

Hiawatha Light Rail (Blue Line)

Minneapolis-St. Paul, Minnesota

Do TOD's Make a Difference?



THE UNIVERSITY OF UTAH

Metropolitan
Research
Center



OTREC
OREGON TRANSPORTATION RESEARCH
AND EDUCATION CONSORTIUM

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6/15/2014

Table of Contents

| | |
|---------------------------------------|----|
| 1-INTRODUCTION..... | 6 |
| Report Structure | 6 |
| 2-DATA AND METHODS | 7 |
| Selection of Treatment corridor | 7 |
| Creation of Comparable Corridors..... | 7 |
| Comparable Corridors Criteria | 8 |
| Data Source and Extent..... | 9 |
| Data Processing..... | 9 |
| Study Area..... | 10 |
| 3-EMPLOYMENT CONCENTRATION | 12 |
| Introduction | 12 |
| Data & Methods..... | 12 |
| Results | 12 |
| Discussion & Implications | 14 |
| 4-EMPLOYMENT GROWTH BY SECTOR | 16 |
| Introduction | 16 |
| Data and Methods | 16 |
| Results | 17 |
| Discussion & Implications | 18 |
| 5-EMPLOYMENT RESILIENCE..... | 20 |
| Introduction | 20 |
| Data and Methods | 20 |
| Results | 21 |
| Discussion & Implications | 24 |
| 6-HOUSING AFFORDABILITY | 26 |
| Introduction | 26 |
| Data and Methods | 26 |
| Data Source and Geography | 27 |
| Data Processing..... | 27 |

| | |
|---------------------------------|----|
| Results | 27 |
| Discussion & Implications | 30 |
| 7-JOB ACCESSIBILITY | 33 |
| Introduction | 33 |
| Data & Methods..... | 33 |
| Results..... | 34 |
| Overall Balance | 34 |
| Income Balance..... | 35 |
| Industry Balance..... | 37 |
| Discussion & Implications | 38 |
| 8-SUMMARY OF FINDINGS..... | 40 |
| 9-REFERENCES..... | 42 |
| 10-APPENDIX A | 44 |
| LEHD | 44 |
| Shift-Share Calculations | 44 |

Table of Figures

| | |
|--|----|
| FIGURE 1: EXAMPLE CORRIDOR, BUFFERS, AND LED CENSUS BLOCK POINTS | 9 |
| FIGURE 2: TRANSIT AND COMPARABLE CORRIDOR LOCATIONS..... | 11 |
| FIGURE 3: CHANGES IN LOCATION QUOTIENT BY CORRIDOR FOR THE TIME PERIOD AFTER THE ADVENT OF TRANSIT | 14 |
| FIGURE 4: REGRESSION TREND LINES AND R-SQUARED VALUES FOR DIFFERENT INDUSTRIES | 21 |
| FIGURE 5: HOUSING, TRANSPORTATION, AND H+T COSTS FOR THE TRANSIT CORRIDOR, 2009, BY BUFFER DISTANCE | 28 |
| FIGURE 6: CHANGE IN HOUSING AND TRANSPORTATION COSTS, 2000-2009, FOR TRANSIT CORRIDOR, BY BUFFER DISTANCE..... | 29 |
| FIGURE 7: CHANGES IN H+T, 2000-2009, FOR TRANSIT AND COMPARABLE CORRIDORS, BY BUFFER DISTANCE | 30 |

Table of Tables

| | |
|---|----|
| TABLE 1: LOCATION QUOTIENTS COMPARISON FOR TRANSIT CORRIDOR | 13 |
| TABLE 2: SHIFT-SHARE ANALYSIS FOR 0.5 MILE BUFFER OF TRANSIT CORRIDOR..... | 17 |
| TABLE 3: SHIFTS BY CORRIDOR AND COMPARISON BETWEEN CORRIDORS..... | 18 |
| TABLE 4: CHANGES IN EMPLOYMENT TRENDS FOR 0.5 MILE BUFFER OF THE TRANSIT CORRIDOR | 23 |
| TABLE 5: COMPARISON OF RESILIENCE BY CORRIDOR..... | 24 |
| TABLE 6: JOBS-HOUSING BALANCE FOR ALL INCOME CATEGORIES | 34 |
| TABLE 7: JOBS-HOUSING BALANCE BY INCOME CATEGORY | 36 |
| TABLE 8: JOB ACCESSIBILITY TRENDS OVER TIME BY INDUSTRY SECTOR AND CORRIDOR | 38 |

Acknowledgements

This project was funded by the Oregon Transportation Research and Education Consortium (OTREC) through a grant provided by the National Institute of Transportation and Communities (NITC). Cash match funding was provided by the Utah Transit Authority (UTA), Salt Lake County (SLCo), the Wasatch Front Regional Council (WFRC), and the Mountainlands Association of Governments (MAG). In-kind match was provided by the Department of City & Metropolitan Planning at the University of Utah, and by the Nohan A. Toulon School of Urban Affairs and Planning at Portland State University.

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PROJECT TITLE

Project Title:
DO TODs MAKE A DIFFERENCE?

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1-INTRODUCTION

This analysis was intended to help answer the following policy questions:

- Q1: Are TODs attractive to certain NAICS sectors?**
- Q2: Do TODs generate more jobs in certain NAICS sectors?**
- Q3: Are firms in TODs more resilient to economic downturns?**
- Q4: Do TODs create more affordable housing measured as H+T?**
- Q5: Do TODs improve job accessibility for those living in or near them?**

The first question investigates which types of industries are actually transit oriented. Best planning practices call for a mix of uses focused around housing and retail, but analysis provides some surprises. The second question tests the economic development effects of transit—do locations provided with transit actually experience employment growth? The third question is intended to determine the ability of employers near transit to resist losing jobs; or having lost jobs, to rapidly regain them.

The fourth research question confronts the issue of affordable housing and transit. Transit is often billed as a way to provide affordable housing by matching low-cost housing with employment. Yet proximity to transit stations is also expected to raise land values. Proximity to transit, however, may increase actual affordability, regardless of increases in housing costs, because of the reduction in transportation costs.

The final research question considers the relationship between workplace and residential locations. To be able to commute by transit, both the workplace and home must be near transit. Effective transit should increase both the number and share of workers who work and live along the transit corridor.

Report Structure

The rest of the report is structured as follows. The following section details the study area and corridors used for analysis in all of the research questions with each research question given its own section. Each section contains a short review of relevant research as well as a description of additional data sources and analytical techniques. Each section then provides relevant analysis, discussion of the analysis, and relevant conclusions. The report concludes with a summary of outcomes from each.

2-DATA AND METHODS

Data from before and after the opening of a transit line were analyzed to determine if the advent of transit causes a significant change in area conditions. To control for exogenous factors (such as things affecting the entire metro area), changes in transit corridors were then compared to changes in comparable corridors located in the same metropolitan region, matching length, location, mix of land uses, and suitability for transit. As corridors differ primarily in their lack of transit, the corridor matching represents a ‘natural experiment’, where one corridor receives the treatment (a fixed guide-way transit line) and the comparable corridor acts as a control. Because of the need to perform this matching, this study used the corridor as its unit of analysis rather than station points. For most transit systems, stations lie within a mile of one another, so the areas are quite similar. Without a network analysis of walking paths, exact distances to transit are difficult to determine.

The remainder of this section describes the selection of existing transit (treatment) corridors, the creation of comparable corridors, and the data used for analysis. It also provides an overview of the transit corridor being analyzed.

Selection of Treatment corridor

The process began with Center for Transit Oriented Development (CTOD)’s Transit Oriented Development (TOD) Database (July 2012 vintage). The database’s unit of analysis is the station. For each station there is information about the station’s location, providing both address and lat-long points. Station attributes include the transit agency for that station as well as the names of routes using that station. The database was enriched with the addition of transit modes for all stations since many transit stations serve more than one mode.

While the database contained routes, it did not identify the corridor for each station. Most transit routes make use of multiple corridors. While routes change in response to operational needs, a corridor consists of a common length of right-of-way that is shared by a series of stations on the corridor. Typically, all stations along a corridor begin active service at the same time. Transit systems grow by adding additional corridors to the network. Initial systems may consist of only a single corridor.

Distinct corridors for each system were identified on the basis of prior transportation reports (Alternative Analysis, Environmental Assessments, Environmental Impact Statements, Full Funding Grant Agreements) as well as reports in the popular media. Whenever possible, a corridor that started operation after 2002 but before 2007 was preferred. Stations relevant to analysis were then queried out, and imported into Google Earth as a series of points. Using aerial images, the path of the corridor was traced. The corridor was then exported as a KML file and imported into a geodatabase in ArcGIS.

Creation of Comparable Corridors

Numerous draft corridors were created and then compared with the existing transit corridor. The following criteria were used while creating a comparable corridor:

Comparable Corridors Criteria

1. Same MSA
2. Equal length
3. Existing transit route; express transit preferred
4. Direct; no doubling back
5. Anchored on both ends (unless the original line was not)
6. Anchors of equal magnitude; downtowns, transit centers, shopping centers, malls, etc.
7. Along a major corridor; major/minor arterial
8. Similar land use mix along the corridor; both corridors contain substantial commercial development
9. Conformity with existing rapid transit plans
10. Existing corridor; rail or highway
11. Similar relative nearness to a parallel freeway in both distance and degree
12. Commuter rail follows existing corridors; either rail or freeway

Keeping the comparable corridor in the same metro area reduced a large number of confounding effects. Maintaining the same length meant a similar amount of area was included in the analysis. Bus routes in analogous locations were used to create draft corridors. Because of their high cost per mile, rapid transit corridors tend to be direct. They also tend to be ‘stretched’ until they reach a reasonable terminus to anchor each end. Whenever possible, the type and magnitude of each anchor used was matched.

For comparable corridors, the emphasis was placed on creating corridors that were contiguous and followed a continuous existing right-of-way that was viable as a transit corridor. Availability of right-of-way was the primary concern, and this dictated either existing major roads or existing railway right-of-way. For the former, highways and major arterials were preferred. For the latter, this meant the majority of right-of-way needed to follow an existing rail corridor. Whenever possible, proposed or future corridors from official planning documents were used, with some limitations.

For all commuter rail systems and most light rail corridors, the availability of right-of-way determines the location of the transit line. For many rail lines, this means that the transit corridor is located alongside incompatible or inappropriate uses, such as light industrial or low density single family residential units. These characteristics affect station accessibility. The mix of land uses along the corridor affects ridership in other ways. For instance, commercial locations generate more trips per acre than either residential or industrial uses, so similar levels of commercial exposure were sought in creating comparable corridors.

Finally, proximity to freeways was matched. The benefits ascribed to TOD are on the basis of the improved accessibility provided by transit. Because freeways also provide accessibility, the confounding effect of proximity to a competing mode can be considerable.

Data Source and Extent

The data used originated from the Census Local Employment-Housing Dynamics (LEHD) datasets. Both the Local Employment Dynamics (LED) and LEHD Origin-Destination Employment Statistics (LODES) were used. Employment data are classified using the North American Industrial Classification System (NAICS), and data are available for each Census Block at the two-digit summary level. Data were downloaded for all years available (2002-2011). The geographic units of analysis are 2010 Census Blocks Points. The database contains information on employment within each block. The data were downloaded from <http://onthemap.ces.census.gov/> for each metro area, using the CBSA (Core Based Statistical Area) definitions of Metropolitan/Micropolitan. In cases where either the transit or comparable corridor extended beyond a CBSA metro area, adjacent counties were included to create an expanded metropolitan area.

