TODs Make a Difference in Job Location[1]

Arthur C. Nelson[2]

Abstract

The end of the 20th century saw the decline of major new investment in heavy rail ("subway") transit systems serving the nation's largest metropolitan areas and the rise of transit systems serving medium and smaller metropolitan areas such as light rail transit (LRT), bus rapid transit (BRT), and streetcar transit (SCT) systems. Whether transit-oriented developments (TODs) served by these systems make a difference has not been studied rigorously. This article reports research about whether and the extent to which jobs are attracted to transit stations. The research is applied to 23 transit systems in the United States during over the period from the Great Recession into the earlier years of recovery (2008 through 2011). The research finds that LRT and SCT TODs increased their share of regional jobs up to a mile away from transit stations while BRT TODs increased their regional job share within one-half mile. The research also finds that all systems gained important shares of regional jobs in office, education and health care economic sectors near transit stations. TOD policy, planning, and investment implications are offered.

[1] Support for research reported in this article came from the National Institute for Transportation and Communities; the Utah Transit Authority; the cities of Ogden and Provo, Utah; Metro (serving metropolitan Portland Oregon); Tri-Met (serving metropolitan Portland, Oregon); Lane Transit Council (serving metropolitan Eugene-Springfield, Oregon); Regional Transit Council of Southern Nevada (serving metropolitan Las Vegas, Nevada); and Transportation for America. Views expressed herein are those of the author and not necessarily those of any or all of the sponsors.

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Overview

Urban America's transportation systems were transformed during the 20th century. At the turn of the 19th to 20th centuries, streetcars, horses, and walking dominated personal transportation.[3] The largest cities—such as Boston, Chicago, New York and Philadelphia also had heavy-rail/subway systems.[4] Automobiles were expensive and thus not available to the mass market.[5] Between the middle 1910s and middle 1920s, the cost of automobiles dropped precipitously through assembly line production efficiencies but even through the Second World War much of urban America depended on public transit to get around. Many larger cities also saw the rise of long-distance commuter rail systems allowing some affluent workers to live in rural Pennsylvania, for example, and commute through New Jersey to Manhattan Island, New York.[6] America's transportation systems and landscape changed after World War II. Its transition from an urban-centric nation to a suburban nation has been well-chronicled, explaining how the automobile

[3] Peter O. Muller, THE OUTER CITY: THE GEOGRAPHICAL CONSEQUENCES OF THE URBANIZATION OF THE SUBURBS, Washington, D.C.: American Association of Geographers.

[4] See https://www.britannica.com/technology/subway

[5] Matthias Holweg, The Evolution of Competition in the Automotive Industry, pp. 13-34 in C. Parry and A. P. Graves, eds., BUILD TO ORDER: THE ROAD TO THE 5-DAY CAR, Springer, 2008.

[6] Auguste C. Spectorsky, THE EXURBANITES, Berkley Publishing Corp. 1955.

supplanted public transit as the chief means of mobility as shown in Figure 1. [7] This transformation fueled "urban sprawl".[8]

The last decades of the 20th century into the first decades of the 21st century saw a subtle but important shift in mode choice that may or may not signal longer-term changes in urban development patterns. The shift is occasioned by the rise of several kinds of fixed-guideway transit (FGT) systems outside America's largest metropolitan areas. They include light rail transit (LRT), bus rapid transit (BRT), and streetcar transit (SCT) systems among others.[9] Importantly, Figure 2 illustrates the growth in the use of FGT systems compared to population growth and change in the vehicle miles traveled by automobiles between 2003 and 2014. Between those years, America's population grew by nearly 10 percent, the nation's total automobile vehicle miles traveled by all passengers in them grew by less than five percent, but the nation's total FGT vehicle miles traveled by all passengers grew by about a third. To be sure,

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[7] Interpretation based on John S. Miller, "The Uncertainty of Forecasts", PUBLIC ROADS, 68(2), September/October 2004 accessed September 14, 2016 from https://www.fhwa.dot.gov/publications/publicroads/04sep/09.cfm. See also Edson L. Tennyson, Impact on Transit Patronage of Cessation or Inauguration of Rail Service, TRANSPORTATION RESEARCH RECORD 1221: 59-70 (1989) for a history of transit use in the United States through the middle 20th century.

[8] For detailed accounts of the role of the automobile in facilitating urban sprawl, see Andres Duany, Elizabeth Plater-Zyberk, and Jeff Speck, SUBURBAN NATION: THE RISE OF SPRAWL AND THE DECLINE OF THE AMERICAN DREAM. Macmillan, 2010, and Robert Bruegmann, SPRAWL: A COMPACT HISTORY, University Of Chicago Press, 2006.

[9] See Arthur C. Nelson, Matt Miller, Dejan Eskic, Keuntae Kim, Reid Ewing, Jenny Liu, Matt Berggren, and Zakari Mumuni, DO TODs MAKE A DIFFERENCE? National Institute for Transportation and Communities accessed September 14, 2016 from http://pdxscholar.library.pdx.edu/trec_reports/7/ and Arthur C. Nelson and Joanna P. Ganning, NATIONAL STUDY OF BRT DEVELOPMENT OUTCOMES, accessed September 14, 2016 from http://pdxscholar.library.pdx.edu/trec_reports/32/.

more than 95 percent of all personal miles traveled in the US are via the automobile.[10] But the subtle shift toward FGT is not trivial.

Does this shift in FGT use also signal important changes in the distribution of America's jobs and people? The answer is yes for reasons reported next, which address the change in total jobs and jobs by economic group attracted to TODs from the beginning of the Great Recession (2008) into the early years of recovery (through 2011). The analysis presented in this article is based on work sponsored by the National Institute for Transportation and Communities.[11]

It includes an analysis of several LRT, BTR and SCT systems operating before the Great Recession (before 2008). LRT systems studied include those in the Charlotte, Dallas, Denver, Portland, Minneapolis, San Diego, Sacramento, Salt Lake City and Seattle metropolitan areas.[12] SCT systems evaluated include those located in the cities of Portland (Oregon), Tacoma, and Tampa. BRT systems assessed include those in the Cleveland, Eugene-Springfield, Kansas City, Las Vegas, Los Angeles, Phoenix, Pittsburgh, and Salt Lake City metropolitan areas, and the Bronx in the New York City metropolitan area.[13]

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[10] Bureau of Transportation Statistics, PASSENGER TRAVEL FACTS AND FIGURES 2015, Washington, DC: US Department of Transportation, accessed September 14, 2016 from http://www.rita.dot.gov/bts/publications/passenger_travel_2015

[11] The author is grateful for receiving support from the National Institute of Transportation and Communities, the Utah Transit Authority, City of Provo, Utah, City of Ogden, Utah, Wasatch Front Regional Council, Portland Metro, See http://nitc.trec.pdx.edu/.

[12] LRT systems in metropolitan areas larger than eight million were excluded because of complications in attributing outcomes between several other types of transit especially in the New York City, Chicago, Los Angeles and San Francisco metropolitan areas.

