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COLLOQUIUM - GETTING THERE FROM HERE: AN EXPLORATION OF REGIONALISM AND TRANSPORTATION IN THE UNITED STATES

Transit-Oriented Developments Make a Difference in Job Location

Arthur C. Nelson*

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TRANSIT-ORIENTED DEVELOPMENTS MAKE A DIFFERENCE IN JOB LOCATION*

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ABSTRACT

The United States is on the cusp of transformative development patterns. For a half-century since the end of the Second World War, the economic advantages of central locations served by transit were cast aside for planning that prioritized and reinforced urban sprawl. However, new trends are emerging. By midcentury, two-thirds of all nonresidential development existing in 2015 will be replaced. Central locations and locations served by fixed guideway transit systems are beginning to attract new development and especially infill and redevelopment. Notably, while the end of the twentieth century saw the decline of major new investment in heavy rail transit systems serving the nation's largest metropolitan areas, new forms of investment emerged. Those investments are in 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 presents research about whether and the extent to which jobs are attracted to transit stations. The research is applied to twenty-three transit systems in the United States covering the period from the Great Recession into the early 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

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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. The bottom line is that those metropolitan areas that seize the economic advantages that fixed guideway transit systems offer may be the economic development winners of the future.

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INTRODUCTION

Between 2015 and 2050, more than two-thirds of all nonresidential development will be redeveloped or otherwise repurposed.[1] Outside most of the largest metropolitan areas, such as Boston, Chicago, Los Angeles, New York, Philadelphia, the San Francisco Bay Area, and Washington, D.C., fixed-guideway transit systems in the U.S. 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.

As this large-scale redevelopment unfolds, consider transportation trends of the past century. Urban America's transportation systems were transformed during the twentieth century. At the turn of the twentieth century, streetcars, horses, and walking dominated personal transportation.[2] Only America's largest cities, such as Boston, Chicago, New York, and Philadelphia, had heavy-rail or subway systems.[3] Automobiles were expensive and not accessible to the mass market.[4] Between the middle

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1. *See* ARTHUR C. NELSON, RESHAPING METROPOLITAN AMERICA 1, 6, 79 (Arthur C. Nelson & Reid Ewing eds., 2013); ARTHUR C. NELSON, FOUNDATIONS OF REAL ESTATE DEVELOPMENT FINANCING: A GUIDE TO PUBLIC-PRIVATE PARTNERSHIPS 4 (Arthur C. Nelson & Reid Ewing eds., 2014).

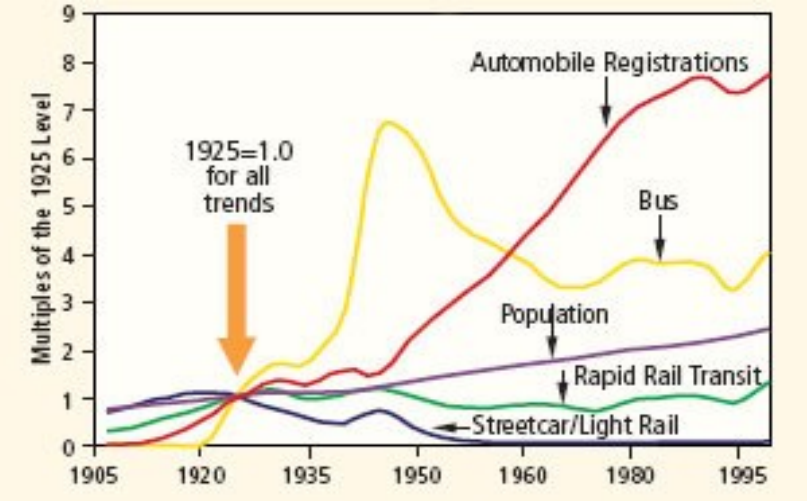
2. *See* PETER O. MULLER, THE OUTER CITY: GEOGRAPHICAL CONSEQUENCES OF THE URBANIZATION OF THE SUBURBS 3 (1976).

3. *See* ENCYCLOPEDIA BRITANNICA, SUBWAY (2015) https://www.britannica.com/technology/subway [https://perma.cc/X9WR-Q2TM].

4. Matthias Holweg, *The Evolution of Competition in the Automotive Industry*, *in* BUILD TO ORDER: THE ROAD TO THE 5-DAY CAR 17 (Glenn Parry & Andrew Graves eds., 2008).

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, New York City.[5] However, America's transportation systems and landscape changed after World War II. America transitioned from an urban nation to a suburban nation, where the automobile supplanted public transit as the chief means of mobility, as shown in Figure 1.[6] This transformation fueled the phenomenon known as "urban sprawl."[7]

Figure 1: Change in Transit Ridership, Population, and Automobile Ownership Relative to 1925[8]



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

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5. AUGUSTE C. SPECTORSKY, THE EXURBANITES 2-7 (1955).

6. *See* John S. Miller, *The Uncertainty of Forecasts*, PUB. ROADS, Sept.-Oct. 2004, 1; *see also* Edson L. Tennyson, *Impact on Transit Patronage of Cessation or Inauguration of Rail Service*, 1221 TRANSP. RES. REC. 59, 60 (1989) (discussing the history of transit use in the United States through the middle twentieth century).