There is a vast difference between TOD, and Transit Adjacent Development (TAD). The latter refers to any development happens to occur within the Transit Station Area (TSA), or 0.5-mile buffer around a fixed guide-way transit station, while the former refers to land uses and built environment characteristics hospitable to transit. This analysis assumes that while the existing development during the year of initial operations (YOIO) may not be TOD, land uses respond to changes in transportation conditions over time, phasing out TAD and replacing it with TOD. On this basis, the TOD is conflated with TSA for the purpose of this analysis.

Data Processing

ArcGIS was used to create a series of buffers around each corridor in 0.25-mile increments. Those buffers were then used to select the centroid point of the LED block groups within those buffers, and summarize the totals. Because the location of census block points varies from year to year (for reasons of non-disclosure), it was necessary to make a spatial selection of points within the buffer for each year rather than using the same points each year. Figure 1 shows an example corridor, the buffers around the corridor, and the location of LED points in reference to both.

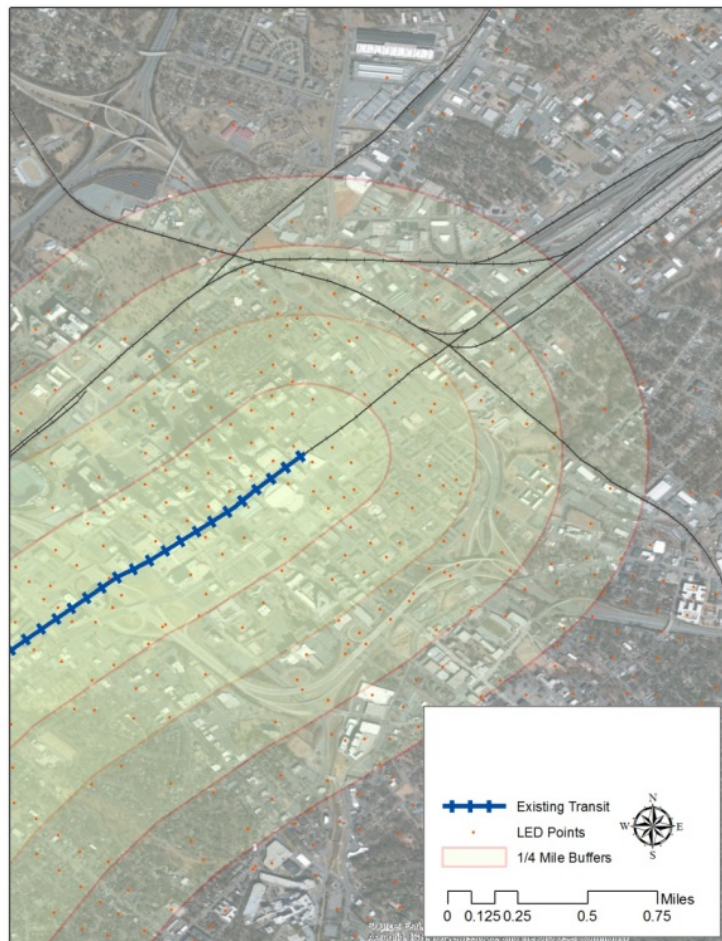


Figure 1: Example corridor, buffers, and LED census block points

Study Area

This study examines a portion of Metro Transit's light rail system. The corridor under analysis is the Hiawatha Corridor, now part of the Blue line. It is 9.4 miles long, with 14 stations. It entered operation in early 2004. It connects downtown Minneapolis to the Minneapolis-St. Paul International Airport. The section of the line connecting to the Mall of America was completed later and was not included in this analysis. The comparable corridor analyzed represents a section of the planned Southwest Corridor. The corridor begins in Minneapolis, and then follows an existing road corridor toward St. Louis Park, then toward Hopkins, ending at Shady Oak road, for a 9-mile corridor. [Figure 2](#) shows the transit and comparable corridors as well as the location of LED points.

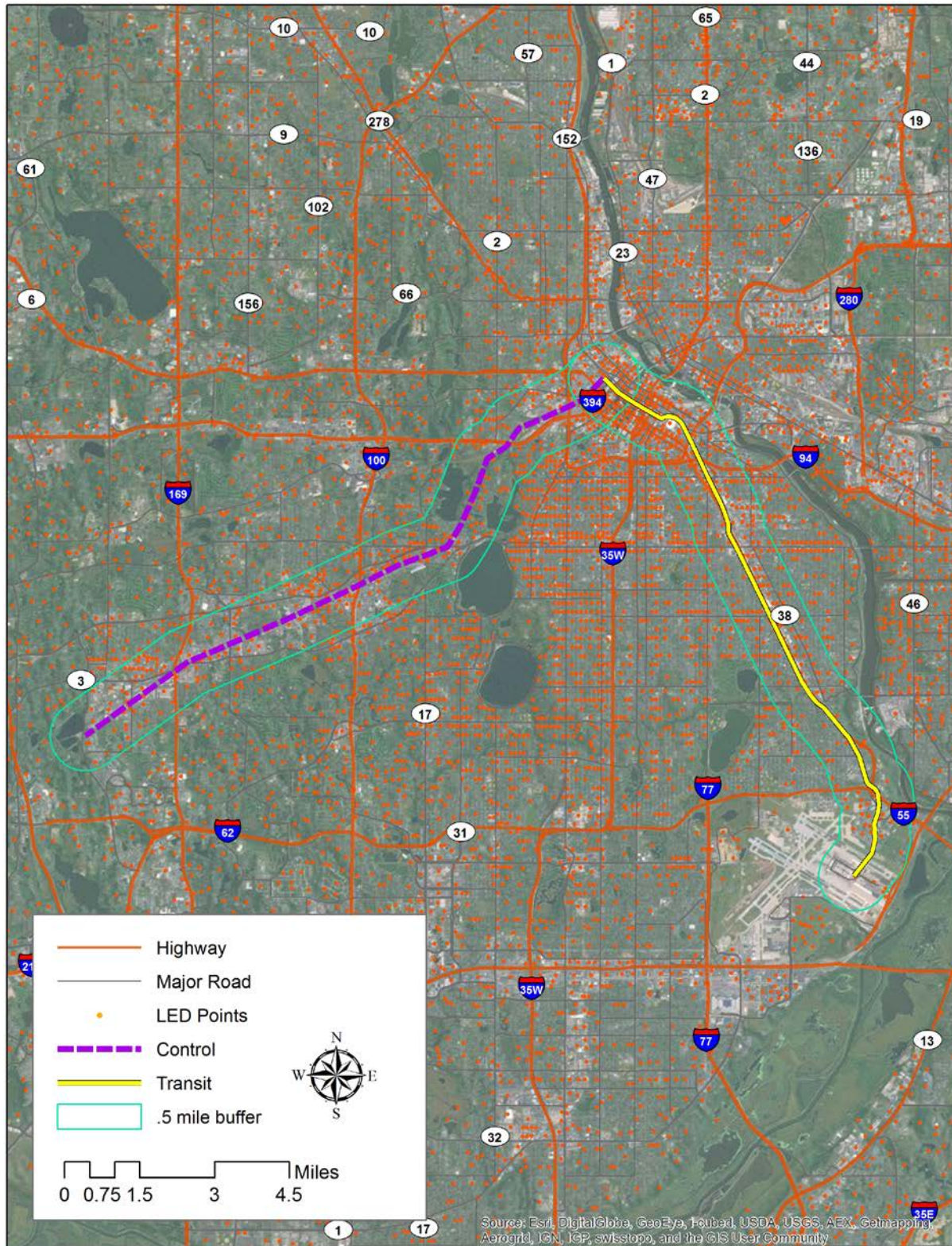


Figure 2: Transit and comparable corridor locations

3-EMPLOYMENT CONCENTRATION

Introduction

This section is intended to determine if TODs are more attractive to certain NACICS industry sectors. Case studies indicate that economic development and land use intensification are associated with heavy rail transit (HRT) development (Cervero et al. 2004; Arrington & Cervero 2008). Case studies associated with light rail transit (LRT) have inconsistent results, suggesting that much of the employment growth associated with transit stations tends to occur before a transit station opens (Kolko 2011). A study by CTOD (2011) examined employment in areas served by fixed guide-way transit systems, and explored how major economic sectors vary in their propensity to locate near stations, finding high capture rates in the Utilities, Information, and Art/Entertainment/Recreation industry sectors.

Data & Methods

To analyze the difference in the attractiveness of TODs, location quotient was used to analyze the concentration of different industries over time. Location quotient is a calculation that compares the number of jobs in each industry in the area of interest to a larger reference economy for each corridor. The analysis then compares the location quotients of each industry between each corridor. A 0.5-mile buffer around each corridor was used as the unit of analysis.

Results

The location quotients within a 0.5-mile buffer for the transit corridor is shown in [Table 1](#). Location quotients are shown for the first and final years, with a sparkline to show trends between the years. Changes in location quotient between the 2002 and the advent of transit are calculated, as well as the advent of transit and 2011. The final column is the difference between the changes in the two periods.

| Industry | Location Quotient | | | Changes | | Differences in Changes | |
|-----------------|-------------------|-----------|------|-------------|-------------|---------------------------|--|
| | 2002 | 2002-2011 | 2011 | Δ 2002-2004 | Δ 2004-2011 | Δ 2002-2004 & Δ 2004-2011 | |
| Utilities | 3.30 | | 7.08 | -0.68 | 4.46 | 5.14 | |
| Construction | 0.52 | | 1.33 | -0.05 | 0.87 | 0.92 | |
| Manufacturing | 0.27 | | 0.21 | -0.07 | 0.01 | 0.08 | |
| Wholesale | 0.62 | | 0.39 | 0.07 | -0.30 | -0.37 | |
| Retail | 0.59 | | 0.33 | -0.07 | -0.19 | -0.12 | |
| Transportation | 1.05 | | 0.72 | 0.03 | -0.36 | -0.38 | |
| Information | 2.72 | | 2.54 | 0.39 | -0.57 | -0.96 | |
| Finance | 3.04 | | 2.55 | -0.21 | -0.29 | -0.08 | |
| Real Estate | 1.22 | | 2.00 | 0.56 | 0.21 | -0.36 | |
| Professional | 2.81 | | 2.58 | -0.34 | 0.11 | 0.45 | |
| Management | 1.22 | | 0.53 | -0.22 | -0.48 | -0.26 | |
| Administrative | 1.24 | | 1.12 | -0.02 | -0.10 | -0.08 | |
| Education | 0.15 | | 0.32 | -0.05 | 0.21 | 0.25 | |
| Health Care | 0.40 | | 0.85 | 0.15 | 0.29 | 0.14 | |
| Arts, Ent. Rec. | 0.95 | | 1.16 | 0.13 | 0.08 | -0.06 | |
| Lodging & Food | 0.87 | | 0.98 | 0.01 | 0.10 | 0.09 | |
| Other Services | 0.98 | | 0.68 | 0.07 | -0.36 | -0.43 | |
| Public Admin | 1.12 | | 1.21 | 0.67 | -0.59 | -1.26 | |

Table 1: Location quotients comparison for transit corridor

For the transit corridor, after the advent of transit (2004-2011), the most significant increases in location quotient occur in the Utilities industry, followed by the Construction industry. The Health Care, Education and Real Estate industries also realize minor increases in location quotients.