[13] Analysis of BRT systems in Los Angeles and Bronx could be isolated from other forms of transit so they were included.

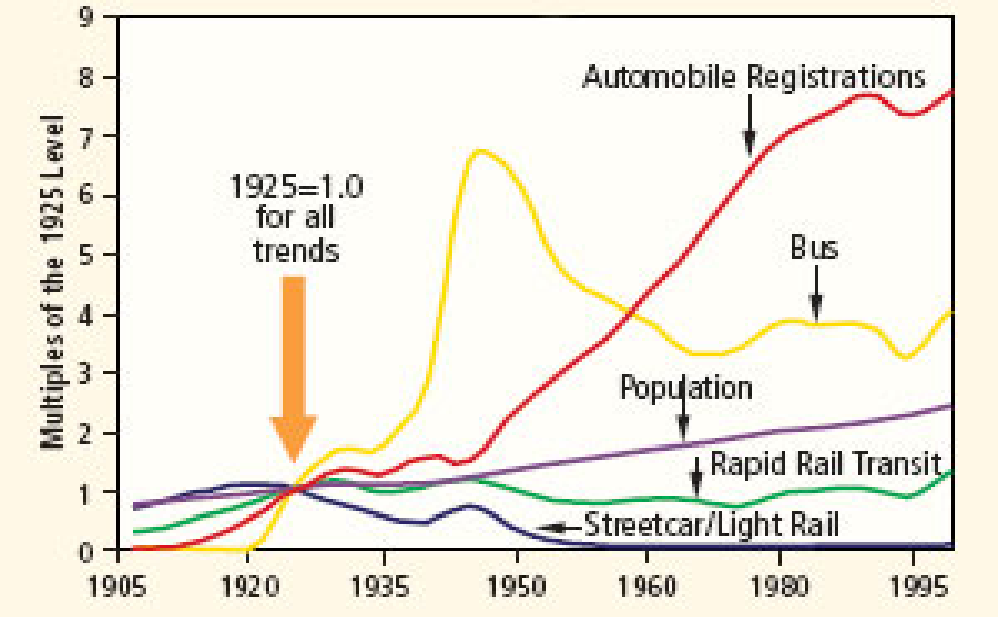

Figure 1

Change in Transit Ridership, Population, and Automobile Ownership Relative to 1925

Source: Image from https://www.fhwa.dot.gov/publications/publicroads/04sep/images/mill5.jpg in the public domain. Source text at https://www.fhwa.dot.gov/publications/publicroads/04sep/09.cfm notes **"**This figure shows the change in transit ridership, population, and automobile ownership relative to 1925. The five trends (population, automobile registrations, streetcar/light rail, rapid rail transit, and bus ridership) now are presented as ratios to their 1925 levels. For example, in 1950, bus ridership was about six times its level in 1925. On the other hand, by 1950, streetcar ridership had dropped to a fraction of its 1925 level."[14]

[14] Data for this figure were compiled by Virginia Transportation Research Council from Bureau of Transportation Statistics, U.S. Census Bureau, American Public Transportation Association, and A. Saltzman, Saltzman, A. Public Transportation in the 20th Century. In PUBLIC TRANSPORTATION, 2nd ed., G. Gray and L. Hoel, eds., Prentice Hall, Englewood Cliffs, NJ, 1992.

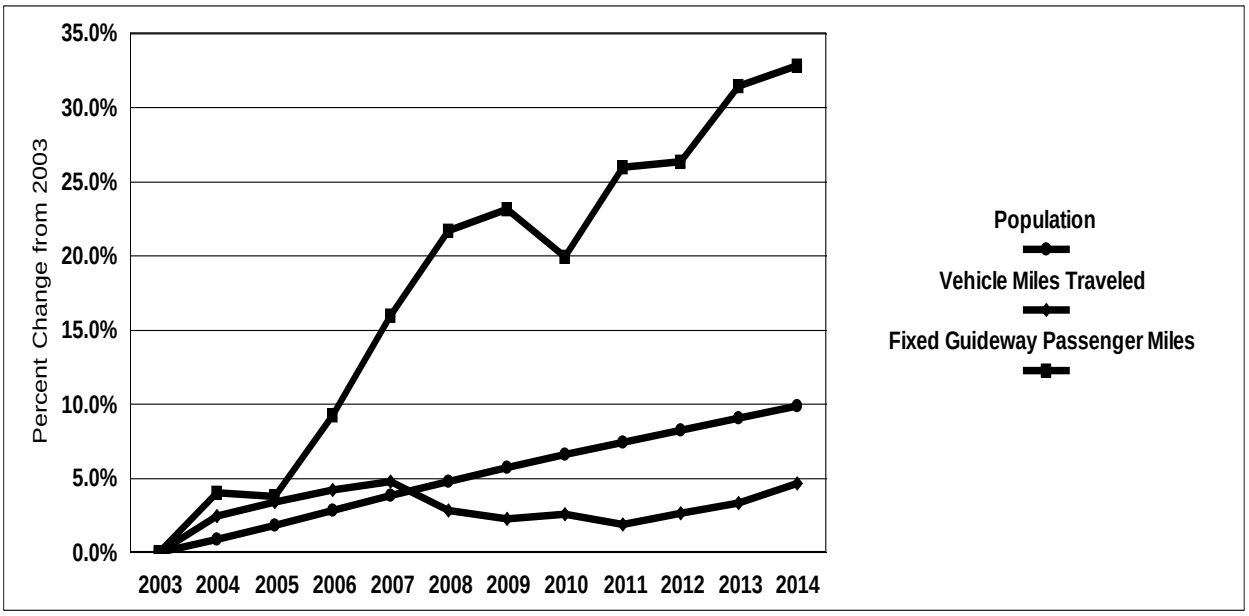

Figure 2

Percent change 2003 to 2014 in population, vehicle miles traveled and FGT passenger miles annually

Source: Calculations by author. Population from Census, vehicle miles traveled from http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_36.html, and FGT passenger miles from https://www.apta.com/resources/statistics/Documents/FactBook/2016-APTA-Fact-Book-Appendix-A.pdf at Table 3.

TODs and Job Attraction

Literature shows that cities and the metropolitan areas around them are formed and grow in large part by creating agglomeration economies.[15] Technically, the term is defined as "the decline in average cost as more production occurs within a specified geographical area".[16] As more firms in related sectors cluster together, costs of production fall as productivity increases. These economies can spill over into complementary sectors, thereby creating even more jobs.[17] Cities can become ever larger as economies of agglomeration are exploited.[18] Transportation improvements make it possible to reduce transportation times, increasing the size of market areas and the effective size of industrial clusters. If cities get too large, however, transportation congestion may have a counter-productive force, encouraging the relocation of firms.[19] Highway projects have been shown to induce this change in metropolitan form, and at a net cost to society.[20] Because firm location follows residential relocation, changes in firm location may not

[15] Edward L. Glaeser, TRIUMPH OF THE CITY: HOW OUR GREATEST INVENTION MAKES US RICHER, SMARTER, GREENER, HEALTHIER, AND HAPPIER. New York: Penguin Books, 2011

[16] A. Anas, R. Arnott, and K. A. Small. 1998. Urban spatial structure. JOURNAL OF ECONOMIC LITERATURE 36(3): 1426–1464 at 1427.

