: Urban and Regional Policy and Its Effects*, volume 4. Washington, DC: Brookings Institution Press.

B. Canepa (2007). Bursting the Bubble: Determining the Transit-Oriented Development's Walkable Limits. *Transportation Research Record: Journal of the Transportation Research Board, No. 1992*, Transportation Research Board of the National Academies, Washington, D.C., 2007, pp. 28–34.

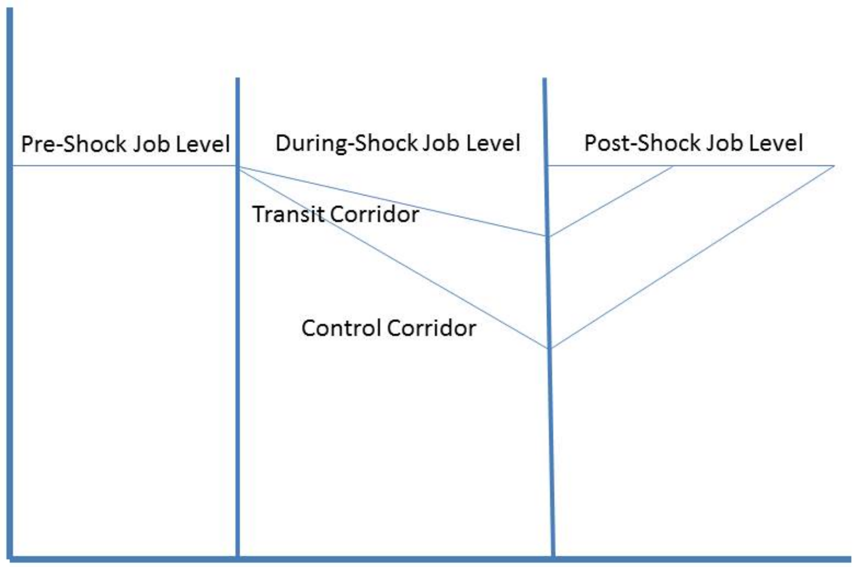

Figure 1
Pre-, during-, and post-shock job levels for transit and control corridors

Table 1
Combinations of NAICS Sectors for Analysis

NAICS	Sector Title
	Manufacturing
31-33	Manufacturing
	Nonman Industrial
22	Utilities
42	Wholesale Trade
48-49	Transportation and Warehousing
	Retail/Lodging
44-45	Retail Trade
72	Accommodation and Food Services
	Office
52	Finance and Insurance
53	Real Estate and Rental and Leasing
55	Management of Companies and Enterprises
56	Administrative and Support and Waste Management and Remediation Services
81	Other Services (except Public Administration)
92	Public Administration
	Knowledge
51	Information
54	Professional, Scientific, and Technical Services
	Education
61	Educational Services
	Health
62	Health Care and Social Assistance
	Entertainment
71	Arts, Entertainment, and Recreation

Table 2
Ratio of Change of Transit to Control Corridor Jobs over Three Time Periods

Metropolitan Area	<0.25 mile	0.25-0.50 mile
	Ratio of Change of Transit to Control Corridor Jobs 2002-2007	
Dallas	**1.11**	0.90
Denver	0.84	0.94
Portland	0.99	0.91
Sacramento	0.81	0.90
Salt Lake City	**1.06**	0.70
San Diego	**1.03**	**1.10**
Composite	**1.02**	0.95
	Ratio of Change of Transit to Control Corridor Jobs 2007-2009	
Charlotte	**1.04**	0.90
Dallas	**1.02**	0.99
Denver	**1.10**	**1.14**
Houston	**1.04**	**1.14**
Portland	0.98	**1.07**
Sacramento	**1.06**	0.83
Salt Lake City	0.91	0.99
San Diego	**1.00**	**1.00**
Twin Cities	**1.32**	0.76
Composite	**1.05**	**1.03**
	Ratio of Change of Transit to Control Corridor Jobs 2009-2011	
Charlotte	0.95	0.98
Dallas	**1.03**	0.96
Denver	**1.03**	0.87
Houston	0.97	**1.51**
Portland	0.97	0.99
Sacramento	**1.30**	0.84
Salt Lake City	0.98	**1.05**
San Diego	**1.14**	0.83
Twin Cities	0.98	0.84
Composite	**1.04**	0.88

Table 3
Resilience Outcomes during First Recover, Great Recession, and Second Recovery, 2002-2011, within 0.25 Mile of Transit and Control Corridor, and Compared to the Metropolitan Area