7. For detailed accounts of the role of the automobile in facilitating urban sprawl, see generally ANDRES DUANY, ELIZABETH PLATER-ZYBERK & JEFF SPECK, SUBURBAN NATION: THE RISE OF SPRAWL AND THE DECLINE OF THE AMERICAN DREAM (2010); ROBERT BRUEGMANN, SPRAWL: A COMPACT HISTORY (2005).

8. *See* FED. HIGHWAY ADMIN., https://www.fhwa.dot.gov/publications/publicroads/04sep/images/mill5.jpg [https://perma.cc/B4JE-8CG2]; *see also* Miller, *supra* note 6.

> hand, by 1950, streetcar ridership had dropped to a fraction of its 1925 level.[9]

The last decades of the twentieth century into the first decades of the twenty-first century saw a subtle but important shift in Americans' preferences in transportation mode, mainly in their choice to use automobile or transit chosen for such destinations as work or shopping. This shift may or may not signal longer-term changes in urban development patterns. The shift is occasioned by the rise of several kinds of fixed-guide way 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.[10] Importantly, Figure 2 illustrates the growth in the use of FGT systems, and change in the vehicle miles traveled by automobiles, compared to population growth between 2003 and 2014. Between those years, America's population grew by nearly ten percent; however, the nation's total automobile miles traveled by all passengers grew by less than five percent, while the nation's total FGT miles traveled by all passengers grew by about thirty-three percent.[11] To be sure, more than eighty-eight percent of all personal miles traveled in the U.S. are still via automobile.[12] But the shift toward FGT use is noticeable.

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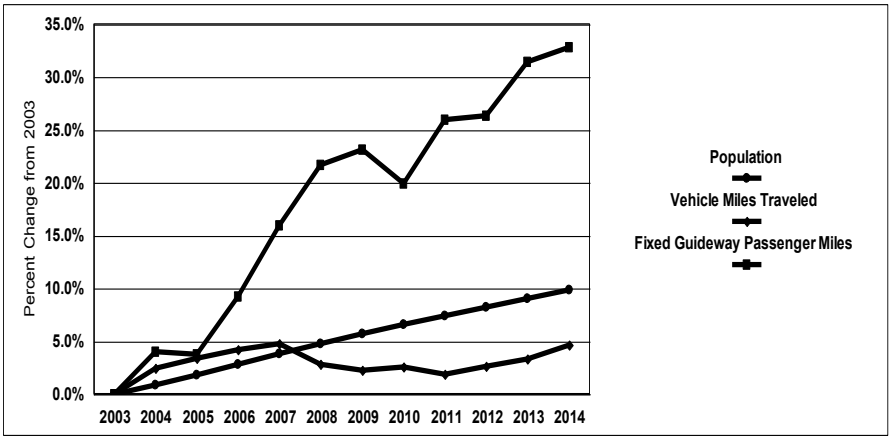
9. Miller, *supra* note 6. Data for this figure were compiled by VA. TRANSP. RES. COUNCIL from BUREAU OF TRANSP. STAT., U.S. CENSUS BUREAU, AM. PUB. TRANSP. ASS'N, and Arthur Saltzman, *Public Transportation in the 20th Century in* PUBLIC TRANSPORTATION 24-45 (George E. Gray & Lester A. Hoel eds., 1992).

10. *See* Arthur C. Nelson et al., *Do TODs Make a Difference?* NAT'L INST. FOR TRANSP. & CMTYS. (2015) http://pdxscholar.library.pdx.edu/trec_reports/7/ [https://perma.cc/J8KH-DA2S]; *see also* Arthur C. Nelson & Joanna P. Ganning, *National Study of BRT Development Outcomes*, NAT'L INST. FOR TRANSP. & CMTYS. 16 (2015), http://pdxscholar.library.pdx.edu/trec_reports/32/ [https://perma.cc/RR9W-LJES].

11. Calculations by author. Population from U.S. Census, vehicle miles traveled from *Table 1-36: Road Vehicle-Miles Traveled (VMT) and VMT per Lane-Mile by Functionale Class(a)*, BUREAU OF TRANSP. STAT., http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_36.html [https://perma.cc/4RP2-WAWV]; FGT passenger miles from John Neff & Matthew Dickens, *2016 Public Transportation Fact Book Appendix A: Historical Tables*, AM. PUB. TRANSP. ASS'N (2016), https://www.apta.com/resources/statistics/Documents/FactBook/2016-APTA-Fact-Book-Appendix-A.pdf [https://perma.cc/JDN3-R738].

12. U.S. DEP'T OF TRANSP., PASSENGER TRAVEL FACTS AND FIGURES 11 (2015), http://www.rita.dot.gov/bts/publications/passenger_travel_2015 [https://perma.cc/P7JB-YRUZ] (showing that as of 2009, 88.4 percent of all person-miles traveled were by personal vehicle).