Differences between the two time periods (2002-2004 and 2004-2011) show the differences between location quotient before and after transit. A positive number indicates that the differences in location quotient is better after transit than before. The difference in changes highlights the Utilities and Construction industries again, but also suggests that the Professional and Education industries benefit from proximity to transit. The Information and Public Administration industries experience declining location quotients after the advent of transit, either as a result of employment losses or as a result of increasing employment elsewhere in the region. The sparklines show that the Retail industry also began to decline at about the same time as the beginning of transit corridor operations, while the Education industry has a strong upswing around this same time.

For both the transit and comparable corridors, changes in location quotient for the time period after the advent of transit are shown in Figure 3. Only some industries benefit from proximity to the transit corridor. Industries that benefit from proximity to transit should experience larger increases in location quotient in the transit corridor than in the comparable corridor. The y-axis shows numeric change in location quotient.

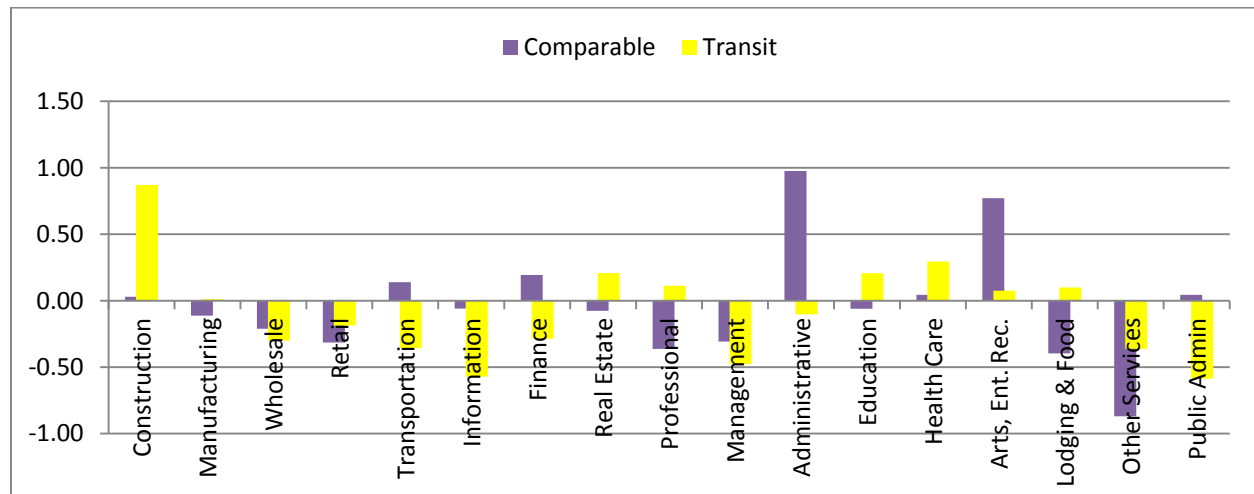


Figure 3: Changes in location quotient by corridor for the time period after the advent of transit

Because the magnitude of effect of the Utilities industry outweighs other trends, it has been omitted from the chart to improve the visual comparability between the corridors. While the Utility industry does extremely well inside the transit corridor, it does even better within the comparable corridor.

The location quotients for all industries vary significantly by corridor. The location quotient declined for most industries in the transit corridor, but increased strongly for a few corridors. Contrast with the comparable corridor confirms the success of the Construction industry, as well as Education and Health Care, all of which do better in the transit corridor. The relative difference between the two corridors also makes notable the relative success of Lodging/Food and Professional industries in the transit corridor. While they experience only moderate increases, the comparable corridor experiences substantial decreases. Even the decline in Other Services is mitigated by comparison with the transit corridor.

Discussion & Implications

The Hiawatha corridor displays some highly atypical results for a transit line. Manufacturing employment is associated with low density industrial land, rather than transit oriented development. More typically, industrial development is displaced by denser, higher value land uses when transit is developed nearby. Closer investigation typically reveals that such uses represent Transit ADJACENT Development rather than Transit ORIENTED Development. The built environment changes slowly, and embedded infrastructure is one of the most difficult land uses to shift.

Attributing causal effect to transit lines is always problematic. Designing successful transit networks is largely a game of connect-the-dots, linking together major employment centers with employee housing along congested corridors. Many stations are co-established with new campuses for major institutions, or at public events venues, so increases in the Health Care and Education industries can be explained. The timing of the upswing in the Education industry supports this.

Which industry sectors do well near transit corridors is not simply a function of proximity to transit. Increases in location quotients near transit may be confounded by the effect of freeway proximity, which is far more important to most industries than transit access. Secondly, while transit may be an amenity which offers competitive advantage to some industries, that does not mean that transit is the only necessary requisite. Transit may enhance a good location, but may not be able to change a bad location into an acceptable one.

4-EMPLOYMENT GROWTH BY SECTOR

Introduction

This section is intended to determine if TODs generate more jobs in certain NAICS sectors. To determine if the new jobs are actually created as a result of proximity to transit, it is necessary to determine what portion of changes in employment can be attributed to transit and what portion of changes is determined by other factors.

In theory, employment in different NAICS sectors should be variable depending on the NAICS code, as some industry sectors are better able to take advantage of the improved accessibility offered by transit. For example, industries in which employment is characterized by low-income workers in need of affordable transportation or salaried office workers with long distance commutes are more likely to make use of transit. Likewise, arts and entertainment venues prone to serious congestion (due to their high peaks of visitors) would also benefit. Finally, institutions with large parking demands (universities, colleges, hospitals, and some government offices) could be expected to find proximity to transit valuable.

It is difficult to determine to what degree employment growth is caused by location near transit, and what is a product of self-selection, as rapidly growing industry sectors locate next to transit. Shift-Share analysis helps answer this question.

Data and Methods

A shift-share analysis attempts to identify the sources of regional economic changes to determine industries where a local economy has a competitive advantage over its regional context. Shift-share separates the regional economic changes within each industry into different categories and assigns a portion of that the change to each category. For the purpose of this analysis, these categories are Metropolitan Growth Effect, Industry Mix, and the Corridor Share Effect.

1. Metropolitan Growth Effect is the portion of the change attributed to the total growth of the metropolitan economy. It is equal to the percent change in employment within the area of analysis that would have occurred if the local area had changed by the same amount as the metropolitan economy.
2. Industry Mix Effect is the portion of the change attributed to the performance of each industrial sector. It is equal to the expected change in industry sector employment if employment within the area of analysis had grown at the same rate as the industry sector at the metropolitan scale (less the Metropolitan Growth Effect).
3. Corridor Share Effect is the portion of the change attributed to location in the corridor. The remainder of change in employment (after controlling for metropolitan growth and shifts in the industry mix) is apportioned to this variable. Within regions, some areas grow faster than others, typically as a result of local competitive advantage. While the source of competitive advantage cannot be exactly identified, the methods of analysis used suggest that the cause of

competitive advantage can be directly attributed to the presence of transit, or factors leveraged by the presence of transit.

Results

A shift-share analysis of changes in employment within a 0.5-mile buffer of the transit corridor is presented in [Table 2](#). The first batch of columns shows numeric and percentage changes in the metropolitan area, and the second batch of columns shows the numeric and percentage changes in the buffer around the transit corridor. The third batch of columns is the actual shift-share analysis, and apportions the numeric change in the buffer around the corridor. The shift-share analysis is representative of a 0.5-mile buffer around the transit corridor.

| NAICS Sector | Metro | | | | Transit Corridor | | | | Sources of Employment Change | | |
|-----------------|------------------|------------------|---------------|-----------|------------------|----------------|--------------|-----------|------------------------------|--------------------|-----------------|
| | 2004 | 2011 | # Change | % Change | 2004 | 2011 | # Change | % Change | Metro Share | Industry Mix Share | Corridor Effect |
| Utilities | 6,799 | 9,281 | 2,482 | 37% | 1,626 | 6,157 | 4,531 | 0% | 25 | 594 | 3,913 |
| Construction | 78,995 | 60,938 | (18,057) | -23% | 3,334 | 7,609 | 4,275 | 128% | 51 | (762) | 4,986 |
| Manufacturing | 190,200 | 182,442 | (7,758) | -4% | 3,382 | 3,532 | 150 | 4% | 52 | (138) | 236 |
| Wholesale | 100,969 | 92,393 | (8,576) | -8% | 6,415 | 3,418 | (2,997) | -47% | 98 | (545) | (2,550) |
| Retail | 179,773 | 168,398 | (11,375) | -6% | 8,520 | 5,241 | (3,279) | -38% | 130 | (539) | (2,870) |
| Transportation | 52,763 | 41,404 | (11,359) | -22% | 5,195 | 2,797 | (2,398) | -46% | 79 | (1,118) | (1,359) |
| Information | 48,899 | 39,400 | (9,499) | -19% | 13,877 | 9,362 | (4,515) | -33% | 211 | (2,696) | (2,031) |
| Finance | 98,132 | 97,429 | (703) | -1% | 25,407 | 23,267 | (2,140) | -8% | 387 | (182) | (2,345) |
| Real Estate | 34,985 | 36,300 | 1,315 | 4% | 5,715 | 6,789 | 1,074 | 19% | 87 | 215 | 772 |
| Professional | 96,961 | 109,728 | 12,767 | 13% | 21,848 | 26,526 | 4,678 | 21% | 333 | 2,877 | 1,468 |
| Management | 81,745 | 72,012 | (9,733) | -12% | 7,528 | 3,582 | (3,946) | -52% | 115 | (896) | (3,164) |
| Administrative | 95,356 | 102,643 | 7,287 | 8% | 10,655 | 10,779 | 124 | 1% | 162 | 814 | (853) |
| Education | 137,684 | 155,565 | 17,881 | 13% | 1,374 | 4,596 | 3,222 | 234% | 21 | 178 | 3,023 |
| Health Care | 196,803 | 245,272 | 48,469 | 25% | 9,927 | 19,459 | 9,532 | 96% | 151 | 2,445 | 6,936 |
| Arts, Ent. Rec. | 25,384 | 27,756 | 2,372 | 9% | 2,518 | 3,022 | 504 | 20% | 38 | 235 | 230 |
| Lodging & Food | 128,321 | 128,136 | (185) | 0% | 10,373 | 11,813 | 1,440 | 14% | 158 | (15) | 1,297 |
| Other Services | 57,921 | 60,439 | 2,518 | 4% | 5,508 | 3,845 | (1,663) | -30% | 84 | 239 | (1,986) |
| Public Admin | 61,053 | 68,644 | 7,591 | 12% | 9,994 | 7,753 | (2,241) | -22% | 152 | 1,243 | (3,636) |
| Total | 1,672,743 | 1,698,180 | 25,437 | 2% | 153,196 | 159,547 | 6,351 | 4% | 2,333 | 1,949 | 2,069 |

Table 2: Shift-share analysis for 0.5 mile buffer of transit corridor

The entire metropolitan area enjoys a minor increase in employment of 2 percent. The transit corridor does yet better, with an increase in employment of about 5 percent. This still represents an increase of over 6,000 jobs. In numeric terms, the Health Care industry enjoys the largest increase, but the Utilities, Construction, and Professional industries all rack up increases of over 3,000 jobs. In addition, Education enjoys a substantial percent increase, as does Construction and Health Care. Numerous industries experience dramatic changes in employment, losing thousands of jobs, representing double digit changes in employment, most notably Information and Retail.

After using Shift-Share analysis to disaggregate the cause of change in employment, different patterns emerge. About a third of the change in employment can be attributed to metro-scale trends, and another third to the Industry Mix within the corridor, and a third to the Corridor Effect.