MSA	Manufact-uring	Nonman Industry	Retail Lodging	Office	Knowledge	Education	Health	Entertain
	Transit/Control = (Transit LQ 2007/Transit LQ 2002)/(Control LQ 2007/ Control LQ 2002) *Transit/Metro = Transit LQ2007/Transit LQ 2002*							
Dallas								
Transit/Control		■		■		■		
Transit/Metro			■		■		■	
Denver								
Transit/Control		■	■				■	
Transit/Metro		■	■	■	■		■	
Portland								
Transit/Control		■	■		■		■	■
Transit/Metro			■	■	■			■
Sacramento								
Transit/Control	■	■			■			
Transit/Metro	■	■				■	■	
Salt Lake City								
Transit/Control				■	■		■	
Transit/Metro				■	■	■		
San Diego								
Transit/Control	■	■	■			■		■
Transit/Metro	■	■	■				■	
Composite								
Transit/Control		■	■					
Transit/Metro		■	■		■		■	
MSA	*Transit/Control = (Transit LQ 2009/Transit LQ 2007)/(Control LQ 2009/ Control LQ 2007)* *Transit/Metro = Transit LQ2009/Transit LQ 2007*							
Charlotte								
Transit/Control	■		■	■	■			
Transit/Metro				■			■	
Dallas								
Transit/Control			■			■		■
Transit/Metro		■	■			■	■	■
Denver								
Transit/Control		■	■	■		■		
Transit/Metro			■	■		■		
Houston								
Transit/Control				■		■	■	

Transit/Metro		[redacted]		[redacted]				
Portland								
Transit/Control	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]			
Transit/Metro			[redacted]	[redacted]				
Sacramento								
Transit/Control	[redacted]		[redacted]	[redacted]			[redacted]	[redacted]
Transit/Metro	[redacted]		[redacted]	[redacted]	[redacted]			[redacted]
Salt Lake City								
Transit/Control	[redacted]	[redacted]	[redacted]			[redacted]	[redacted]	[redacted]
Transit/Metro	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
San Diego								
Transit/Control	[redacted]	[redacted]				[redacted]		
Transit/Metro	[redacted]					[redacted]	[redacted]	
Twin Cities								
Transit/Control				[redacted]	[redacted]			
Transit/Metro				[redacted]	[redacted]			
Composite								
Transit/Control	[redacted]		[redacted]	[redacted]		[redacted]		
Transit/Metro			[redacted]	[redacted]		[redacted]		

Transit/Control = (Transit LQ 2011/Transit LQ 2009)/(Control LQ 2011/ Control LQ 2009)
Transit/Metro = Transit LQ2011/Transit LQ 2009

MSA								
Charlotte								
Transit/Control				[redacted]	[redacted]	[redacted]		
Transit/Metro			[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
Dallas								
Transit/Control	[redacted]						[redacted]	[redacted]
Transit/Metro	[redacted]							[redacted]
Denver								
Transit/Control			[redacted]				[redacted]	
Transit/Metro	[redacted]		[redacted]	[redacted]			[redacted]	[redacted]
Houston								
Transit/Control	[redacted]	[redacted]	[redacted]		[redacted]	[redacted]		[redacted]
Transit/Metro		[redacted]	[redacted]		[redacted]	[redacted]		[redacted]
Portland								
Transit/Control	[redacted]	[redacted]	[redacted]		[redacted]			[redacted]
Transit/Metro			[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
Sacramento								
Transit/Control				[redacted]	[redacted]	[redacted]		[redacted]
Transit/Metro		[redacted]		[redacted]	[redacted]			[redacted]
Salt Lake City								
Transit/Control		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]
Transit/Metro	[redacted]	[redacted]		[redacted]		[redacted]	[redacted]	
San Diego								

Transit/Control	[redacted]			[redacted]				
Transit/Metro	[redacted]	[redacted]		[redacted]		[redacted]		
Twin Cities								
Transit/Control	[redacted]		[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
Transit/Metro	[redacted]		[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
Composite								
Transit/Control	[redacted]		[redacted]		[redacted]	[redacted]		[redacted]
Transit/Metro	[redacted]		[redacted]		[redacted]	[redacted]	[redacted]	[redacted]

Table 4
Resilience Outcomes during First Recover, Great Recession, and Second Recovery, 2002-2011, between 0.25 and 0.50 Mile of Transit and Control Corridor, and Compared to the Metropolitan Area