Figure 2: Percent change 2003 to 2014 in population, vehicle miles traveled, and FGT passenger miles annually[13]



The shift toward FGT use also signals important changes in the distribution of America's jobs and people. This Article explores the reasons for these changes by examining the change in total jobs and jobs by economic group attracted to transit-oriented developments ("TODs") from the beginning of the Great Recession in 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.[14]

Further, this Article analyzes several LRT, BRT, and SCT systems operating before the Great Recession to assess change in development outcomes with respect to those systems during and after the recession. LRT systems studied include those in the Charlotte, Dallas, Denver, Minneapolis, Portland (Oregon), Sacramento, Salt Lake City, San Diego, and Seattle metropolitan areas.[15] 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

13. *See* calculations by author, *supra* note 11.

14. 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, and Portland Metro. *See generally* NAT'L INST. FOR TRANSP. & CMTYS., http://nitc.trec.pdx.edu [https://perma.cc/ST2B-YZS7].

15. 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 Chicago, Los Angeles, New York City, and San Francisco metropolitan areas.

area.[16] In sum, this Article presents new empirical research that should guide transit station area planning efforts to midcentury and beyond.

I. TODS AND JOB ATTRACTION

TODs are an old concept, but their application to shaping development patterns is fairly new. During the late nineteenth century, private development interests in partnership with local governments extended urban streetcars into suburbs, creating "streetcar suburbs."[17] These private developers assembled suburban land and financed streetcar extensions from cities to their newly planned suburban communities.[18] Within roughly one quarter to one half mile of a typical streetcar suburb station stood some convenience retail and service functions with nearby low-rise attached homes, surrounded by homes on detached lots.[19] Though subways were built in several eastern cities from the late nineteenth century into the middle of the twentieth, it was not until new subway systems were built in the Washington, D.C. and San Francisco Bay areas that public interest arose in using planning to guide development around transit stations, especially in the suburbs. For instance, during the 1960s and through the 1980s, Arlington, Virginia choreographed land use and facility plans to focus high-density housing, high-rise offices, and service activities within one quarter mile of metropolitan Washington, D.C.'s Metro rail system stations, which traversed the center of the county. This was called the "bull's-eye" approach to metro rail transit station area planning.[20]

It was not until the early 1990s when the role of transit station area planning in shaping metropolitan development patterns was appreciated fully. Pioneering thinking was advanced by Peter Calthorpe, who arguably coined the term TOD. He defined a TOD as a "mixed-use community within an average 2,000-foot walking distance of a transit stop and core commercial area. TODs mix residential, retail, office, open space, and public uses in a walkable environment, making it convenient for residents and employees to travel by transit, bicycle, foot, or car."[21] Moreover, to Calthorpe, TODs represent a reversal of history especially since the end of the Second World War. He wrote, "[t]he principles [for TODs] may seem radical and familiar at the same time. Making such changes would reverse

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

17. *See* SAM B. WARNER JR., STREETCAR SUBURBS 64 (1962).

18. *See id.* at 23-29.

19. *See id.* at 73-77.

20. *See Planning and Development History*, ARLINGTONVA.US, https://projects.arlingtonva.us/planning/history/ [https://perma.cc/NYT3-4B6H].

21. PETER CALTHORPE, THE NEXT AMERICAN METROPOLIS: ECOLOGY, COMMUNITY, AND THE AMERICAN DREAM 56 (1993).

forty years of planning that put cars ahead of pedestrians, put private space before public, put segregation and isolation of uses before integrated diversity."[22] TOD planning has evolved considerably over the past quarter-century. The concept is now extended to LRT and BRT systems, as well as streetcars serving infill and redevelopment areas, and the occasional commuter rail station.[23] Increasingly, TOD planning often extends to one half mile and beyond.

The question that planners must confront is how TODs should influence development. Literature shows that cities and the metropolitan areas around them are formed and grow in large part by creating agglomeration economies.[24] Technically, the term means increased production within a specified geographical area resulting in a decline in average cost.[25] As more firms in related sectors cluster together, productivity increases and costs of production fall. These economies can spill over into complementary sectors, thereby creating even more jobs.[26] Cities can become ever larger as economies of agglomeration are exploited.[27] Transportation improvements make it possible to reduce transportation times, increasing the size of market areas and the effective size of industrial clusters. But congestion can result if traffic expands because of agglomeration effects, thereby exceeding transportation facility with resulting decreases in worker productivity.[28] Highway projects have been shown to induce this negative change in metropolitan form, and at a net cost to society.[29] Because firm location follows residential relocation, changes in firm location may not be temporally traceable to specific

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22. *Id.* at 53.

23. *See generally Transit-Oriented Development (TOD)*, NLC.ORG, http://www.sustainablecitiesinstitute.org/topics/land-use-and-planning/transit-oriented-development-(tod), [https://perma.cc/RP8R-QS5R]; *What is TOD?*, ITDP.ORG, https://www.itdp.org/library/standards-and-guides/transit-oriented-development-are-you-on-the-map/what-is-tod/ [https://perma.cc/8WQ6-WEFS].

24. *See* EDWARD L. GLAESER, TRIUMPH OF THE CITY: HOW OUR GREATEST INVENTION MAKES US RICHER, SMARTER, GREENER, HEALTHIER, AND HAPPIER 46 (2011).

25. Alex Anas, Richard Arnott & Kenneth A. Small, *Urban Spatial Structure*, 36 J. ECON. LITERATURE 1426, 1427 (1998).

26. *See* Thomas J. Holmes, *How Industries Migrate When Agglomeration Economies Are Important*, 45 J. OF URB. ECON. 240, 241 (1999).