The Corridor Effect has its strongest positive effect on the Health Care industry, followed by the Construction industry, followed by the Utilities industry. Other industries that appear to benefit from

the Corridor Effect are Education and Professional, but not all industries benefit from the Corridor Effect. The industries to suffer declines due to the Corridor Effect are the same as those listed earlier.

Information about the Corridor Effect is presented for both the transit and comparable corridor in [Table 3](#). Differences between the corridors are also presented. It is intended to confirm that the corridor effects attributed to transit are specific to the transit corridor, and not the result of another effect. The 'Corridor Benefit' relates the change in employment totals to the change due to the Corridor Effect. It is calculated as the corridor effect divided by the absolute value of employment change. A value of 1 indicates that almost all the change can be attributed to the corridor effect, while a value of 0 means that the corridor has almost no effect.

| Industry | Comparable | | | Transit | | | Transit Advantage | | |
|-----------------|-------------|-----------------|------------------|-------------|-----------------|------------------|----------------------|-----------------------------|------------------------------|
| | # Change | Corridor Effect | Corridor Benefit | # Change | Corridor Effect | Corridor Benefit | Difference, # Change | Difference, Corridor Effect | Difference, Corridor Benefit |
| Utilities | 4230 | 3435 | 0.8 | 4531 | 3913 | 0.9 | 301 | 478 | 0.1 |
| Construction | 233 | 142 | 0.6 | 4275 | 4986 | 1.2 | 4508 | 4844 | 0.6 |
| Manufacturing | 828 | 729 | -0.9 | 150 | 236 | 1.6 | 978 | 965 | 2.5 |
| Wholesale | 993 | 643 | -0.6 | 2997 | 2550 | -0.9 | 2004 | 1907 | -0.2 |
| Retail | 2379 | 2010 | -0.8 | 3279 | 2870 | -0.9 | 1900 | 1859 | 0.0 |
| Transportation | 103 | 291 | 2.8 | 2398 | 1359 | -0.6 | 2501 | 1650 | -3.4 |
| Information | 364 | 35 | -0.1 | 3515 | 2031 | -0.4 | 4151 | 1995 | -0.4 |
| Finance | 1100 | 1064 | 1.0 | 2140 | 2345 | -1.1 | 3240 | 3409 | -2.1 |
| Real Estate | 37 | 43 | -1.2 | 1074 | 772 | 0.7 | 1037 | 815 | 1.9 |
| Professional | 860 | 1161 | -3.2 | 4678 | 1468 | 0.3 | 4318 | 2630 | 3.5 |
| Management | 1119 | 897 | -0.8 | 3946 | 3164 | -0.8 | 2827 | 2267 | 0.0 |
| Administrative | 4900 | 4639 | 0.9 | 124 | 853 | -6.9 | 4776 | 5491 | -7.8 |
| Education | 204 | 242 | -1.2 | 3222 | 3023 | 0.9 | 3018 | 3265 | 2.1 |
| Health Care | 2828 | 961 | 0.3 | 9532 | 6936 | 0.7 | 6704 | 9975 | 0.4 |
| Arts, Ent. Rec. | 1225 | 1049 | 0.9 | 504 | 230 | 0.5 | 1721 | 1819 | -0.4 |
| Lodging & Food | 1703 | 1824 | -1.1 | 1440 | 1297 | 0.9 | 3143 | 3121 | 2.0 |
| Other Services | 1815 | 2095 | -1.2 | 1663 | 1986 | -1.2 | 152 | 108 | 0.0 |
| Public Admin | 233 | 164 | 0.7 | 2241 | 3636 | -1.6 | 2474 | 3799 | -2.3 |
| Total | 5786 | 2066 | na | 6351 | 2069 | na | 565 | 3 | na |

Table 3: Shifts by corridor and comparison between corridors

That the Corridor Effect is specific to transit can be discerned by contrasts with the comparable corridor. The Corridor Benefit aids in comparison by providing a metric that is independent of the magnitude of employment. The Corridor Effect is provided for both as a reference. The Corridor Benefit for the transit corridor is much larger for the Professional, Manufacturing, Education, and Lodging/Food industries, but for all but Education this is due to poor results in the comparable corridor. Contrast confirms the Construction and Professional industries increase as specific to the transit corridor. In terms of the differences in the corridor effect, the dominance of the Health Care industry is asserted, and the Manufacturing industry is confirmed again. The Education industry does well, although the Public Administration industry does extremely poorly. Examining the difference in changes column only serves to confirm these findings.

Discussion & Implications

All evidence suggests that the Hiawatha line is light rail done right. Of all the light rail system in America, the Hiawatha corridor has the greatest empirical claim to inducing growth. Many light rails systems

claim improvements that can be attributed largely to collateral downtown redevelopment efforts, but the Hiawatha line shows clear trends in employment growth over an extended period of time, and focused around a limited number of industries, indicating that the development is in fact transit oriented, rather than a general benefit from transit accessibility.

The Health Care and Education industries have been mainstays of not only urban redevelopment, but also of new transit lines. While it has long been theorized that retail and office development are transit oriented, empirical evidence suggests that this is incorrect. Rather, the main beneficiaries of transit oriented development appear to be campus style developments such as hospitals and schools. Entertainment venues are also (erratically) big winners for proximity to transit. In effect, every land use characterized by high parking ratios, and thus big parking lots, is attracted to transit. Transit not only enables such uses to manage peak loads for parking, it reduces their land costs, and makes it possible to locate in central urban locations.

While the improvements in the Lodging/Food industry results from access to the downtown core and proximity to the airport, the increases in the Manufacturing and Utilities industries are far more difficult to explain. They are likely confounders. Almost all light rail systems make use of pre-existing railroad right of way, which has a pre-existing warehouse and industrial uses associated with it. These uses endure after the advent of transit, typically in the interstice between station areas.

5-EMPLOYMENT RESILIENCE

Introduction

Resilience is defined as the ability to absorb and recover from shocks or disruptions. Resilient systems are characterized by diversity and redundancy. The resilience of employment is a critical factor in community economic health. For many communities, the loss of a single primary employer can be catastrophic, resulting in a state of sustained collapse. Employment resilience is the capacity to recover from such disruptions, due to locational characteristics.

Access to transit can help improve employment resilience because proximity to transit is a source of competitive advantage for some industries. Firms located near transit also benefit from reduced employee and visitor parking needs. This translates into an ability to economize on the size of parcels required, both reducing costs and increasing the number of viable sites for business locations.

Transit provides a mechanism to meet transportation needs and unusual or unexpected conditions, such as an automobile breakdown or lower income, and it provides alternate transportation options during conditions that impair other modes, such as weather, construction projects, or accident-induced delay. It also provides accessibility to a population unable to drive such as the young, the elderly, and the poor (VPTI 2014). These factors act to reduce tardiness and absenteeism, thus reducing employment turnover.

Transit also helps create ‘thick’ markets for employment, whereby employees can match themselves to numerous different employment opportunities. This reduces the time necessary to find matches, unemployment duration, and the unemployment rate.

Data and Methods

An interrupted time series was used to compare the resilience of employment in both areas to determine if proximity to transit represents a locational advantage. An interrupted time series divides a time series dataset into two time series with the datasets separated by an ‘interruption’ and compares the differences. For the purpose of this analysis, the interruption is the Great Recession, considered to have begun in 2007.

If an interruption has a causal impact, the second half of the time series will display a significantly different regression coefficient than the first half. Failure to be adversely affected by a severe economic shock indicates employment resilience. A low R-squared (R^2) represents larger variability in total employment. Industry sectors with a high R^2 demonstrate robust trends, indicating that employment failed to change regardless of the effects on the larger economy. The regression coefficient represents the relationships between the change in variables, and the R^2 explains how much of the variance in the data is explained by the regression equation—a measure of the ‘goodness’ of the regression.

Results

A line graph of the employment by industry time series is presented in Figure 4. The time series (2002-2011) for each is interrupted in 2008. The vertical axis shows total employment in each industry sector along the corridor. Illustrative regression lines with R^2 values have been added for some of the industries. The trend lines and associated R^2 values for all industry sectors can be found in Table 4.

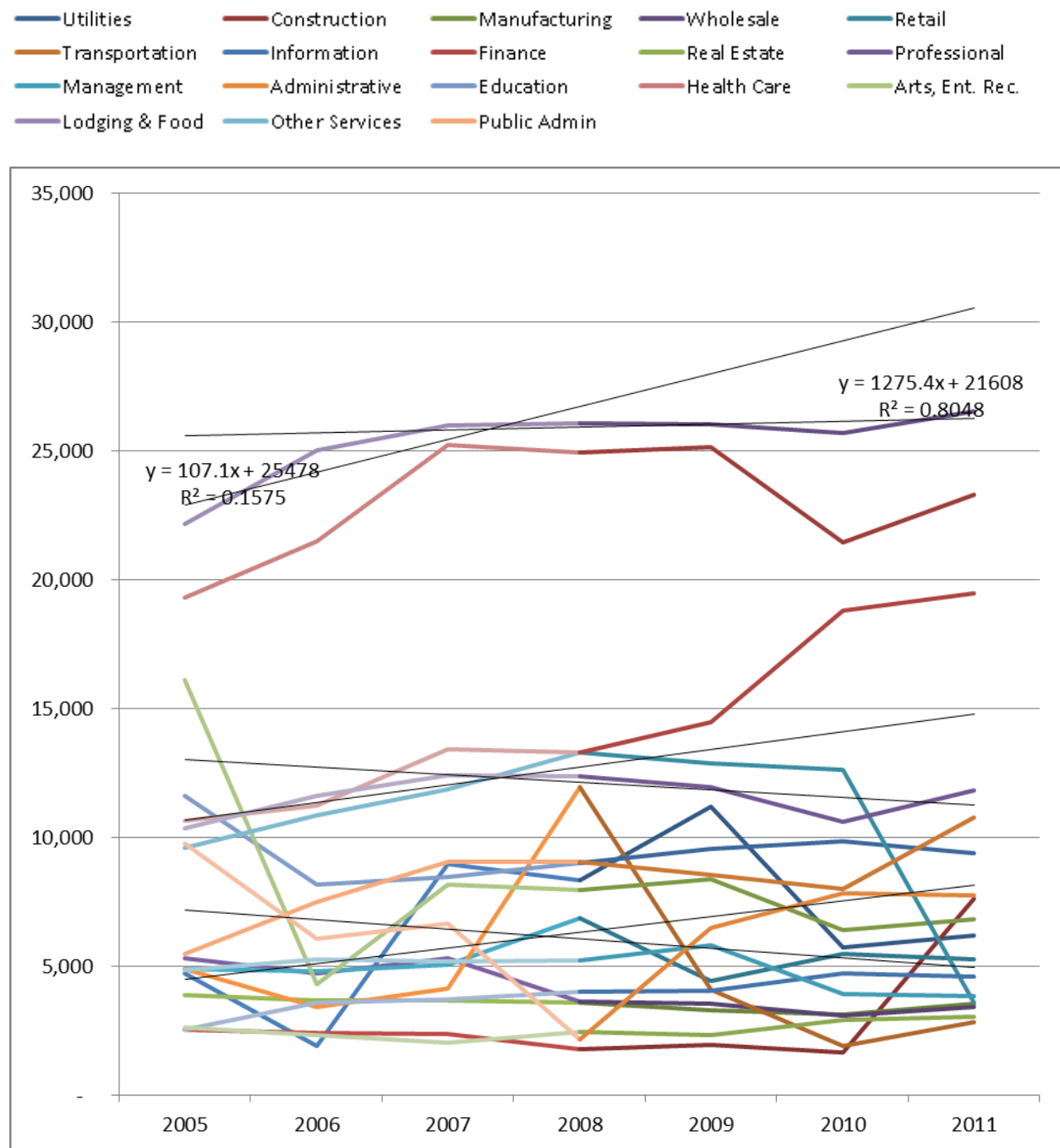


Figure 4: Regression trend lines and R-squared values for different industries

As the graph shows, industry employment varies by year, with many industries affected by substantial fluctuations in employment, both before and after the recession. While visual inspection is valuable, more rigorous interpretation is necessary.