[17] Thomas Holmes, How industries migrate when agglomeration economies are important. JOURNAL OF URBAN ECONOMICS 45: 240–263, 1999.

[18] Antonio Ciccone, and Robert E. Hall. Productivity and the density of economic activity. AMERICAN ECONOMIC REVIEW 86: 54–70, 1996.

[19] Bogart, William T. THE ECONOMICS OF CITIES AND SUBURBS. Upper Saddle River, NJ: Prentice Hall, 1998.

[20] Boarnet, Marlon. Highways and economic productivity: Interpreting recent evidence. JOURNAL OF PLANNING LITERATURE 11(4): 476–486, 1997, and Marlon G. Boarnet and Andrew F. Haughwout. DO HIGHWAYS MATTER? EVIDENCE AND POLICY IMPLICATIONS OF HIGHWAYS INFLUENCE ON METROPOLITAN DEVELOPMENT. Washington, DC: The Brookings Institution, Center on Urban and Metropolitan Policy, 2000.

be temporally trackable to specific highway projects.[21] If one presumes the urban rent curve to be a proxy for accessibility, any transportation improvement having a metropolitan-area effect will shift the value surface of the land market. Thus, firm location in a metropolitan area is a sort of slow-motion equilibrium assignment process. In a static or stagnant economy, any transportation improvement will just shuffle jobs (and housing) around.[22]

More recent research shows that the degree of suburbanization significantly varies within metropolitan regions, in accordance to both variation in the levels of population de-concentration drivers and sub-regional fixed effects.[23] Thus, the preservation and creation of new agglomeration economies within metropolitan regions varies considerably and in ways that may be influenced by policy decisions such as transit investments.

A key role of transit is to facilitate agglomeration economies by mitigating the transportation congestion effects of automobile traffic induced by agglomeration. This is because public transit is essentially "noncongestible" and is best suited to sustaining agglomeration economies in high density nodes as well as along the corridors that connect them.[24] Nonetheless, not all economic sectors benefit from agglomeration economies.

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[21] Joanna P. Ganning and Benjamin D. McCall. The Spatial Heterogeneity and Geographic Extent of Population Deconcentration: Measurement and Policy Implications, in Laszlo J. Kulcsar and Katherine J. Curtis, eds., INTERNATIONAL HANDBOOK OF RURAL DEMOGRAPHY, Springer, pp. 319-332, 2012, and M. Renkow, and D.M. Hoover, Commuting, migration, and the nonmetropolitan turnaround, JOURNAL OF REGIONAL SCIENCE 40: 261-287, 2000.

[22] Nelson, et al. DO TODs MAKE A DIFFERENCE?

[23] Ganning and McCall.

[24] Richard Voith, Parking, Transit, and Employment in a Central Business District, JOURNAL OF URBAN ECONOMICS 44(1): 43-48, 1998.

In part because of their role in facilitating agglomeration economies, there is a growing body of research showing that rail-based public transit enhances economic development.[25] Transit improves accessibility between people and their destinations by reducing travel time relative to alternatives.[26] At the metropolitan scale, adding transit modes in built-up urban areas increases aggregate economic activity.[27] There is another aspect of agglomeration economies: although transit systems can lead to higher-density development by shifting new jobs and population to station areas, they could lead instead to the redistribution of existing development even in the absence of growth,[28] such as in the case of Detroit.[29]

Additionally, it will be interesting to know which industries gained or lost share of employment. Prior studies have found that not all economic sectors benefit from transit. In an analysis of 34 transit systems within one-half mile of transit stations, one study found that while jobs increase in the arts, entertainment and recreation sector, as well as the food,

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[25] Arthur C. Nelson, Geoff Anderson, Reid Ewing, Pamela Perlich, Thomas W. Sanchez, and Keith Bartholomew, THE BEST STIMULUS FOR THE MONEY: BRIEFING PAPERS ON THE ECONOMICS OF TRANSPORTATION SPENDING, Salt Lake City: Metropolitan Research Center at the University of Utah for Smart Growth America. http://www.smartgrowthamerica.org/documents/thebeststimulus.pdf, 2009.

[26] Todd Littman, EVALUATING TRANSPORTATION ECONOMIC DEVELOPMENT IMPACTS, Victoria, BC: Victoria Transportation Institute, http://www.vtpi.org/econ_dev.pdf.

[27] D. J. Graham, Agglomeration, productivity and transport investment, JOURNAL OF TRANSPORT ECONOMICS AND POLICY 41(3), September: 317–343, 2007. www.ingentaconnect.com/content/lse/jtep/2007/00000041/00000003/art00003.

[28] Daniel G. Chatman and Robert B. Noland (2011). Do public transport improvements increase agglomeration economies? A review of literature and an agenda for research, TRANSPORT REVIEWS 31(6): 725-742, 2011.

[29] George C. Galster, The Mechanism(s) of Neighbourhood Effects: Theory, Evidence, and Policy Implications**,** pp. 23-56 in van Ham, M., Manley, D., Bailey, N., Simpson, L., and Maclennan, D., eds. NEIGHBOURHOOD EFFECTS RESEARCH: NEW PERSPECTIVES. Dordrecht, NL: Springer, 2012.

accommodation, health care, and social assistance sectors, jobs fell in the manufacturing sector. This study also found that 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, the station areas as a whole experienced declining shares of jobs relative to their regions, with the exception of jobs in the utilities, information, and the arts, entertainment, and recreation sectors. The study authors surmised that much of the metropolitan job growth continues to favor auto-oriented locations. Their study did not report results for individual systems or even types of systems. Also, with a study period from 2002 to 2008, it did not include the Great Recession or recovery periods.[30]

[30] Dena Belzer, Sujata Srivastava, and Mason Austin, TRANSIT AND REGIONAL ECONOMIC DEVELOPMENT. Oakland, CA: Center for Transit-Oriented Development, 2011

Analytic Approach

Economic development can be measured in many ways. The focus in this article is whether, and to what extent, there is a link between kinds of transit and employment changes. The specific interest is whether there are changes in both the numbers and concentration of jobs. Theoretically, areas proximate to commuter rail stations should have much better job accessibility.[31] By reducing the effects of congestion, TODs should abet both the preservation of existing agglomeration economies and the creation of new ones.[32] Without the diseconomies of congestion, existing employment clusters should continue to grow, and the relative concentration of employment within clusters served by a TOD should continue to increase.[33]

As this is an article about the economic development implications of TODs, it reports the change in total jobs and jobs by economic group from 2008 through 2011 in four distance bands from transit stations for:

- 11 Light rail transit (LRT) systems—Charlotte, Dallas, Denver, Houston, Phoenix, Portland, Sacramento, Salt Lake City, San Diego, Seattle and the Twin Cities—Minneapolis-St. Paul;

[31] Robert Cervero and Samuel Seskin, AN EVALUATION OF THE RELATIONSHIPS BETWEEN TRANSIT AND URBAN FORM, Washington, DC: Transportation Research Board, 1995.