27. *See* Antonio Ciccone & Robert E. Hall, *Productivity and the Density of Economic Activity*, 86 AM. ECON. REV. 54, 55 (1996).

28. *See* Edward L. Glaeser & Janet E. Kohlhase, *Cities, Regions and the Decline of Transportation Costs*, 83 PAPERS REG'L SCI. 197, 224 (2004).

29. *See* Marlon G. Boarnet, *Highways and Economic Productivity: Interpreting Recent Evidence*, 11 J. PLAN. LITERATURE 476, 482 (1997); Marlon G. Boarnet & Andrew F. Haughwout, *Do Highways Matter? Evidence and Policy Implications of Highways' Influence on Metropolitan Development*, BROOKINGS INST. CTR. ON URB. & METRO. POL'Y 8 (2000).

highway projects.[30] However, if one presumes the urban rent curve to be a proxy for accessibility, any transportation improvement having a metropolitan-area effect will increase land values near those improvements and perhaps lower it in places with less accessibility such as distant suburbs and exurbs. 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.[31]

More recent research shows that the degree of suburbanization significantly varies within metropolitan regions in accordance with variations in population de-concentration drivers, such as socioeconomic segregation, and sub-regional growth factors, such as suburban activity centers.[32] Thus, the preservation and creation of new agglomeration economies within metropolitan regions varies considerably and can 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. Since public transit is essentially non-congestible, it can sustain agglomeration economies in high-density nodes as well as along the corridors that connect them.[33] Nonetheless, not all economic sectors benefit from agglomeration economies.

There is a growing body of research showing that rail-based public transit enhances economic development, in part because of its role in facilitating agglomeration economies.[34] Transit improves accessibility between people and their destinations by reducing travel time relative to alternatives.[35] At the metropolitan scale, adding transit modes in built-up

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30. *See generally* Joanna P. Ganning & Benjamin D. McCall, *The Spatial Heterogeneity and Geographic Extent of Population Deconcentration: Measurement and Policy Implications*, *in* INTERNATIONAL HANDBOOK OF RURAL DEMOGRAPHY 319-32 (Laszlo J. Kulcsar & Katherine J. Curtis eds., 2012); Mitch Renkow & Dale Hoover, *Commuting, Migration, and the Rural-Urban Population Dynamics*, 40 J. REGIONAL SCI. 261-87 (2000).

31. *See, e.g.*, Nelson et al., *supra* note 10 at 1.

32. Ganning & McCall, *supra* note 30.

33. *See* Richard Voith, *Parking, Transit, and Employment in a Central Business District*, 44 J. URB. ECON. 43, 45 (1998).

34. Arthur C. Nelson et al., *The Best Stimulus for the Money: Briefing Papers on the Economics of Transportation Spending*, METRO. RES. CTR., U. OF UTAH 28 (2009), http://www.smartgrowthamerica.org/documents/thebeststimulus.pdf [https://perma.cc/9YWQ-CR4N].

35. *See* Todd Litman, *Evaluating Transportation Economic Development Impacts*, VICTORIA TRANSP. INST. 13, 51 (2017), http://www.vtpi.org/econ_dev.pdf [https://perma.cc/6QJJ-8MLA].

urban areas increases aggregate economic activity.[36] Still, not all agglomeration economies develop similarly. Although transit systems can lead to higher-density development by shifting new jobs and population to station areas, they can also lead to the redistribution of existing development even in the absence of growth,[37] such as in the case of Detroit.[38]

Additionally, not all industries respond similarly to agglomeration economies, and continued analysis should consider which industries tend to gain or lose their share of employment. Prior studies have found that not all economic sectors benefit from transit. In an analysis of thirty-four transit systems from across the U.S. 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, accommodation, health care, and social assistance sectors, jobs fell in the manufacturing sector.[39] 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.[40] 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.[41] The study authors surmised that much of the metropolitan job growth continues to favor auto-oriented locations.[42] 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.[43]

II. ANALYTIC APPROACH

Economic development can be measured in many ways. This Article focuses on whether, and to what extent, which types of transit and employment changes are linked, and specifically whether transit access to

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36. *See* D. J. Graham, *Agglomeration, Productivity and Transport Investment*, 41(3) J. TRANSP. ECON. & POL'Y 317, 321 (2007) www.ingentaconnect.com/content/lse/jtep/2007/00000041/00000003/art00003 [https://perma.cc/X3KX-NW3H].

37. *See* Daniel G. Chatman & Robert B. Noland, *Do Public Transport Improvements Increase Agglomeration Economies? A Review of Literature and an Agenda for Research*, 31 TRANSP. REV. 725, 737 (2011).

38. *See generally* GEORGE GALSTER, DRIVING DETROIT: THE QUEST FOR RESPECT IN THE MOTOR CITY 75 (2012).

39. *See* Dena Belzer et al., *Transit and Regional Economic Development*, CTR. FOR TRANSIT-ORIENTED DEV. 5 (2011).

40. *Id.* at 5-6.

41. *Id.* at 6.

42. *Id.* at 4.