Resilience by industry is presented in [Table 4](#). It highlights the resilience of different industries between 2002-2008 and 2008-2011. The trend number is the linear regression line on industry employment over time. Trends indicate whether total employment increases or decreases during each time period. A negative trend indicates sustained loss of employment while a positive trend indicates a sustained gain. The trend number is the slope of the regression line. However, industries with larger total employment will have larger slopes. To normalize trend numbers for comparison between industries, the trend percent is presented. It is calculated by dividing the trend number for a time period by the average employment for that period. Finally, the R^2 column indicates how strong a trend is. Industry sectors with a high R^2 demonstrate robust trends—trends in employment change that are consistent over time with less tendency to fluctuate.

The change in the trend between the two time periods is given in the differences column. A positive value for the trend number represents a change from employment loss to employment gain, or a reduction in the rate of decline in employment for that industry. The change in strength of trend is given by the R^2 column. A positive value indicates that a previously erratic trend has become more consistent. A negative value means a previously consistent trend has become more erratic.

| Industry | 2005-2008 | | | 2008-2011 | | | Differences | | |
|-----------------|-----------|---------|------|-----------|---------|------|-------------|---------|-------|
| | Trend # | Trend % | R2 | Trend # | Trend % | R2 | Trend # | Trend % | R2 |
| Utilities | 1787 | 30% | 0.49 | -189 | -1% | 0.38 | -2976 | -45% | -0.11 |
| Construction | -234 | -10% | 0.76 | 1731 | 54% | 0.59 | 1965 | 64% | -0.17 |
| Manufacturing | -79 | -2% | 0.83 | -33 | -1% | 0.04 | 46 | 1% | -0.79 |
| Wholesale | -449 | -9% | 0.54 | -108 | -3% | 0.34 | 341 | 6% | -0.20 |
| Retail | 611 | 11% | 0.66 | -375 | -7% | 0.23 | -986 | -18% | -0.43 |
| Transportation | 2191 | 36% | 0.51 | -2958 | -57% | 0.69 | -5149 | -93% | 0.18 |
| Information | -755 | -8% | 0.38 | 139 | 1% | 0.26 | 894 | 10% | -0.12 |
| Finance | 2054 | 9% | 0.87 | -860 | -4% | 0.42 | -2914 | -13% | -0.45 |
| Real Estate | -2057 | -23% | 0.29 | -542 | -7% | 0.57 | 1515 | 15% | 0.29 |
| Professional | 1275 | 5% | 0.80 | 107 | 0% | 0.16 | -1168 | -5% | -0.65 |
| Management | 1211 | 11% | 1.00 | -2937 | -28% | 0.66 | -4148 | -38% | -0.34 |
| Administrative | 1232 | 16% | 0.87 | 466 | 5% | 0.25 | -767 | -11% | -0.63 |
| Education | 452 | 13% | 0.84 | 250 | 6% | 0.75 | -202 | -7% | -0.09 |
| Health Care | 1001 | 8% | 0.85 | 2289 | 14% | 0.92 | 1287 | 6% | 0.07 |
| Arts, Ent. Rec. | -78 | -3% | 0.16 | 231 | 9% | 0.77 | 309 | 12% | 0.61 |
| Lodging & Food | 689 | 6% | 0.84 | -296 | -3% | 0.26 | -985 | -8% | -0.59 |
| Other Services | 116 | 2% | 0.51 | -607 | -13% | 0.64 | -722 | -15% | 0.13 |
| Public Admin | -2219 | -36% | 0.84 | 1817 | 30% | 0.77 | 4036 | 66% | -0.07 |
| Total | 6751 | 4% | 0.50 | 2877 | -2% | 0.47 | -9628 | -6% | -0.03 |

Table 4: Changes in employment trends for 0.5 mile buffer of the transit corridor

Prior to 2008, only a few industries had falling employment, although those which did had very negative trends, particularly the Real Estate and Public Administration industries. The Transportation and Finance industries were growing strongly.

During the 2008 to 2011 period, many industries had falling employment, but a number of industries continued to have strong positive trends. Numerically, the Health Care, Public Administration and Construction industries all had positive employment trends. All three industries also had strong positive Trend %, and high R² values.

The difference between the pre- and post- recessionary periods should reveal which industries are resilient. Resilient industries should have positive trends for both periods. By this criteria, very few industries are resilient, with the notable exception of the Health Care industry.

In addition to resilient industries, there are industries that are emergent. They represent a phase shift or transition away from pre-recession industrial ecology and toward a new and different one. Emergent industries are characterized by flat or falling trends prior to the recession, but large positive trends following the recession. Industries that characterize this pattern are Construction, Real Estate and Public Administration.

Comparing R² values of different industries before and after the Great Recession makes it possible to determine the consistency of trends. Trend numbers represent a line fitted to the data points, an averaging value of sorts, which only track general trends. R² is a kind of meta-measure of that measure. It indicates that the trend consistently increases for the Health Care and Real Estate industries, but

declines for Construction and Public Administration. However, the positive changes for the Real Estate industry are a result of doing less badly than of doing well, and should be disregarded.

The same trend information for a comparable corridor is presented [Table 5](#). Industries with similar trends and trend strengths in both corridors are likely due to factors affecting both corridors, such as metropolitan scale trends.

| Industry | Differences | | | | | | Differences in Differences | | |
|-----------------|-------------|---------|-------|------------|---------|-------|----------------------------|---------|-------|
| | Transit | | | Comparable | | | | | |
| | Trend # | Trend % | R2 | Trend # | Trend % | R2 | Trend # | Trend % | R2 |
| Utilities | -2976 | -45% | -0.11 | 620 | 12% | 0.93 | -3596 | -57% | -1.05 |
| Construction | 1965 | 64% | -0.17 | -197 | -12% | 0.57 | 2162 | 75% | -0.74 |
| Manufacturing | 46 | 1% | -0.79 | 18 | -1% | -0.04 | 28 | 2% | -0.75 |
| Wholesale | 341 | 6% | -0.20 | 229 | 5% | -0.69 | 112 | 1% | 0.49 |
| Retail | -966 | -18% | -0.43 | -768 | -15% | -0.77 | -218 | -3% | 0.34 |
| Transportation | -5149 | -93% | 0.18 | -277 | -27% | 0.81 | -4873 | -66% | -0.14 |
| Information | 894 | 10% | -0.12 | 33 | 2% | 0.11 | 861 | 8% | -0.23 |
| Finance | -2914 | -13% | -0.25 | -500 | -13% | -0.93 | -2414 | 0% | 0.48 |
| Real Estate | 1515 | 15% | 0.29 | 46 | -3% | -0.28 | 1561 | 18% | 0.56 |
| Professional | -1168 | -5% | -0.65 | -543 | -5% | 0.03 | -625 | 0% | -0.68 |
| Management | -4148 | -38% | -0.34 | 10 | 2% | 0.59 | -4159 | -40% | -1.03 |
| Administrative | -767 | -11% | -0.63 | 1124 | 24% | 0.29 | -1891 | -35% | -0.91 |
| Education | -202 | -7% | -0.09 | 17 | 0% | -0.05 | -219 | -3% | -0.04 |
| Health Care | 1287 | 6% | 0.07 | -324 | -4% | -0.72 | 1611 | 9% | 0.79 |
| Arts, Ent. Rec. | 309 | 12% | 0.61 | 377 | 17% | 0.84 | -68 | -5% | -0.23 |
| Lodging & Food | -985 | -8% | -0.59 | -703 | -9% | 0.24 | -282 | 1% | -0.83 |
| Other Services | -722 | -15% | 0.13 | -528 | -14% | 0.51 | -194 | -1% | -0.39 |
| Public Admin | 4036 | 66% | -0.07 | 98 | 16% | 0.48 | 3938 | 50% | -0.56 |
| Total | -9628 | -6% | -0.03 | -1365 | -2% | -0.43 | -8263 | -4% | 0.40 |

Table 5: Comparison of resilience by corridor

Comparison of the two corridors suggests that the transit corridor is overall significantly less resilient than the comparable corridor, suffering much worse as a result of the Great Recession. However, the transit corridor has the advantage in a large number of industries. The Construction and Public Administration do much better in the transit corridor, as does Health Care. The comparable corridor highlights the Information industry as doing atypically well. Comparing R^2 values between the two corridors suggests that the trend for the Health Care industry is also unusually strong.

Discussion & Implications

To be resilient is to have the capacity to endure shocks and recover to a previous equilibrium. That equilibrium may refer to a prior employment level, or to a prior employment trend.

Prior to the recession, the Construction industry was a mainstay of many economies. Atypically, the Construction industry does better in the Twin Cities after the recession than before. Growth in the Education, Public Administration and Health Care industries has been a near-constant for post-recessionary urban centers, but in addition the Twin Cities displays an atypical pattern where Administrative and Arts/Entertainment/Recreation also do better after the Great Recession. Because the Hiawatha Corridor runs into downtown, it may be picking up the effect of high culture arts venues.

Such venues are typically relocated into proximity to transit as a way of reducing parking demands, thus reducing land costs and making downtown locations feasible alternatives for space-hungry entertainment venues.

Some caveats are necessary. Employment in any industry sector is variable over time, and the amount of variability increases with smaller geographic units of analysis. Because the geographic unit of analysis is small, the amount of fluctuation is larger. Changes might 'average out' over a larger unit of geographic aggregation and may have significant effects. In a given year, the relocation of a single firm or the addition of a new building would be sufficient to dramatically change employment trends in any industry. Finally, the area within a 0.5-mile buffer is fixed, so new development requires the displacement of existing development. The new development may employ workers in different industries, or new residential development may replace existing employment.

6-HOUSING AFFORDABILITY

Introduction

It is not always possible to maintain a supply of affordable housing for a growing population by adding housing at the urban periphery. Such locations are the furthest from employment and services, requiring long distance travel to meet basic needs. Total cost of automobile ownership is considerable, given not only the cost of the automobile itself, but also the operations and maintenance costs associated with fuel, insurance, and repairs. Housing in exurban locations may be cheap without actually being affordable.

It is necessary for housing affordability to include both housing and transportation costs ($H + T$). Housing costs do not exist in isolation but within the context of transportation costs. While housing in an urban location with transit access may cost more than suburban housing, it may still be more affordable once the effect of associated transportation costs has been taken into account. Low-income households tend to spend a high proportion of their income on basic transportation (VPTI 2012). Faced with high transportation costs, close proximity to public transit networks is an effective solution. Populations in poverty remain concentrated in central cities partially because such locations enjoy high quality public transit (Glaeser et al 2008).

While the effects of heavy rail transit on housing affordability have been extensively researched, the effects of non-heavy rail TOD on housing affordability are mixed. Matching low-income employment to high-income housing fails to improve housing affordability, and matching high-income employment to low-income housing may actually decrease affordability through gentrification-induced displacement. Maintaining affordable housing through TODs may require the allocation of affordable housing resources (NAHB 2010). A review of the hedonic literature reporting the price effects of transit stations on housing suggests that TODs may be an anathema to the provision of affordable housing, given their propensity to increase housing values (Bartholomew and Ewing 2011).