[32] Todd Litman, EVALUATING TRANSPORTATION ECONOMIC DEVELOPMENT IMPACTS: UNDERSTANDING HOW TRANSPORT POLICY AND PLANNING DECISIONS AFFECT EMPLOYMENT, INCOMES, PRODUCTIVITY, COMPETITIVENESS, PROPERTY VALUES AND TAX REVENUES, Victoria, BC: Victoria Transportation Institute, 2016.

[33] Interpretation based on Alex Iams and Pearl Kaplan, eds., ECONOMIC DEVELOPMENT AND SMART GROWTH: 8 CASE STUDIES ON THE CONNECTIONS BETWEEN SMART GROWTH DEVELOPMENT AND JOBS, WEALTH, AND QUALITY OF LIFE IN COMMUNITIES, Washington, DC: International Economic Development Council, 2006.

- 8 Bus rapid transit (BRT) systems—Cleveland, Eugene-Springfield, Kansas City, Las Vegas, Los Angeles, New York-Bronx, Phoenix, and Pittsburgh; and
- 3 Streetcar transit (SCT) systems—Portland, Seattle, and Tampa.

The distance bands from transit stations include:

- One-eighth mile or less ("1/8 mile band");
- From more than one-eighth mile to and including one-quarter mile ("1/8-1/4 mile band");
- From more than one-quarter mile to and including one-half mile ("1/4-1/2 mile band"); and
- From more than one-half mile to and including one mile ("1/2-1 mile band").

Jobs are organized pursuant to the North American Industrial Classification System (NAICS).[34] Not all jobs are considered; the study focuses only on jobs that are predominantly characterized as urban land uses, thus excluding (a) agriculture, forestry, fishing and hunting; (b) mining, quarrying, and oil and gas extraction, and (c) construction. Further, jobs are combined into groups of reasonably homogenous economic sectors as shown in Table 1.[35]

[34] See http://www.census.gov/eos/www/naics/.

[35] This is consistent with work by Belzer et al.

Table 1

Combinations of NAICS Sectors into Economic Groups for Analysis

Manufacturing

Manufacturing (sectors 31-33)

Industrial

Utilities (sector 22)

Wholesale Trade (sector 42)

Transportation and Warehousing (sectors 48, 49)

Retail-Accommodation-Food Service [Retail-Acc-Food]

Retail Trade (sectors 44, 45)

Accommodation and Food Services (sector 72)

Knowledge

Information (sector 51)

Professional, Scientific, and Technical Services (sector 54)

Office

Finance and Insurance (sector 52)

Real Estate and Rental and Leasing (sector 53)

Management of Companies and Enterprises (sector 55)

Administrative and Support and Waste Management and Remediation Services (sector 56)

Other Services (except Public Administration) (sector 81)

Public Administration (sector 92)

Education

Educational Services (sector 61)

Health Care

Health Care and Social Assistance (sector 62)

Art-Entertainment-Recreation [Arts-Ent-Rec]

Arts, Entertainment, and Recreation (sector 71)

The research reported here assesses changes in total jobs and jobs by economic group, by distance band from transit stations compared to change in those jobs for the "transit county" as a whole. Transit counties are those in which the transit systems used in this study operate. If station-distance changes are significantly different from transit county changes, there may be an associative, though not a causal, relationship between transit per se and distance from transit stations, and change in the distribution of total jobs and jobs by economic group.

The analytic approach uses simple comparisons of the change in number of jobs for each economic group from 2008 to 2011 for each transit mode within each of four distance bands comprising a one-mile study area around transit stations, compared to the change in the number of jobs for each economic group for the transit county as a whole. While this has been done for each of the 23 transit systems studied, this article reports only the sum of all economic group jobs within each distance band for each transit mode compared to the sum of all economic group jobs for the transit counties. Z-scores are used to test for significance (p <0.01).[36]

The study assesses job change over time within distance bands up to one mile from transit stations based on three recent studies. In one, a team of researchers at the University of Utah found that transit stations influenced the value of rental residential property to about one mile away from the LRT system serving the Salt Lake City metropolitan area.[37] In another, a

[36] A z-score measures how many standard deviations below or above the mean a raw score is. For a review, see www.indiana.edu/~educy520/sec6342/week_09/z_score_intro.pdf. In this application, relationships are considered significantly different if there is a great than one-on-one hundred chance that it is a random outcome.

[37] Susan J. Petheram, Arthur C. Nelson, Matt Miller and Reid Ewing, Use of the Real Estate Market to Establish Light Rail Station Catchment Areas: Case Study of Attached Residential Property Values in Salt Lake County, Utah, by Light Rail Station Distance, TRANSPORTATION RESEARCH RECORD 2357: 95-99, 2013.

team of researchers from the University of Minnesota determined that LRT stations had a positive effect on office and industrial property values within one mile of LRT stations along the Hiawatha Line in the Minneapolis-St. Paul metropolitan area.[38] A third study, also conducted by University of Utah researchers, found that office rents were affected positively up to 1.85 miles from the LRT system serving the metropolitan Dallas, Texas area, though around three-quarters of that effect was found within about the first mile.[39] Given this evidence, assessing transit station effects on job location within the first mile is reasonable. Moreover, differences in effects between bands can be assessed.

Data for the analysis comes from the Longitudinal Employer-Household Dynamics (LEHD) database.[40] These data provide estimates of jobs for each NAICS economic sector for each year of the study period. The unit of analysis is census block groups (BGs) that are assigned to distance bands based on their centroid locations. This also assures that a BG is assigned to only one distance band even if it straddles two or more.

Results for each transit mode are discussed next.

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[38] Ko, K. 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.

[39] Arthur C. Nelson, Dejan Eskic, Shima Hamidi, Reid Ewing, Susan J. Petheram and Jenny H. Liu, Office Rent Premiums with Respect to Light Rail Transit Stations: Case Study of Dallas with Implications for TOD Planning, TRANSPORTATION RESEARCH RECORD, 2015.

[40] See http://lehd.ces.census.gov/ for details.

Light Rail Transit Job Location Results

The analysis includes all 11 LRT systems in operation since 2008. Collectively, those metropolitan areas served by LRT systems added more than 190,000 jobs between 2008 and 2011, a nearly two percent increase, even though the nation as a whole had about two percent fewer jobs in 2011 than in 2008.[41] Table 2 reports the change in jobs by distance band from LRT stations over the study period and compared to the central counties as a whole. Figure 3 illustrates the analysis.