43. *Id.* at 6.

an area affects both the quantity and concentration of jobs. Theoretically, areas proximate to commuter rail stations should have much better job accessibility.[44] By reducing the effects of congestion, TODs should abet both the preservation of existing agglomeration economies and the creation of new ones.[45] 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.[46]

This Article presents research ("Nelson research") that analyzes the change in total jobs and jobs by economic group from 2008 through 2011 in four different distance bands from transit stations for:

- Eleven LRT systems: Charlotte, Dallas, Denver, Houston, Phoenix, Portland, Sacramento, Salt Lake City, San Diego, Seattle, and the Twin Cities—Minneapolis-St. Paul;
- Eight BRT systems: Cleveland, Eugene-Springfield, Kansas City, Las Vegas, Los Angeles, New York-Bronx, Phoenix, and Pittsburgh; and
- Three SCT systems: Portland, Seattle, and Tampa.

The four 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).

These distance bands are based on literature or are extensions of it. The half mile band is the most common distance band used in prior research with the quarter mile band being next and the one-eighth mile and full mile distances being rarely used.[47] Literature also suggests that nearly all development effects occur within the one mile band.[48] Until this Article,

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44. *See generally* Robert Cervero & Samuel Seskin, *An Evaluation of the Relationships Between Transit and Urban Form,* TRANSIT COOPERATIVE RESEARCH PROGRAM RESEARCH RESULTS DIGEST, TRANSP. RES. BD. (1995).

45. *See generally* Litman, *supra* note 35.

46. *See generally* Alex Iams & 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*, INT'L ECON. DEV. COUNCIL (2006).

47. *See* Christopher D. Higgins & Pavlos S. Kanaroglou, *Forty Years of Modelling Rapid Transit's Land Value Uplift in North America: Moving Beyond the Tip of the Iceberg*, 36 TRANSP. REV. 610-34. Note that the Article uses the term "proximity band," which means the same as "distance band" in the text of this Article.

48. *Id.*

no research reported TOD development outcomes with respect to all four of these distance bands.

The Article organizes jobs pursuant to the North American Industrial Classification System ("NAICS").[49] 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.[50]

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)

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49. *See North American Industry Classification System*, OFF. OF MGMT. & BUDGET, EXEC. OFF. OF THE PRESIDENT (2017), https://www.census.gov/eos/www/naics/2017NAICS/2017_NAICS_Manual.pdf [https://perma.cc/D4Q4-Y53Y].

50. *See generally* Belzer et al., *supra* note 39 at 14.

The Nelson research assesses change in total jobs and jobs by economic group, by distance band from transit stations compared to change in those jobs for the relevant transit counties.[51] Transit counties are the counties where the transit systems used in this study operate. The research determines whether the rate of change in jobs around stations is more than the transit county as a whole, which excludes the one mile band distance around stations; if so, this is circumstantial evidence that TODs have a positive effect on attracting jobs. Moreover, the research also determines whether the rate of change in jobs differs by distance band from transit stations up to one mile away; if so, this would be circumstantial evidence of a distance effect. Finally, the research teases out all these differences with respect to individual economic groups.

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 twenty-three 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 ($p < 0.01$).[52]

The Nelson research assesses job change over time within distance bands up to one mile from transit stations; limiting the research to up to one mile bands is based on three recent studies. In the first study, a team of researchers at the University of Utah found that transit stations influenced the value of rental residential property up to about one mile away from the LRT system serving the Salt Lake City metropolitan area.[53] In the second study, a 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

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51. *See* Nelson et al., *supra* note 10. This report uses the term "metropolitan counties," which means, though does not explicitly say, those metropolitan counties with transit systems being evaluated. This Article uses the term "transit county" for ease of clarity.

52. *See generally Z-Scores: Why is This Important?* IND. U. www.indiana.edu/~educy520/sec6342/week_09/z_score_intro.pdf [https://perma.cc/WNG6-7TL2]. A z-score measures how many standard deviations a raw score is below or above the mean. In this application, relationships are considered significantly different if there is a greater than one-on-one hundred chance that it is a random outcome.

53. *See* Susan J. Petheram et al., *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*, 2357 TRANSP. RES. REC.: J. TRANSP. RES. BOARD 95 (2013).

Minneapolis-St. Paul metropolitan area.[54] A third study, also conducted by University of Utah researchers, found that office rents fell with respect to distance from the nearest LRT station in metropolitan Dallas, up to 1.85 miles away, though around three-quarters of that effect was found within about the first mile.[55] 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 Nelson research analysis comes from the Longitudinal Employer-Household Dynamics ("LEHD") database.[56] This data provides 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 only the distance band within which the center point of the BG falls. 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.

III. LIGHT RAIL TRANSIT JOB LOCATION RESULTS

The Nelson research on LRT analysis includes all eleven 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.[57] Table 2 reports the change in jobs by distance band from LRT stations over the study period compared to the central counties as a whole. Figure 3 illustrates the analysis.

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54. *See* Kate Ko & Xinyu (Jason) Cao, *The Impact of Hiawatha Light Rail on Commercial and Industrial Property Values in Minneapolis*, 16 J. OF PUB. TRANSP. 47 (2013).

55. *See* Arthur C. Nelson et al., *Office Rent Premiums with Respect to Light Rail Transit Stations: Case Study of Dallas, Texas, with Implications for Planning of Transit-Oriented Development*, 2500 TRANSP. RES. REC.: J. TRANSP. RES. BOARD 110 (2015).