Calthorpe (1993) initially proposed a ten-minute walk, or about a 0.5-mile radius, as the ideal size for a TOD. Empirical studies confirm that while the majority of walk trips occur for distances of or equal to 0.5 miles, the effects of proximity to transit can be detected out to 1.5 miles away (Nelson 2011). Access to fixed guide-way transit systems is frequently by non-walk modes such as bicycle, bus, and automobile. The characteristics of the built environment within a mile buffer of a station can still affect transit ridership (Guerra, Cervero, & Tischler 2011).

Data and Methods

This section describes the data used for analysis, and the techniques used to process and analyze the data. Unlike all other analysis contained in this report, the $H+T$ analysis included data from multiple 0.25-mile buffers, not just a single 0.5-mile buffer. Doing so makes it possible to relate the magnitude of the effect of proximity to transit. Near things are more related than distant things (Tobler 1970). This makes it possible to track the relationship between magnitude of effect and proximity to transit. The area within the smallest buffers should show the strongest reaction.

Data Source and Geography

This study uses the Housing + Transportation (H+T) Affordability Index developed by the Center for Neighborhood Technology (CNT). The Index was initially developed for St. Paul, Minnesota in 2006. By the end of the 2006 year, the Center for Housing Policy had expanded the H+T index to include 28 metropolitan areas. With support from the Brookings Institution, it was expanded to 52 metropolitan areas in 2008. In March 2010, CNT included additional metros in the index, for a total of 337 metropolitan areas. The H+T Index has since been expanded to include almost 900 metro areas. The 2010 vintage was used for this analysis.

The unit of analysis for the dataset is the 2000 Decennial Census Block Group. The data extent is the Census 2000 Metropolitan Areas. The H+T Index was developed using Decennial Census 2000 data, and then expanded to a time series format using data from the American Community Survey five-year estimates, 2009 vintage. Differences in Census data collection procedures means the two dataseries are not directly comparable. As a result, transportation costs were calculated using the National Median Income. This may result in over-estimation or underestimation of the value transportation cost amounts, but suffices for the purpose of trend detection.

This analysis makes use of five characteristics: Transportation Costs, Transportation Costs as a Percent of Income, Housing Costs, Housing Cost as a Percent of Income, and H+T costs as a Percent of Income. Data from both the 2000 and 2009 time periods were used.

Data Processing

Census Block Groups represent an unacceptably large geography for transit relevant analysis. It was necessary to devise an alternative to determining buffer membership by selecting a centroid. Instead, ArcGIS was used to create a series of buffers around each corridor, in 0.25-mile increments, out to 2 miles. Those buffers were then used to clip the block groups. The H+T characteristics of each block were then weighted by geographic ratio, which is the ratio between the area of the block group, and the area of the portion of the block group that was within a buffer. For instance, if a block group represented 3 percent of the area in the buffer, H+T characteristics for that block group received a weight of 3 percent. The weighted variables were then summed to obtain a geographically weighted value for the buffer.

For the purpose of comparison, a metro H+T Index was devised. Because the metropolitan area contains all census blocks, characteristics could not be weighted by area. Nor would it have been appropriate to do so. Census block groups are intended to contain similar amounts of population, rather than volumes of area, so the size of Census block groups varies by orders of magnitude. Consequently, the comparison H+T Index value for the metro area was calculated by weighting the block group characteristics by Census 2000 block group population. This weighted average is intended to provide a referent for what are normal H+T values for the metropolitan area.

Results

The change in housing and transportation (H+T) costs are presented below with three results presented:

1. Housing, Transportation, and H+T dollar costs for the transit corridor
2. Change in H+T costs for transit corridors

3. Change in H+T costs for transit and comparable corridors

For interpreting the CNT H+T Affordability Index, housing is considered affordable if total housing and transportation costs do not exceed 45 percent of income.

The 2009 combined housing, transportation, and H+T dollar costs for the transit corridor are shown in [Figure 5](#). The vertical axis shows the dollar cost of housing and transportation. The horizontal axis shows how the total varies by buffer distance from the transit corridor.

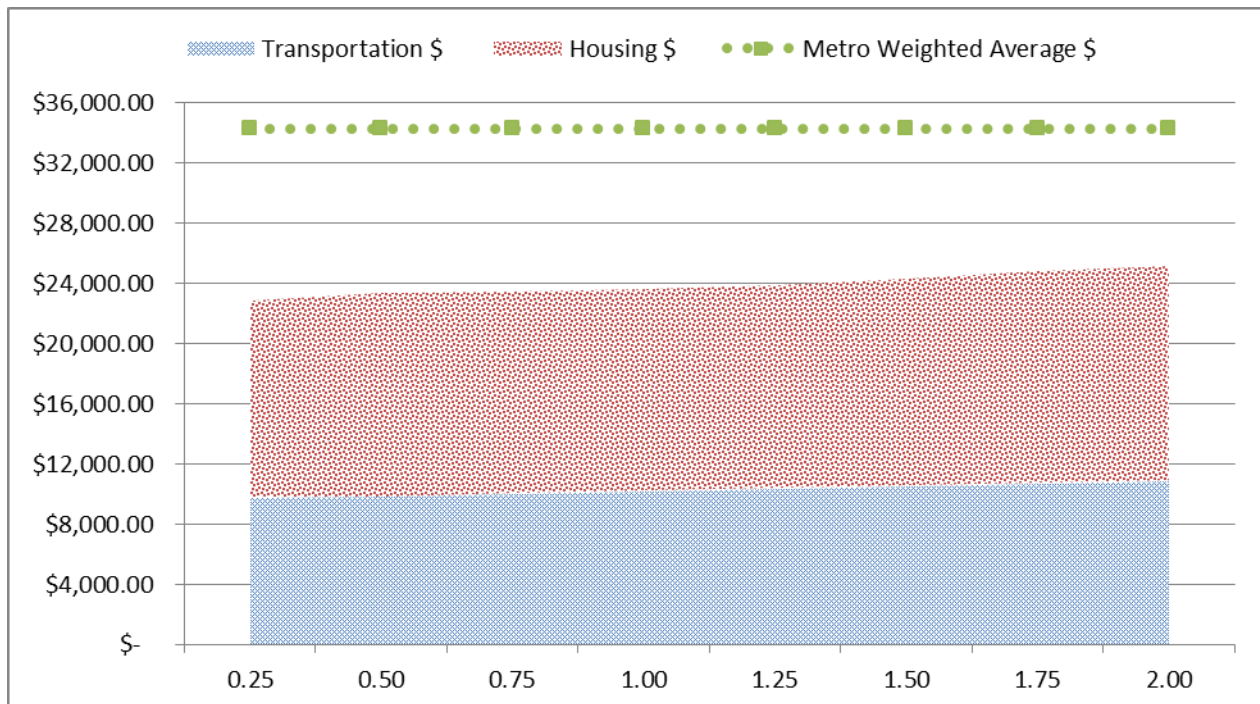


Figure 5: Housing, transportation, and H+T costs for the transit corridor, 2009, by buffer distance

As the above graph shows, H+T costs near the transit line are lower than the metropolitan average. Housing costs are lower nearer to the transit line. Differences in transit costs they are perceptibly lower nearer the transit corridor.

Percentage point changes in housing, transportation, and H+T costs are shown below in [Figure 6](#). The changes represent the difference in the percentage of income calculated to be necessary for housing and transportation expenditures. A stacked graph has been used to display the disaggregated effects of housing and transportation on H+T affordability. The vertical axis shows the change in percentage points needed to meet housing and transportation costs. The horizontal axis shows how the total varies by buffer distance from the transit corridor. The time series analysis is intended to show if changes in H+T cost respond to proximity to transit.

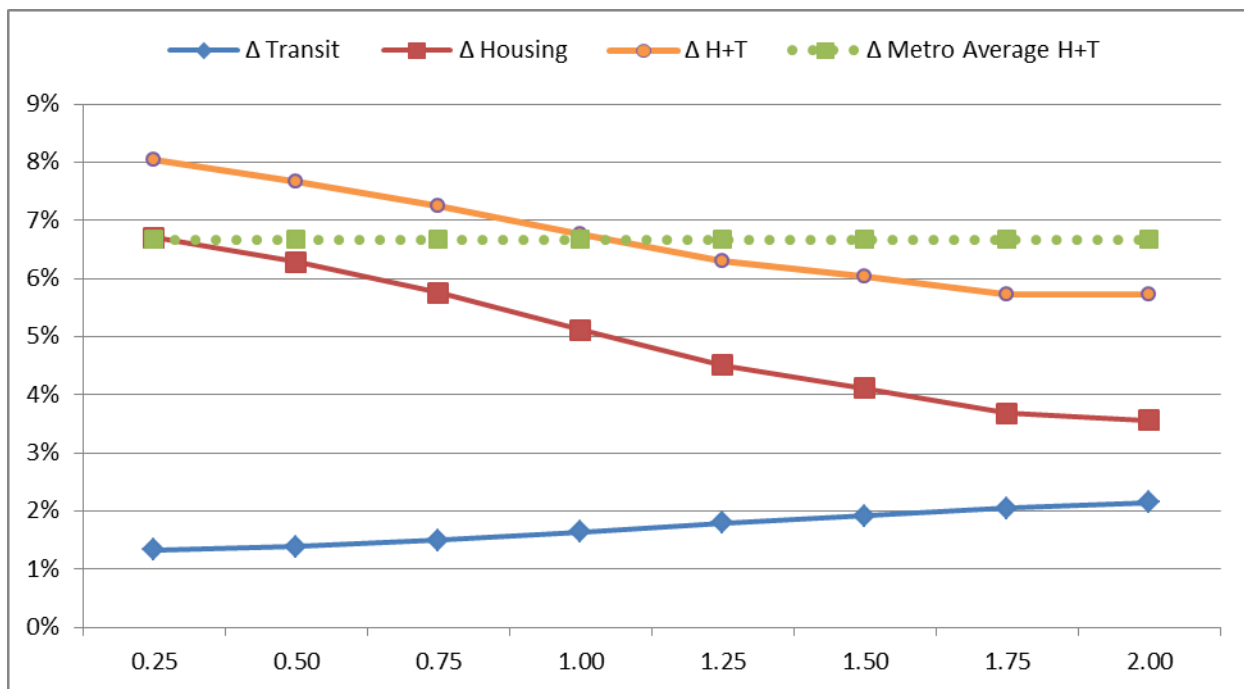


Figure 6: Change in housing and transportation costs, 2000-2009, for transit corridor, by buffer distance

The changes in H+T costs for the transit corridor are notably dissimilar to the metropolitan area average. Changes in H+T costs vary with distance to the transit corridor. Changes in the transportation costs in the transit corridor are smaller than changes in housing costs, but still vary significantly with distance from the transit corridor by almost a full percentage point. Housing costs display a consistent pattern in relation to proximity to the transit corridor. They rise with proximity to the light rail line, for all buffers except the 2.0-mile buffer. The higher changes in housing costs near the transit corridor are not fully offset by the difference in transportation costs, so that the total H+T costs near the transit corridor is higher than the metropolitan area average.

Percentage point changes in housing, transportation, and H+T costs for the transit corridor, comparable corridor, and metro area are shown below in Figure 7. The vertical axis shows the change in percentage points needed to meet housing and transportation costs. The horizontal axis shows how the total varies by buffer distance from the transit corridor.