Analysis shows that the 1-mile band around transit stations accounted for 38 percent of all the jobs added to the central counties during our study period. Indeed, only the 1/8-1/4 mile band lost jobs.

The closest band (1/8 mile) saw the largest number of economic groups that gained jobs. On the surface, one group seems surprising—manufacturing. Yet, manufacturing includes the largest number of 2-digit NAICS economic sectors so the range of manufacturing firms is quite large from ship building to microbreweries. One could suspect that small-scale, localized manufacturing such as microbreweries account for much of these new jobs and along with them the gain in retail, accommodation and food service jobs in the same distance band. The loss of jobs in the industrial economic group seems reasonable since those sectors (such as utilities, warehousing and wholesaling) tend to be land-extensive. Indeed, this economic group lost jobs across all distance bands. Somewhat surprising is the loss of jobs in the office economic group though this group added jobs in all the other distance bands. It may be that firms in that economic group were outbid for locating near transit stations and were thus displaced to other

[41] Though the Great Recession started in later 2007 job losses did not accelerate until the middle of 2008. From the middle of 2008 to the middle of 2010 about 6.6 million jobs were lost, or about 3.7 percent of 2008 the level.

distances. Job gains in the knowledge economic group are consistent with national trends,[42] suggesting that higher educated and especially younger workers favor working in locations accessible to transit. Neither are gains in the other categories surprising, since transit systems are often designed to provide close connections to education, health, and arts-entertainment-recreation institutions.

One surprise is the loss of jobs overall and in nearly all economic groups in the 1/8-1/4 mile band. It seems as though many firms choose to bid high for locations closest to transit stations, and failing that, settle for locations farther away though perhaps reasonably accessible to transit. But why are jobs hollowing out in this band? Perhaps residential development is outbidding many firms for location in this band, pushing firms farther away. Indeed, in the innermost band, residential and nonresidential development co-exist as mixed-use developments; as such, residential development may be especially competitive out to one-quarter mile from transit stations. This is the subject of ongoing research.

Figure 3 illustrates these distributions. For instance, in the "total" bar, the figure shows a loss for one band that sits below the 0-line (1/8-1/4 mile band) and gains for all others. The industrial economic groups show losses for all four bands while the office, education and health care economic groups show losses in one band but gains in the other three. The figure also illustrates the relative changes within and between the economic groups.

[42] Miller, Claire Cain (2015) More New Jobs Are in City Centers, While Employment Growth Shrinks in the Suburbs. *New York Times*, February 24, 2015. Accessed August 13, 2016 from http://www.nytimes.com/2015/02/24/upshot/more-new-jobs-are-in-city-centers-while-employment-growth-shrinks-in-the-suburbs.html?_r=0.

Table 2

Comparisons of Economic Group Job Change by LRT Station Distance Band Compared to Transit Counties, 2008-2011

Economic Group	Transit Counties	1/8 Mile	1/8-1/4 Mile	1/4-1/2 Mile	1/2-1 Mile	All 1 Mile
Manufacturing	(87,459)	**864**	(2,011)	(4,000)	**8,270**	**3,123**
Industrial	(47,266)	(1,481)	(2,388)	(3,801)	(4,923)	(12,593)
Retail-Acc-Food	(32,447)	**2,848**	(6,492)	(2,548)	(1,920)	(8,112)
Knowledge	(10,112)	**2,443**	(3,933)	(13,579)	(1,796)	(16,865)
Office	119,811	(13,090)	**7,216**	**22,976**	**18,436**	**35,538**
Education	54,836	**7,044**	(1,569)	**11,103**	**4,522**	**21,100**
Health Care	186,715	**15,242**	(13,163)	**31,550**	**17,536**	**51,165**
Arts-Ent-Rec	6,921	**958**	(312)	**251**	(1,826)	(929)
Total	190,999	**14,828**	(22,652)	**41,952**	**38,299**	**72,427**
Transit Counties %		8%		22%	20%	38%

Note: Bold means the economic group within BRT station area distance band is positive.

Unless italicized, all comparisons are significant at $p < 0.01$.