56. *See generally Longitudinal Employer-Household Dynamics*, U.S. CENSUS BUREAU, http://lehd.ces.census.gov/ [https://perma.cc/3Q8F-CUPD].

57. 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 the 2008 level.

Table 2: Comparisons of Economic Group Job Change by LRT Station Distance Band Compared to Transit Counties, 2008-2011[58]

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 LRT station area distance band is positive. Unless italicized, all comparisons are significant at p <0.01.

Analysis of the Nelson research on LRT shows that the one mile band around transit stations accounted for thirty-eight percent of all the jobs added to the central counties during the study period. Indeed, only the 1/8-1/4 mile band lost jobs.[59]

The one-eighth mile band saw the largest number of economic groups gain jobs. On the surface, one group's gains seem surprising—manufacturing.[60] Yet, the manufacturing economic group includes a range of individual manufacturing activities from shipbuilding to microbreweries. One could suspect that small-scale, localized manufacturing, such as microbreweries, accounts for much of these new jobs. Microbreweries as a manufacturing activity will also likely stimulate activities in other economic groups in the same distance band such as those in the retail-accommodation-food service economic group—and even jobs in the office economic group for perhaps logical reasons. The one-eighth mile band also saw the loss of jobs in the industrial economic group; a reasonable consequence since industrial sectors, such as utilities, warehousing, and wholesaling, tend to be land-extensive. Indeed, the industrial economic

58. *See* Arthur C. Nelson et al., *supra* note 10; *see also* Nelson & Ganning, *supra* note 10.

59. *See supra* Table 2.

60. See generally Nelson & Ganning, *supra* note 10, for an exploration.

group lost jobs across all distance bands.[61] Somewhat surprising is the loss of jobs in the office economic group while this group added jobs in all the other distance bands.[62] It may be that firms in that economic group were outbid for locating near transit stations and were thus displaced to other distances. Job gains in the knowledge economic group are consistent with national trends,[63] suggesting that higher educated and especially younger workers favor working in locations accessible by transit. The other categories, retail-accommodation-food service, health care, arts-entertainment-recreation, and education, saw gains as well.[64] These gains are not surprising since transit systems are often designed to provide close connections to these very sectors.[65]

One surprise is the loss of jobs overall and in nearly all economic groups in the 1/8-1/4 mile band.[66] One explanation is that many firms chose to bid high for locations closest to transit stations, and failing that, settled for locations farther away though reasonably accessible to transit. It is possible that residential development is outbidding many firms for location in this band, pushing firms farther away and hollowing out jobs in this band. 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.

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

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61. *See supra* Table 2.

62. *See supra* Table 2.

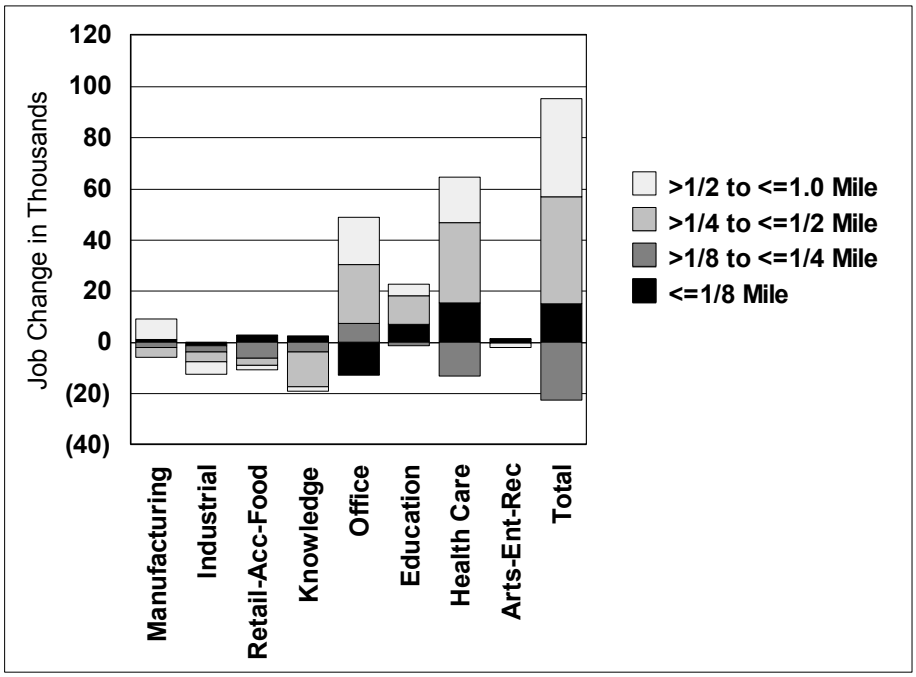
63. *See generally* Claire Cain Miller, *More New Jobs Are in City Centers, While Employment Growth Shrinks in the Suburbs*, N.Y. TIMES (Feb. 24, 2015), http://www.nytimes.com/2015/02/24/upshot/more-new-jobs-are-in-city-centers-while-employment-growth-shrinks-in-the-suburbs.html [https://perma.cc/VH7D-HZF6].