MSA	Manufact-uring	Nonman Industry	Retail Lodging	Office	Knowledge	Education	Health	Entertain
	Transit/Control = (Transit LQ 2007/Transit LQ 2002)/(Control LQ 2007/ Control LQ 2002) *Transit/Metro = Transit LQ2007/Transit LQ 2002*							
Dallas								
Transit/Control				■	■		■	■
Transit/Metro				■	■		■	■
Denver								
Transit/Control				■	■		■	■
Transit/Metro	■	■	■		■	■	■	■
Portland								
Transit/Control	■		■	■	■		■	
Transit/Metro	■	■	■	■	■		■	■
Sacramento								
Transit/Control	■	■			■			
Transit/Metro	■			■	■	■		
Salt Lake City								
Transit/Control				■	■	■		■
Transit/Metro				■	■	■		■
San Diego								
Transit/Control			■			■	■	
Transit/Metro		■	■			■	■	
Composite								
Transit/Control			■		■	■	■	
Transit/Metro		■	■		■		■	
MSA	*Transit/Control = (Transit LQ 2009/Transit LQ 2007)/(Control LQ 2009/ Control LQ 2007)* *Transit/Metro = Transit LQ2009/Transit LQ 2007*							
Charlotte								
Transit/Control	■	■			■		■	
Transit/Metro		■		■		■	■	
Dallas								
Transit/Control	■				■	■		■
Transit/Metro	■				■			■
Denver								
Transit/Control		■				■		■
Transit/Metro		■		■				■
Houston								
Transit/Control			■		■		■	■
Transit/Metro			■		■		■	■

Portland								
Transit/Control				[redacted]			[redacted]	[redacted]
Transit/Metro				[redacted]				[redacted]
Sacramento								
Transit/Control	[redacted]		[redacted]	[redacted]			[redacted]	[redacted]
Transit/Metro		[redacted]			[redacted]		[redacted]	[redacted]
Salt Lake City								
Transit/Control	[redacted]			[redacted]		[redacted]	[redacted]	[redacted]
Transit/Metro	[redacted]		[redacted]			[redacted]		[redacted]
San Diego								
Transit/Control		[redacted]	[redacted]					[redacted]
Transit/Metro		[redacted]	[redacted]	[redacted]			[redacted]	
Twin Cities								
Transit/Control	[redacted]		[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
Transit/Metro	[redacted]		[redacted]		[redacted]		[redacted]	[redacted]
Composite								
Transit/Control			[redacted]		[redacted]	[redacted]	[redacted]	[redacted]
Transit/Metro					[redacted]		[redacted]	[redacted]

Transit/Control = (Transit LQ 2011/Transit LQ 2009)/(Control LQ 2011/ Control LQ 2009)
Transit/Metro = Transit LQ2011/Transit LQ 2009

MSA								
Charlotte								
Transit/Control	[redacted]	[redacted]		[redacted]				[redacted]
Transit/Metro	[redacted]	[redacted]			[redacted]	[redacted]		[redacted]
Dallas								
Transit/Control		[redacted]	[redacted]			[redacted]	[redacted]	
Transit/Metro		[redacted]				[redacted]	[redacted]	
Denver								
Transit/Control	[redacted]		[redacted]	[redacted]				
Transit/Metro	[redacted]		[redacted]	[redacted]		[redacted]		
Houston								
Transit/Control						[redacted]	[redacted]	
Transit/Metro			[redacted]				[redacted]	
Portland								
Transit/Control			[redacted]		[redacted]	[redacted]	[redacted]	
Transit/Metro			[redacted]			[redacted]		
Sacramento								
Transit/Control				[redacted]	[redacted]	[redacted]		[redacted]
Transit/Metro				[redacted]				
Salt Lake City								
Transit/Control	[redacted]		[redacted]					
Transit/Metro			[redacted]	[redacted]		[redacted]	[redacted]	
San Diego								
Transit/Control		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]		[redacted]

Transit/Metro			[redacted]	[redacted]			
Twin Cities							
Transit/Control	[redacted]	[redacted]		[redacted]	[redacted]	[redacted]	
Transit/Metro	[redacted]	[redacted]			[redacted]	[redacted]	[redacted]
Composite							
Transit/Control			[redacted]		[redacted]	[redacted]	
Transit/Metro		[redacted]				[redacted]	

Endotes

[1] Adapted from http://www.merriam-webster.com/dictionary/resilient?show=0&t=1406213694.

[2] For details, see http://lehd.ces.census.gov/.

[3] Two LRT systems were launched after 2007: Phoenix and Seattle.

[4] The formula is:

$$LQ = \frac{e_i/e}{E_i/E}$$

Where:

e_i = Local employment in industry i

e = Total local employment

E_i = Reference area employment in industry i

E = Total reference area employment