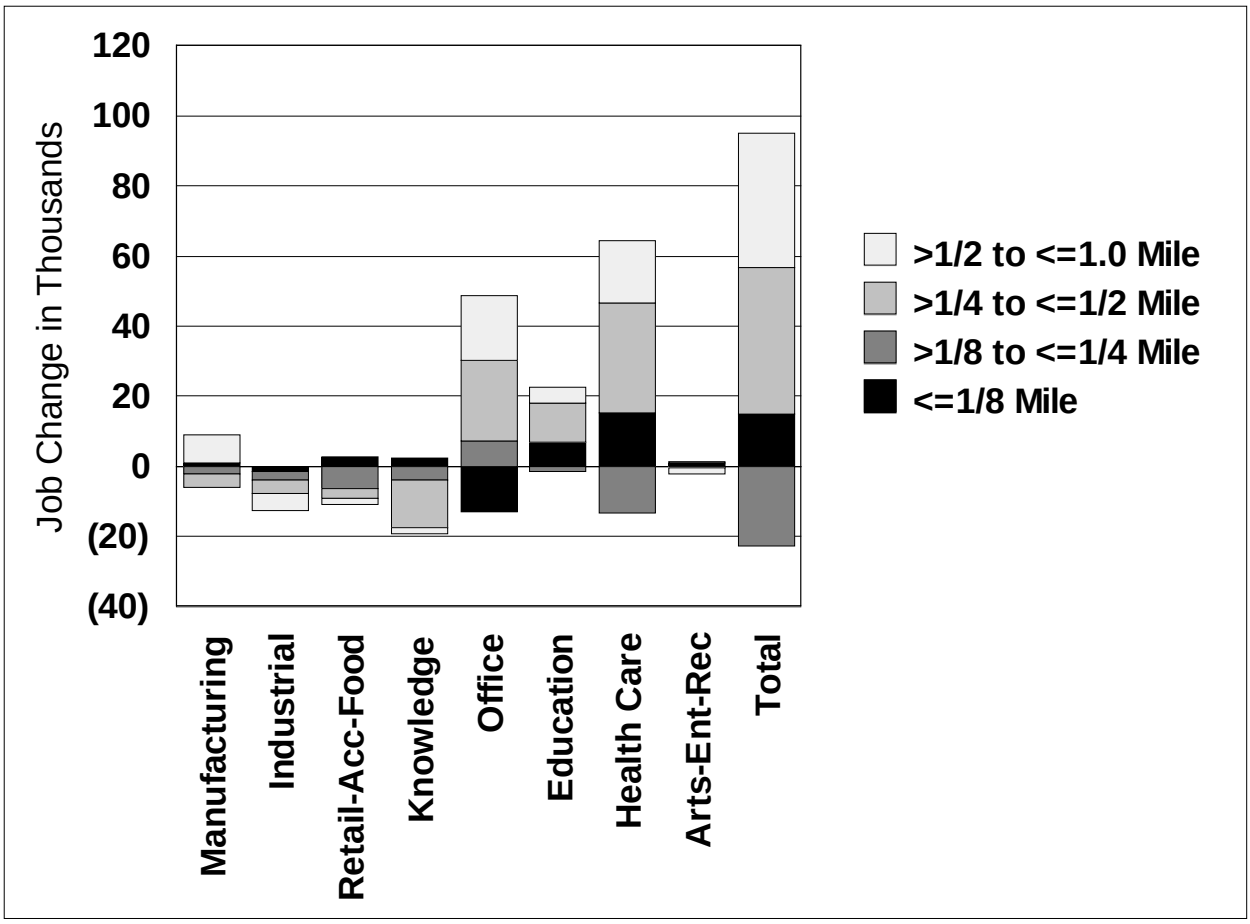

Figure 3

Comparisons of Economic Group Job Change by LRT Station Distance Band, 2008-2011

Bus Rapid Transit Job Location Results

The analysis also includes all eight BRT systems operating in the U.S. since 1983. They serve metropolitan areas ranging from slow or stagnating ones such as Cleveland and Pittsburgh, to moderately growing ones such as Kansas City, Eugene-Springfield, Los Angeles, and New York's Bronx borough, to rapidly growing ones such as Las Vegas and Phoenix. As a group, Table 3 shows that the central counties of these metropolitan areas gained barely more than 1,000 jobs as the stagnating and moderately growing areas mostly lost jobs, while the rapidly growing ones lost tens of thousands of jobs. It seems remarkable that virtually all transit county job growth was associated with job gains within the first three distance bands to one-half mile. It is almost as if nearly all new firms locating on those transit counties choose locations within one-half mile of BRT stations, and perhaps many firms chose to relocate from elsewhere in the transit county to locations near BRT stations. Further, about half the increase in jobs within one-half mile occurred in the 1/8 mile band as did nearly all the increase in jobs within the first one-quarter mile. This is similar to earlier research on effects of the Eugene-Springfield BRT systems.[43]

Unlike LRT systems, knowledge jobs were lost in the closest distance band as well as for transit counties as a whole, while office jobs gained in all distance bands. Also, unlike LRT systems, industrial firms added jobs to the closest BRT station locations though jobs in the industrial economic group fell across the other distance bands as well as for the transit counties

[43] Nelson, Arthur C., Bruce Appleyard, Shyam Kannan, Reid Ewing, Matt Miller, Dejan Eskic, Bus Rapid Transit and Economic Development: Case Study of the Eugene-Springfield BRT System, JOURNAL OF PUBLIC TRANSPORTATION 16(3): 41-57.

as a whole. It is possible that many BRT stations were located along major streets that serve industrial activities and may have helped attract new or relocating firms.

Considering that there were substantial job gains in the closest distance band as well as in the 1/4-1/2 mile band, but nearly no gain the middle distance band, perhaps there might be a residential attractiveness element similar to what we suspect for LRT systems. Current research is exploring this possibility. One may suspect that any BRT effects on residential or nonresidential development are limited to the first one-half mile from transit stations.

Although it is not possible to assert that BRT systems by themselves generate jobs, transit counties served by BRT systems gained just over 1,000 jobs, and more than 60,000 jobs were generated within one-eighth mile of BRT stations. It is as though new firms moving into the area tended to choose being near BRT stations, or firms relocated from elsewhere within transit counties to be near BRT stations. One wonders how those transit counties may have performed from 2008 to 2011 in the absence of their BRT systems.

Figure 4 illustrates these associations graphically. Note the strong job-additions associated with the office, education and health care economic groups compared to all others.

Table 3

Comparisons of Economic Group Job Change by BRT Station Distance Band Compared to Transit Counties, 2008-2011

Economic Group	Transit Counties	1/8 Mile	1/8-1/4 Mile	1/4-1/2 Mile	1/2-1 Mile	All 1 Mile
Manufacturing	(109,253)	(657)	(577)	(5,257)	(6,774)	(13,265)
Industrial	(40,938)	**3,016**	*(518)*	*(1,216)*	(1,309)	(27)
Retail-Acc-Food	(69,357)	**1,302**	(3,102)	**1,483**	(6,205)	(6,522)
Knowledge	(24,929)	(82)	(619)	(3,183)	(1,189)	(5,073)
Office	27,381	**48,531**	**3,743**	**9,047**	**3,671**	**64,992**
Education	54,611	(766)	**596**	**24,883**	(17,916)	**6,797**
Health Care	165,465	**7,333**	**567**	**2,762**	**6,227**	**16,889**
Arts-Ent-Rec	(1,747)	**383**	**533**	(247)	(1,942)	(1,273)
Total	1,233	**59,060**	**623**	**28,272**	(25,437)	**62,518**
Transit Counties %		na	na	na		na

Note:

Bold means the economic group within BRT station area distance band outperformed the transit county as a whole.

Unless italicized, all comparisons are significant at $p < 0.01$.

"na" is used because jobs added within one-half mile of BRT transit stations exceeded jobs gained by the transit counties as a whole. (See text for discussion.)