64. *See supra* Table 2.

65. *See supra* Table 2.

66. *See supra* Table 2.

Figure 3: Comparisons of Economic Group Job Change by LRT Station Distance Band, 2008-2011[67]



IV. BUS RAPID TRANSIT JOB LOCATION RESULTS

The Nelson research for BRT 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 Eugene-Springfield, Kansas City, Los Angeles, and New York's Bronx borough, to rapidly growing ones such as Las Vegas and Phoenix. Detailed analysis of each system is not reported here. As a group including all these metropolitan areas, Table 3 shows that the transit counties of these metropolitan areas gained barely more than one thousand jobs (1233) as the stagnating and moderately growing areas mostly lost jobs, while the rapidly growing ones lost tens of thousands of jobs during the 2008 to 2011 timeframe.[68] Remarkably, virtually all transit county job growth was associated with job gains within the first three distance bands, to one-half mile. This indicates that nearly all new firms locating in those transit counties chose 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, the job increase in the one-eighth

67. *See supra* Table 2.
68. *See infra* Table 3.

mile band alone accounted for nearly all the increase in jobs within the first quarter mile, and about half the increase in jobs within one-half mile. This is similar to earlier research on effects of the Eugene-Springfield BRT systems where nearly all job effects associated with distance from the nearest BRT station occurred within the one-eighth mile band.[69]

In contrast to 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, but lost across the other distance bands and in the transit counties 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.

The substantial job gains in the closest distance band as well as in the 1/4-1/2 mile band are notable, especially where there was nearly no gain in the middle distance band. It remains likely, as with the LRT systems, that a residential attractiveness element is responsible. This needs to be addressed in future research. This study would suggest 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, they may help keep them. While transit counties served by BRT systems gained just over one thousand jobs, the areas within one-eighth of a mile from BRT stations gained more than sixty thousand jobs.[70] The data imply that new firms moving into transit counties may have chosen locations near BRT stations and perhaps firms relocated from elsewhere within transit counties to be near BRT stations. Put differently, but for BRT stations, transit counties may have lost jobs during the study period. Whether these trends will be sustained over time should be addressed by future research.

Figure 4 illustrates these associations graphically. Notably, the office, education, and health care economic groups experienced strong job growth compared to all other groups.

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69. *See* Arthur C. Nelson et al., *Bus Rapid Transit and Economic Development: Case Study of the Eugene-Springfield BRT System*, 16 J. PUB. TRANSP. 41, 50 (2013).

70. *See infra* Table 3.

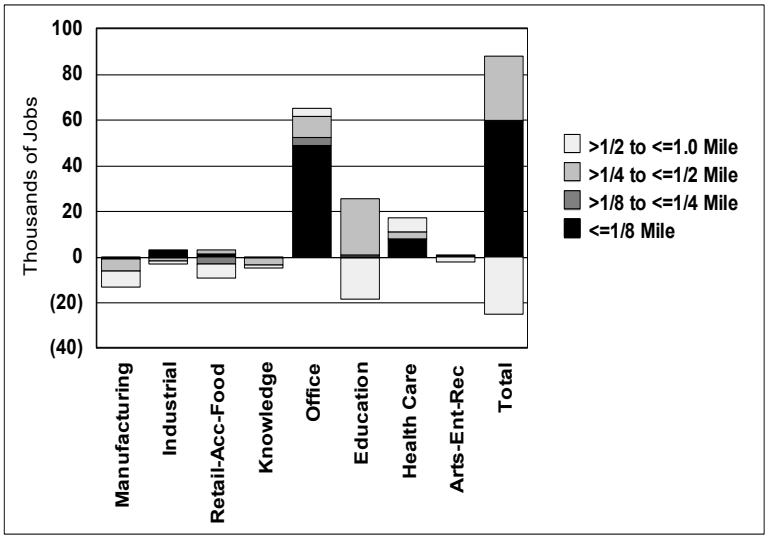
Table 3: Comparisons of Economic Group Job Change by BRT Station Distance Band Compared to Transit Counties, 2008-2011[71]

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.)

71. Derived from analysis by the author for this publication. The underlying data is published, and methods described, in Nelson et al., *supra* note 10.

Figure 4: Comparisons of Economic Group Job Change by BRT Station Distance Band, 2008-2011[72]



V. STREETCAR TRANSIT JOB LOCATION RESULTS

In contrast to the Nelson 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.[73] Moreover, America's streetcar systems serve mostly downtown or near-downtown areas, though the Portland system has 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.[74] 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 ten percent of the change in transit county jobs is located between one-quarter and one mile of SCT stations.

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72. *See supra* Table 3.

73. *See* Jeffrey Brown et al., *The Purpose, Function, and Performance of Streetcar Transit in Modern U.S. City: A Multiple-Case-Study Investigation*, MINETA TRANSP. INST. 18 (2015).

74. *See infra* Table 4.

Table 4: Comparisons of Economic Group Job Change by SCT Station Distance Band Compared to Transit Counties, 2008-2011[75]

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 SCT station area distance band outperformed the transit county as a whole. Unless italicized, all comparisons are significant at p <0.01.