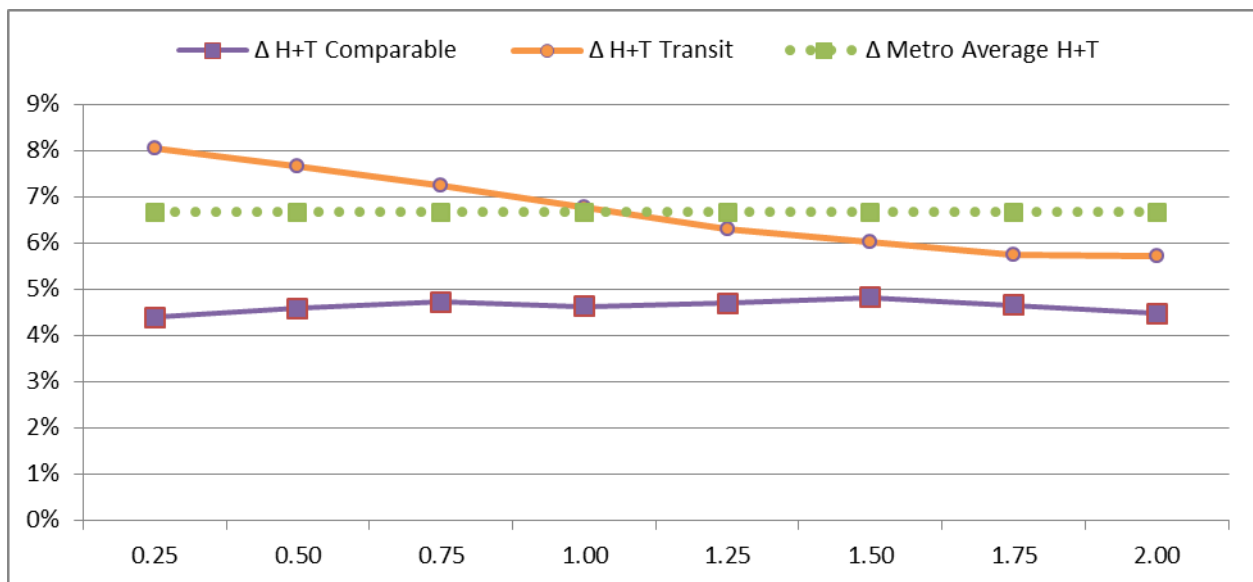


Figure 7: Changes in H+T, 2000-2009, for transit and comparable corridors, by buffer distance

The transit and comparable corridors display significantly different patterns in changes in H+T costs. The transit corridor experiences much higher increases in H+T costs than the comparable corridor for all buffer distances. For the transit corridor, the change in H+T cost is largest near the transit station, while the comparable corridor is nearly flat, displaying not consistent pattern.

Discussion & Implications

These results are incredibly exciting, as they confirm two theoretical assumptions about transit. Theoretically, the value of the additional accessibility generated by proximity to transit should be capitalized into property value, resulting in rising housing costs. The strongest response to transit should be in the areas closest to the transit station. The pattern of increases in housing costs matches this relationship. The increases in housing costs are greatest near the transit line. The cause of the increase can be attributed to rising housing costs suggesting that the value of the accessibility provided by the Hiawatha light rail is being capitalized into housing values. This can be partially explained by congestion in the Minneapolis-St. Paul metropolitan area, which is already some of the worst in the nation, and is predicted to worsen. Access to faster, cheaper and more reliable rapid transit becomes more valuable.

The value of reliability is often understated. The primary transit market is typically thought of as low-income transit dependent households. But for rapid transit, there exists a second distinct market of workers with high enough incomes to both afford cars and access to desirable transit proximate locations, as an alternate if conditions favor its use. Rapid transit is less prone to delay from weather, accidents, or congestion. Travel time along a freeway corridor varies radically by conditions and by time of day. Many of the most congested corridors are barely sub-critical—even minor disruptions in traffic flow can trigger gridlock.

This suggests that rather than improving housing affordability, transit actually impair its. While this has been empirically demonstrated repeatedly, the extended hypothesis has been that reductions in

transportation costs actually offset the increase in housing case. Evidence from the Hiawatha line suggests that while transportation costs do respond to proximity to the light rail, the effect is insufficient to counter the increase in housing values.

The continued rise in housing prices above the value of transportation costs can be explained by household and housing lifecycles. The effect of increasing H+T costs is compounded by tenure type. Housing affordability issues are most severe in locations where renting is the primary form of tenure. Renters, unlike owners, are not insulated against increases in housing costs. Rental tenure in America is characterized by short leases, so increases in property value can rapidly be capitalized into higher rents. Rising rents increase housing costs, resulting in the displacement of previous tenants, who are no longer able to afford the higher rents. In contrast, mortgage payments are fixed upon purchase, so that current homeowners are largely isolated from the effects of increases in housing costs. The primary cause of declining affordability for existing homeowners is increasing property taxes, of which homeowners pay only a fraction of the increase in value.

The percent of homeowners also acts to confound actual housing affordability conditions. In the past decade, the appreciation in home value has outstripped appreciation in wages so that many current homeowners could no longer afford to buy their own homes. While they are affordable for the current owners, their appreciated value makes them less affordable to prospective owners. Over time, this compounds housing affordability issues. Lower housing affordability means that fewer households are able to become home owners, and must remain renters. They thus remain vulnerable to further increases in housing costs. As rents rise, so does the premium associated with home ownership, so that households are willing to pay more for property. Cities with high monthly rents also have high property prices for a reason.

Policy intervention is necessary to ensure that housing locations near transit stations remain affordable. Without measures to maintain housing affordability, areas around transit stations will see the displacement of low-income renters in favor of medium income owners. There is a strong negative relationship between income and transit ridership, as low-income households are more likely to be transit dependent, so this process acts to reduce transit ridership. Changes in the distribution of tenure will also reduce the benefits of self-selection. Households locating near transit self-select for proximity to transit, and are thus the types of households most likely to make use of transit.

Over time, as household characteristics, such as place of work and size of household change, the utility of proximity to transit changes. A single person household is extremely likely to be able to make use of transit, while a two-worker family household is less likely to be able to do so. Unable to make use of transit, such households would then require multiple vehicles, resulting in transportation costs in line with the metropolitan norm. In a worst case scenario, housing units around transit stations are owned by non-transit using households and yet suffer from higher average housing costs. In contrast, households in rental tenure are more likely to relocate in response to changing conditions, so that even if housing costs rise, transit ridership suffers less.

Long term, ensuring a supply of affordable transit oriented housing near stations will require policy intervention. The amount of affordable housing that is constructed is minimal. Most affordable housing results from the depreciation of former medium income housing. Constructing new housing as infill development requires higher density housing than the surrounding urban fabric, because the land value

has increased in the interval since the initial development of the area. Constructing new affordable housing requires higher densities, due to the lower return per unit. In combination with parking requirements, new affordable housing is required to 'go vertical' to achieve sufficient density.

Reducing or eliminating parking minimums near transit stations would be an effective policy. Reduced parking would lower per-unit cost of new affordable housing, and reduce the tendency to convert affordable transit oriented rental units to unaffordable transit indifferent owner-occupied units.

7-JOB ACCESSIBILITY

Introduction

Commuters have the ability to travel long distances more rapidly by fixed guide-way transit, making it possible to connect to destinations that are otherwise too distant. TOD is based on the premise that locating housing and employment in close proximity to transit stations will significantly enhance the accessibility of those locations. Because each transit line connects multiple stations, it creates a Transit Oriented Corridor (TOC) where people can live or work near any station and use the rapid transit system to access destinations at any other station along the corridor. Therefore, transit oriented development should significantly enhance employment accessibility along the corridor.

To achieve jobs-housing balance, there should be a rough proportionality between the amount of employment and the amount of housing. However, merely matching the total number of jobs and housing along a corridor is not enough. In recent years, the jobs-housing balance has been refined to include how well jobs (by income) are matched to housing (by income), to ensure that people working in the corridor can afford to live in the corridor. Proximity to light rail stations and bus stops offering rail connections is associated with low-wage job accessibility, but proximity to bus networks alone does not show the same correlation (Fan 2012). To check the degree of match between employment and residence, this analysis controls for both low and high wages. To further check for the degree of match, it compares the occupation balance of how well the number of people employed in the corridor matches the number of people residing in the corridor. If an industry is making heavy use of transit along the corridor, the numbers should be near equivalent.

If transit has a positive effect on jobs-housing balance, there should be a detectable change in the employment resident balance for both wage categories and for all occupation categories. Comparing the changes in these balances to the comparable corridor will ensure that the effect is contingent upon the transit corridor rather than metropolitan trends.

Data & Methods

The data used comes from the Census Local Employment-Housing Dynamics (LEHD) data source, using the Local Employment Dynamics (LED) datasets. Because the LODES data contains both place of employment and place of residence, it is possible to aggregate data to obtain both workplace area characteristics (WAC) and residential area characteristics (RAC). The ratio between the total workers at these different geographies was used as the jobs-housing balance. Corridors with better jobs-housing balance were presumed to have better job accessibility.

Three analyses were performed to determine job accessibility within the corridors: overall jobs-housing balance, jobs-housing balance by earnings category, and jobs-housing balance by industry. In addition to providing total number of employees per Census Block, the LED employment data are classified by earnings category. The LED classifies income by monthly earnings, into the following categories:

- \$1250/month or less
- \$1251/month to \$3333/month
- Greater than \$3333/month

The categories have been treated as low-medium-high income classifications. The actual monthly values are less significant than changes over time in the distribution of each of the categories in proximity to the transit corridor. LED employment data are also classified by industry using NAICS at the two-digit summary level.

ArcGIS was used to create a series of buffers around each corridor in 0.25-mile increments. Those buffers were then used to select the centroid point of the LED block groups within those buffers, and summarize the totals. Because the location of census block points varies from year to year (for reasons of non-disclosure), it was necessary to make a spatial selection of points within the buffer for each year, rather than using the same points each year. For this analysis, the 0.5-mile buffer was used.

Results

Overall jobs-housing balance for the existing transit and comparable corridor are presented below in Table 6 for each year. The ratio column indicates the ratio of workers who are employed within the corridor to the number of workers residing in the corridor. The year-on-year change for ratios is also presented. Sparklines at the bottom show the trend for each column. Years for which the transit system is in operation are shaded.