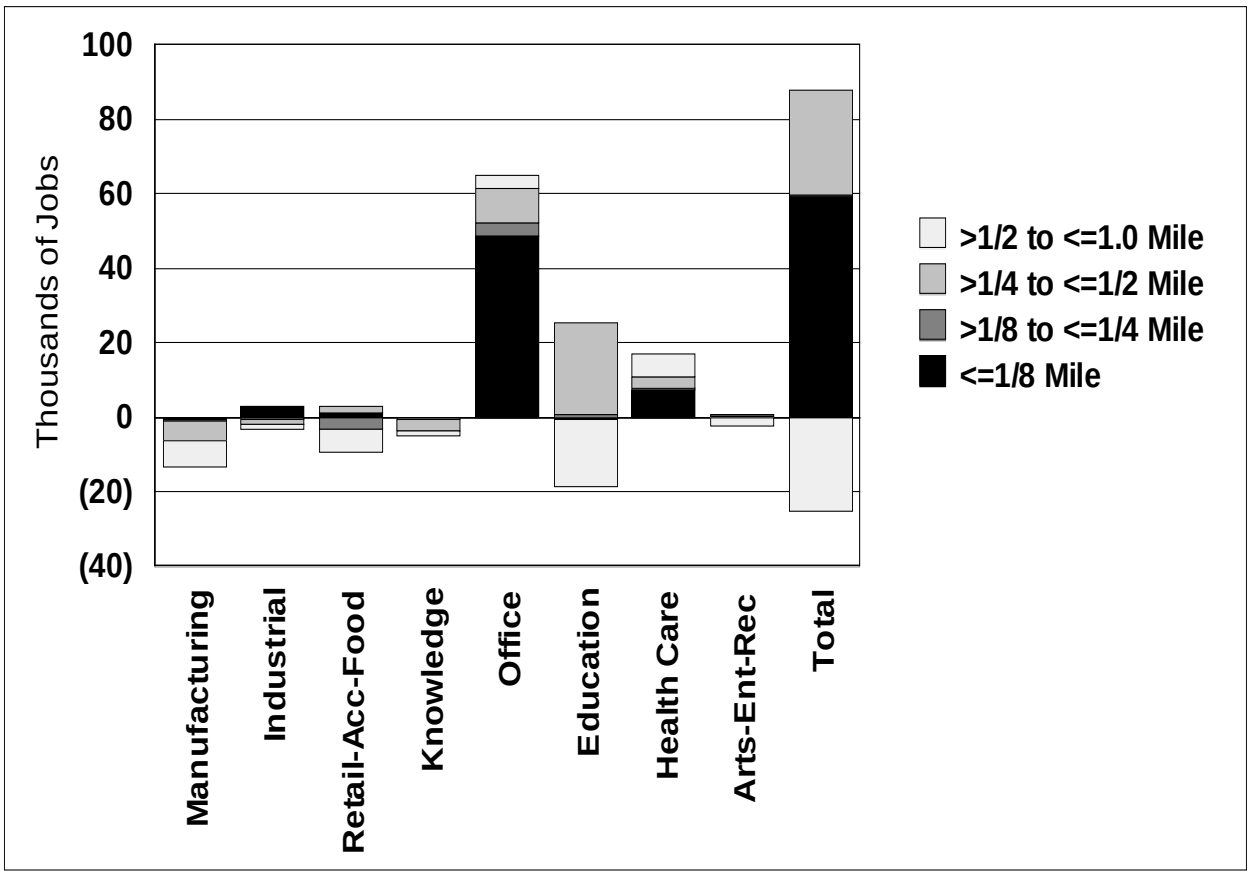

Figure 4

Comparisons of Economic Group Job Change by BRT Station Distance Band, 2008-2011

Streetcar Transit Job Location Results

In contrast to analyses of LRT and BRT systems, there are negative associations between new jobs across nearly all economic groups and the closest distance bands to SCT stations, as seen in Table 4. America has very few modern streetcar systems, so the sample of all three systems operating since 2008 may not be representative of all newer and planned systems. Moreover, America's streetcar systems serve mostly downtown or near-downtown areas, though the Portland system has been expanded considerably in recent years. Analysis is thus limited, at least in these respects. Those three systems serve transit counties that added jobs between 2008 and 2011. Yet, as seen in Table 4, nearly all economic groups within the first one-quarter mile of SCT stations lost jobs. This is in stark contrast to LRT and BRT systems. Jobs were added, however, from one-quarter mile to one mile away from SCT stations. Overall, only 10 percent of the change in transit county jobs is located between one-quarter and one mile of SCT stations.

It may be that increasing market demand for downtown housing is squeezing jobs away from SCT stations. In recent years, America's downtowns have experienced important reversals in historic patterns, especially in attractive downtowns such as Portland, Seattle, and Tampa.[44]

Though the downtown housing market may be especially attracted to streetcars, displaced jobs may relocate not too far away. The more than 34,000 new jobs added between 2008 and 2011 in the 1/4-1/2 mile band was 1.5 times more jobs than the transit counties added as a whole. Those jobs were concentrated in the industrial, office, education, and health care economic groups (see Figure 5 for the visual distributions), substantially consistent with transit county job growth overall.

Ongoing research is exploring the role of downtown residential development in displacing jobs from close proximity to streetcar stations while adding downtown population.

[44] See Urban Land Institute, EMERGING REAL ESTATE TRENDS: US AND CANADA 2016.

Summary and Implications

This analysis generates evidence relating to which kinds of firms appear to be attracted to LRT, BRT and SCT transit stations in the post-recession and recovery period. Table 5 summarizes the findings.

One may be impressed that each type of transit system—light rail, bus rapid transit, and streetcars—have such different associations with respect to change in jobs by economic group in four distance bands to one mile from transit stations. LRT systems seem to have the most robust associations at the closest band and less robust though not trivial associations at the 1/4-1/2 mile and 1/2-1 mile bands. BRT systems have robust associations in the three closest bands, with the closest clearly dominating. SCT systems have very different associations, having no discernable positive effect on jobs in the two closest bands, but having robust positive effects between one-quarter mile and one-half mile.

Equally, if not more, important than positive associations between job change in economic groups with respect to distance bands from stations by transit type are negative associations. Negative associations can mean several things. First, it is possible that transit investment makes locations closer to stations more valuable to some firms in terms of transit accessibility than to their outbid competitors. Land-extensive industrial group firms in warehousing, wholesaling and utilities may be outbid for transit-accessible locations by more land-intensive economic groups.

Table 4

Comparisons of Economic Group Job Change by SCT Station Distance Band Compared to Transit Counties, 2008-2011

Economic Group	Transit Counties	1/8 Mile	1/8-1/4 Mile	1/4-1/2 Mile	1/2-1 Mile	All 1 Mile
Manufacturing	(21,286)	*(191)*	(249)	(1,248)	(414)	(2,102)
Industrial	(11,940)	(4,740)	(985)	**2,399**	(1,970)	(5,296)
Retail-Acc-Food	(4,348)	(1,020)	(948)	(1,142)	**1,356**	(1,754)
Knowledge	5,638	(2,373)	(2,179)	(109)	**1,005**	(3,656)
Office	6,205	(6,781)	(19,403)	***30,695***	(3,580)	**931**
Education	12,017	(74)	*246*	***2,312***	***2,176***	**4,660**
Health Care	36,404	(256)	*836*	**2,033**	**6,231**	**8,844**
Arts-Ent-Rec	(1,170)	**66**	*747*	(621)	**427**	**619**
Total	21,520	(15,369)	(21,935)	**34,319**	**5,231**	**2,246**
Transit Counties %				159%	24%	10%

Note: Bold means the economic group within BRT station area distance band outperformed the transit county as a whole.

Unless italicized, all comparisons are significant at $p < 0.01$.