Increasing market demand for downtown housing may be 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.[76]

Though the downtown housing market may be especially attracted to streetcars, displaced jobs may relocate not too far away. The more than thirty-four thousand new jobs added between 2008 and 2011 in the 1/4-1/2 mile band were one and a half times more jobs than the transit counties added as a whole. As depicted in Figure 4, those jobs were concentrated in the industrial, office, education, and health care economic groups, substantially consistent with transit county job growth overall.

Future research is needed to explore the role of downtown residential development in displacing jobs from close proximity to streetcar stations while increasing the downtown population.

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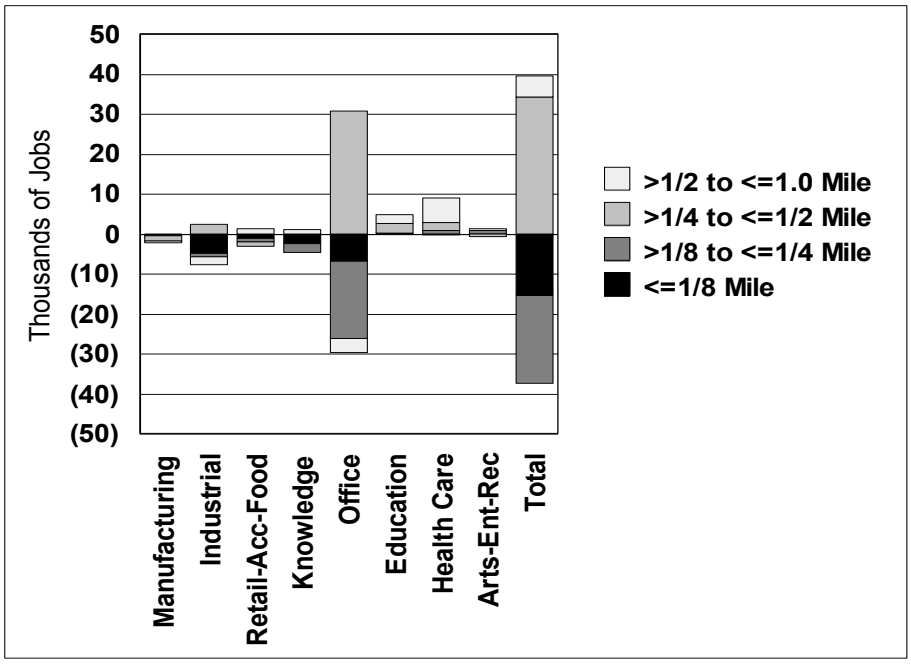
75. *See* Arthur C. Nelson et al., *supra* note 10; *see also* Nelson & Ganning, *supra* note 10.

76. *See* PWC & URBAN LAND INSTITUTE, EMERGING REAL ESTATE TRENDS: U.S. AND CANADA 6, 43 (2016).

Figure 5: Comparisons of Economic Group Job Change by SCT Station Distance Band, 2008-2011[77]



CONCLUSION

The Nelson research provides important evidence indicating the extent to which TODs influence the location of jobs within LRT, BRT, and SCT distance bands with respect to economic groups and relative to transit counties as a whole in the post-recession and recovery period. Table 5 summarizes these findings.

A comparison of transit systems indicates that each type has different associations with respect to change in jobs by economic group in the four distance bands up to one mile from transit stations. LRT systems have the most robust economic 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.

77. *See supra* Table 4.

Table 5: Summary of Economic Groups Direction of Association with Transit Station Proximity by Transit Type[78]

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.

The Nelson research is critical because, in addition to unveiling the positive associations between job change with respect to distance bands, it provides insight into negative associations that occur simultaneously. Negative associations can mean several things. First, they can mean that transit accessibility is more valuable to some firms than others such that they 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—or even by activities within the same economic group. Such land-intensive manufacturing activities as microbreweries can outbid other urban land uses for location near transit stations.

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. If losses closer to transit stations were proportionately less than those in the transit county, a logical conclusion would be that transit accessibility improves firms' productivity so they can remain in business at those locations, or even move from elsewhere to those locations. However, this is not the

78. *See supra* Tables 2-4.

case. 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. The implication is that locating near transit stations is more important to some economic groups than others, who are thus displaced. On the other hand, 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. Both outcomes may be explained by the differences in the effects of agglomeration economics on different economic activities. TODs may create agglomeration economies that attract firms from elsewhere to TOD areas and as those firms move in others move out because they cannot compete.

The first and second interpretations give rise to a third. Economic development planning may be advanced as follows: for a given transit mode and within a given distance band from a transit station, economic development planners may consider attracting firms in certain economic groups, but not in others.

There is also 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. To the extent 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. This is yet another area for future research.

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. New research will be needed to address the residential dimension of transit station land use impacts.

As two-thirds of the nation's nonresidential built environment and a fifth of its residential built environment will be redeveloped or otherwise repurposed by midcentury, America's metropolitan areas will be reshaped. The role of fixed guideway transit systems in facilitating this cannot be

understated. Consider that the share of total transportation trips attributable to fixed guideway transit systems seems to have increased since TOD planning took hold in the last quarter century. One reason, based on research, is that job markets respond to TODs substantially a mile away from fixed guideway transit stations—perhaps more. Research reported in this Article may guide TOD planning in ways that sustain growth in FGT use, if not accelerate it.