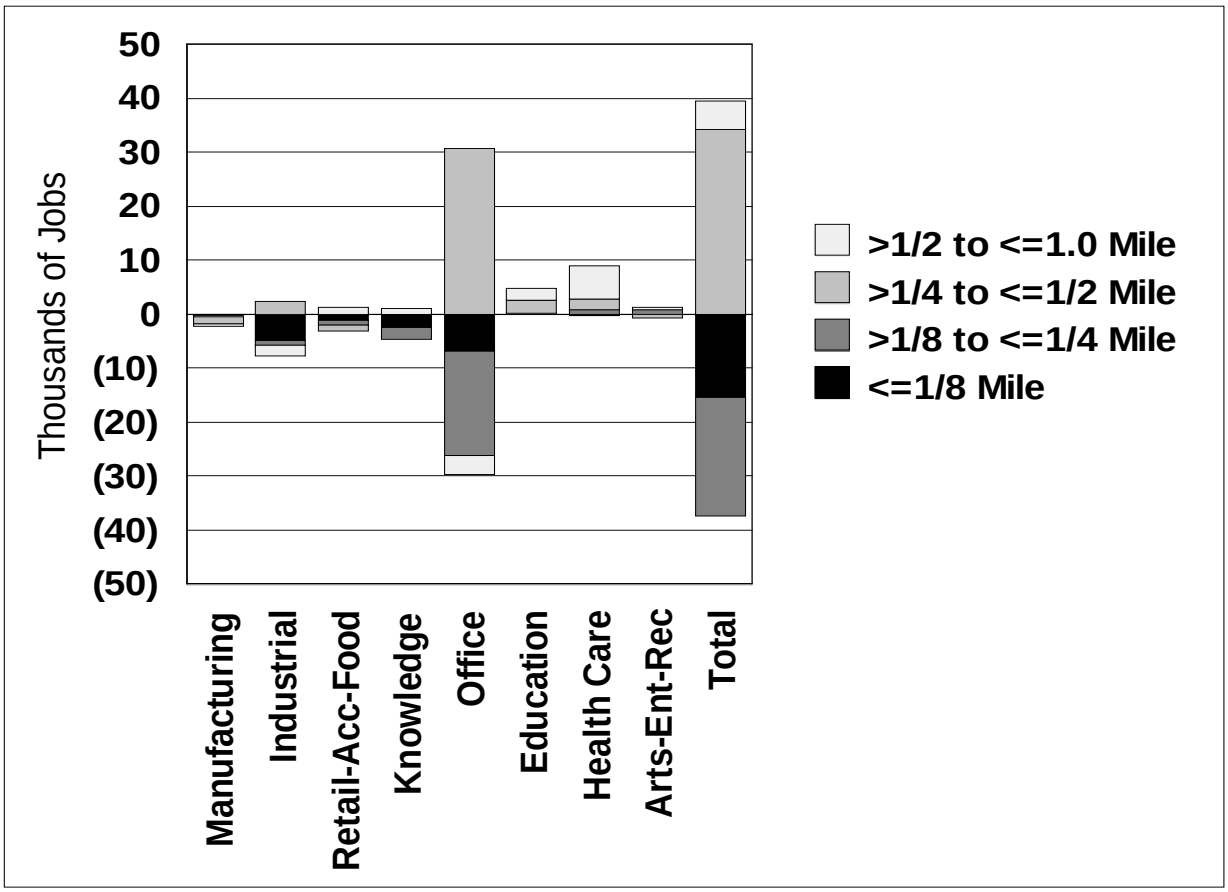

Figure 4

Comparisons of Economic Group Job Change by SCT Station Distance Band, 2008-2011

Table 5

Summary of Economic Groups Direction of Association with Transit Station Proximity by Transit Type

Economic Group	**1/8 Mile**			**1/8-1/4 Mile**			**1/4-1/2 Mile**			**1/2-1 Mile**		
Transit Mode	***LRT***	***BRT***	***SCT***	***LRT***	***BRT***	***SCT***	***LRT***	***BRT***	***SCT***	***LRT***	***BRT***	***SCT***
Manufacturing	++	-	-	-	-	-	-	-	-	+	-	-
Industrial	-	+	-	-	-	-	-	-	+	-	-	-
Retail-Acc-Food	++	+	-	-	-	-	-	+	-	-	-	+
Knowledge	++	-	-	-	-	-	-	-	-	-	-	+
Office	-	+	-	+	+	-	+	+	+	+	+	-
Education	+	-	-	-	+	-	+	+	+	+	-	+
Health Care	+	+	-	-	+	-	+	+	+	+	+	+
Arts-Ent-Rec	+	+	+	-	+	-	-	-	-	+	+	+
Positive Number	6	5	1	1	4	0	3	4	4	5	3	5

Note:

"+" means jobs were added in the respective economic group.

"++" means jobs were added in the respective economic group though jobs were lost in the transit counties as a whole.

Second, job losses in any given economic group may be merely the effect of regional shifts in jobs away from those groups to others. Most transit counties, for instance, lost jobs in the manufacturing group. But if losses closer to transit stations were proportionately less than those in the transit county, perhaps transit accessibility improves firms' productivity so they could remain in business at those locations, or even move from elsewhere to those locations. This is not the case, however. Considering only the economic groups that lost jobs, nearly all of them lost jobs at a faster pace within one mile of transit stations than the transit county as a whole. This finding is nuanced because many economic groups that lost jobs in the transit county gained jobs near transit stations. They are noted as "++" in Table 5.

The first and second interpretations can lead to a third: Economic development planning may be advanced as follows. For a given transit mode and within a given distance from a transit station, economic development planners may consider attracting firms in target economic groups noted in Table 4. Because of data limitations, however, we cannot be more specific about which types of 3-, 4- or longer-digit NAICS firms may have the best chances of success for any given distance band.

There is a fourth consideration. This article addresses only nonresidential activities. As noted earlier, the distribution of change in jobs for any given economic group may be influenced by residential development that is attracted to transit stations. In downtowns with streetcars, for instance, residential development may be outbidding nonresidential development for locations up to one-quarter mile away from SCT stations. Put differently, to the extent that streetcar systems are designed to serve built-out downtown and near-downtown areas dominated by nonresidential development, meeting new residential development demand may be the driving force behind

redevelopment or the repurposing of existing development close to SCT stations. Ongoing research is attempting to address this.

In contrast, for both LRT and BRT systems, firms may outbid residential development in the first one-eighth mile. But in the next one-eighth mile, residential development may outbid firms. Over time, this may have the effect of creating distinct bands of real estate development around LRT and BRT transit stations with the inner one-eighth mile dominated by nonresidential development, the next one-eighth mile dominated by residential development, and the next one-quarter mile dominated by nonresidential development. Of course all rings would likely have a mix of nonresidential and residential development so the difference will be the degree of dominance. Ongoing research is attempting to address the residential dimension of transit station land use impacts.

The nation's built environment continues to evolve. Notably, between 2015 and 2050 more than two-thirds of all nonresidential development will be redeveloped or otherwise repurposed.[45] Outside most of the largest metropolitan areas (such as Boston, Chicago, Los Angeles, New York, Philadelphia, San Francisco Bay Area, and Washington, DC), fixed-guideway transit systems in the US are in their infancy. As existing systems are expanded and new ones added, it is important for transit system decision-makers to assure that transit investments generate economically and politically acceptable rates of return. This article may help transit station area planning efforts achieve these objectives.

[45] Arthur C. Nelson, RESHAPING METROPOLITAN AMERICA, Washington, DC: Island Press, 2013 and Arthur C. Nelson, FOUNDATIONS OF REAL ESTATE DEVELOPMENT FINANCE: A GUIDE FOR PUBLIC-PRIVATE PARTNERSHIPS, Washington, DC: Island Press, 2014.