Overall Balance

The jobs-housing ratio at the metropolitan level represents a balanced level of jobs to workers. Comparing that value to the jobs-housing ratio for each corridor demonstrates how far out of balance both corridors are. Ideally, the addition of transit (years of operation highlighted in pink) should make the jobs-housing ratio more similar to the metropolitan level ratio.




| Year | Metro | | | Comparable | | | | Transit | | | | Year |
|-------|---|-------------|--------------------|---|-------------|--------------------|---------------------|---|-------------|--------------------|---------------------|-------|
| | Work, 000's | Home, 000's | Jobs-Housing Ratio | Work, 000's | Home, 000's | Jobs-Housing Ratio | Year on Year Change | Work, 000's | Home, 000's | Jobs-Housing Ratio | Year on Year Change | |
| 2002 | 714 | 699 | 1.02 | 54.9 | 22.5 | 2.44 | 0.00 | 36.5 | 20.8 | 1.76 | 0.00 | 2002 |
| 2003 | 739 | 725 | 1.02 | 55.5 | 21.9 | 2.54 | 0.09 | 36.4 | 20.4 | 1.78 | 0.02 | 2003 |
| 2004 | 786 | 773 | 1.02 | 59.1 | 22.1 | 2.68 | 0.14 | 35.2 | 20.8 | 1.69 | -0.09 | 2004 |
| 2005 | 851 | 834 | 1.02 | 60.5 | 23.7 | 2.55 | -0.13 | 41.5 | 23.4 | 1.77 | 0.07 | 2005 |
| 2006 | 897 | 878 | 1.02 | 61.4 | 25.6 | 2.40 | -0.16 | 40.8 | 25.3 | 1.61 | -0.16 | 2006 |
| 2007 | 918 | 899 | 1.02 | 58.5 | 22.8 | 2.57 | 0.17 | 41.4 | 22.3 | 1.85 | 0.24 | 2007 |
| 2008 | 901 | 879 | 1.02 | 58.4 | 20.8 | 2.80 | 0.24 | 41.5 | 20.0 | 2.07 | 0.22 | 2008 |
| 2009 | 823 | 804 | 1.02 | 52.2 | 21.7 | 2.41 | -0.39 | 38.7 | 18.8 | 2.06 | -0.01 | 2009 |
| 2010 | 807 | 788 | 1.02 | 50.0 | 16.9 | 2.95 | 0.54 | 37.8 | 15.0 | 2.52 | 0.46 | 2010 |
| 2011 | 819 | 799 | 1.02 | 89.7 | 16.4 | 5.46 | 2.51 | 34 | 15.5 | 2.19 | -0.33 | 2011 |
| Trend |  | | |  | | | |  | | | | Trend |

Table 6: Jobs-housing balance for all income categories

The overall jobs-housing ratio for both the comparable and transit corridors is relatively job-rich. The transit corridor has 1 to 2 times as many jobs per worker than the metropolitan area. The ratio does not significantly change with the advent of transit in 2004. There are big changes in 2011, which can be attributed to a drop in the number of workers living in the corridor. The comparable corridor is more

job-rich, with a jobs-housing ratio between 2 and 3. It has similar year on year changes than the transit corridor, barring a large surge of employment in 2011.

Income Balance

Jobs-housing balance by earnings category improves on the overall jobs-housing balance, as the overall jobs-housing ratio provides only a rough metric of the degree to which residents are matched to places of work within a corridor. Matching low income residents to high income workplaces will not increase job accessibility. Comparing the jobs-housing ratio by income category makes it possible to gauge not just the overall improvement in jobs-housing balance, but which earnings categories benefit the most from proximity to transit. To determine the degree to which an earnings-specific match is accomplished, [Table 7](#) compares the jobs-housing balance to the earnings category.

| Low Income | | | | | | | | | | | | |
|---------------|-------------|-------------|--------------------|-------------|-------------|--------------------|---------------------|-------------|-------------|--------------------|---------------------|-------|
| Year | Metro | | | Comparable | | | | Transit | | | | Year |
| | Work, 000's | Home, 000's | Jobs-Housing Ratio | Work, 000's | Home, 000's | Jobs-Housing Ratio | Year on Year Change | Work, 000's | Home, 000's | Jobs-Housing Ratio | Year on Year Change | |
| 2002 | 191 | 186.10 | 1.03 | 14.9 | 6.9 | 2.15 | 0.00 | 7.3 | 6.8 | 1.07 | 0.00 | 2002 |
| 2003 | 191 | 185.93 | 1.03 | 14.4 | 6.5 | 2.20 | 0.05 | 7.3 | 6.4 | 1.14 | 0.07 | 2003 |
| 2004 | 203 | 199.03 | 1.02 | 14.6 | 6.6 | 2.21 | 0.02 | 7.5 | 6.8 | 1.11 | -0.03 | 2004 |
| 2005 | 218 | 213.20 | 1.02 | 15.3 | 6.9 | 2.21 | 0.00 | 9.5 | 7.6 | 1.25 | 0.14 | 2005 |
| 2006 | 221 | 215.34 | 1.03 | 14.7 | 7.4 | 1.98 | -0.23 | 9.0 | 7.9 | 1.14 | -0.11 | 2006 |
| 2007 | 214 | 209.45 | 1.02 | 14.9 | 6.2 | 2.39 | 0.41 | 7.9 | 6.5 | 1.22 | 0.08 | 2007 |
| 2008 | 206 | 199.88 | 1.03 | 13.6 | 5.7 | 2.40 | 0.01 | 7.7 | 5.4 | 1.41 | 0.19 | 2008 |
| 2009 | 181 | 176.15 | 1.03 | 11.8 | 5.4 | 2.17 | -0.22 | 6.8 | 5.1 | 1.34 | -0.07 | 2009 |
| 2010 | 174 | 169.18 | 1.03 | 11.4 | 4.2 | 2.70 | 0.53 | 6.6 | 4.0 | 1.64 | 0.30 | 2010 |
| 2011 | 175 | 169.96 | 1.03 | 15.2 | 4.2 | 3.65 | 0.95 | 5.9 | 4.3 | 1.39 | -0.25 | 2011 |
| Trend | | | | | | | | | | | | Trend |
| Medium Income | | | | | | | | | | | | |
| Year | Metro | | | Comparable | | | | Transit | | | | Year |
| | Work, 000's | Home, 000's | Jobs-Housing Ratio | Work, 000's | Home, 000's | Jobs-Housing Ratio | Year on Year Change | Work, 000's | Home, 000's | Jobs-Housing Ratio | Year on Year Change | |
| 2002 | 346 | 337 | 1.03 | 2.6 | 12.0 | 0.21 | 0.00 | 17.6 | 12.1 | 1.45 | 0.00 | 2002 |
| 2003 | 354 | 345 | 1.03 | 2.5 | 11.6 | 0.22 | 0.00 | 16.3 | 12.0 | 1.36 | -0.09 | 2003 |
| 2004 | 371 | 362 | 1.02 | 2.7 | 11.6 | 0.23 | 0.02 | 14.5 | 11.8 | 1.23 | -0.13 | 2004 |
| 2005 | 384 | 374 | 1.03 | 2.6 | 12.2 | 0.22 | -0.02 | 16.6 | 12.9 | 1.28 | 0.05 | 2005 |
| 2006 | 401 | 391 | 1.03 | 2.8 | 13.0 | 0.21 | -0.01 | 16.4 | 13.9 | 1.18 | -0.10 | 2006 |
| 2007 | 406 | 395 | 1.03 | 2.7 | 11.7 | 0.23 | 0.02 | 16.6 | 12.3 | 1.35 | 0.17 | 2007 |
| 2008 | 388 | 376 | 1.03 | 2.4 | 10.3 | 0.24 | 0.01 | 16.5 | 11.2 | 1.47 | 0.12 | 2008 |
| 2009 | 361 | 350 | 1.03 | 2.2 | 11.2 | 0.20 | -0.04 | 14.5 | 10.8 | 1.34 | -0.13 | 2009 |
| 2010 | 355 | 344 | 1.03 | 2.1 | 8.7 | 0.23 | 0.04 | 13.5 | 8.8 | 1.54 | 0.20 | 2010 |
| 2011 | 358 | 346 | 1.03 | 3.14 | 8.44 | 0.37 | 0.14 | 12.9 | 8.8 | 1.46 | -0.08 | 2011 |
| Trend | | | | | | | | | | | | Trend |
| High Income | | | | | | | | | | | | |
| Year | Metro | | | Comparable | | | | Transit | | | | Year |
| | Work, 000's | Home, 000's | Jobs-Housing Ratio | Work, 000's | Home, 000's | Jobs-Housing Ratio | Year on Year Change | Work, 000's | Home, 000's | Jobs-Housing Ratio | Year on Year Change | |
| 2002 | 176 | 176 | 1.00 | 14.2 | 3.5 | 4.02 | 0.00 | 11.6 | 1.8 | 6.32 | 0.00 | 2002 |
| 2003 | 194 | 194 | 1.00 | 15.9 | 3.7 | 4.27 | 0.24 | 12.8 | 2.0 | 6.30 | -0.02 | 2003 |
| 2004 | 212 | 212 | 1.00 | 17.4 | 3.8 | 4.56 | 0.29 | 13.2 | 2.2 | 5.90 | -0.40 | 2004 |
| 2005 | 249 | 247 | 1.01 | 18.7 | 4.6 | 4.05 | -0.51 | 15.4 | 2.9 | 5.25 | -0.65 | 2005 |
| 2006 | 274 | 272 | 1.01 | 19.2 | 5.2 | 3.70 | -0.35 | 15.4 | 3.5 | 4.45 | -0.80 | 2006 |
| 2007 | 297 | 294 | 1.01 | 16.9 | 4.9 | 3.47 | -0.23 | 16.9 | 3.5 | 4.77 | 0.31 | 2007 |
| 2008 | 307 | 304 | 1.01 | 20.5 | 4.8 | 4.23 | 0.76 | 17.4 | 3.4 | 5.15 | 0.38 | 2008 |
| 2009 | 281 | 278 | 1.01 | 18.5 | 5.1 | 3.65 | -0.59 | 17.4 | 2.9 | 6.00 | 0.85 | 2009 |
| 2010 | 278 | 275 | 1.01 | 18.0 | 4.0 | 4.54 | 0.89 | 17.7 | 2.2 | 7.91 | 1.91 | 2010 |
| 2011 | 286 | 283 | 1.01 | 43.2 | 3.8 | 11.25 | 6.71 | 15.0 | 2.4 | 6.28 | -1.64 | 2011 |
| Trend | | | | | | | | | | | | Trend |

Table 7: Jobs-housing balance by income category

The transit corridor is job-rich for all three income categories, but particularly for high income, where it has 4 to 7 times as many workers as working residents. The ratio is lower for medium-income workers, and lower still for low-income workers. Over time, the jobs-housing ratio for low income workers is erratic, rising or falling almost every year, with small year on year changes. For low income, the year-on-year change in the jobs-housing ratio demonstrates no pattern of changes before or after transit. The pattern is significantly different for the comparable corridor, for which the jobs-housing ratio rise significantly in 2011.

After the advent of transit, the jobs-housing ratio seesaws erratically for medium-income workers in the transit corridor, and shows no general trend. The employment decline predates the Great Recession, and continues steadily through it, as does the number of employed workers residing in the corridor.

High-income workers are the sole category to see increases in employment throughout study period. The jobs-housing ratio continues to rise, as the number of workers with homes in the corridor peaks in about 2007.

There is a high jobs-housing ratio for the entire study period, although it is characterized by very large year on year changes. These changes continue with the advent of transit, and are due to large shifts in both workers and workers resident in the corridor. After 2007, there is a consistent trend for the corridor to become more job-rich for high income residents, but this declines in 2011.

Industry Balance

Industry balance provides a more refined understanding of the match between place of residence and place of work. Comparing the jobs-housing ratio by industry category makes it possible to determine which industries benefit the most from proximity to transit. The industry balance for the transit corridor is presented in [Table 8](#). The jobs-housing ratio has been broken into two data series by the year of the advent of transit.

If any population is making extensive use of transit, they would be expected to be both working and living in the transit corridor. If so, the number of people in any given industry both working and living in the corridor should increase over time, bringing the jobs-housing ratio for the corridor closer to the ratio for the metropolitan area.

| Industry | Comparable | | | | | Transit | | | | |
|-----------------|------------|--------------|-------|--------------|-------|---------|--------------|-------|--------------|-------|
| | 2002 | 2002 to 2004 | 2004 | 2004 to 2011 | 2011 | 2002 | 2002 to 2004 | 2004 | 2004 to 2011 | 2011 |
| Utilities | 36.13 | | 28.26 | | 81.04 | 19.29 | | 23.91 | | 72.44 |
| Construction | 3.84 | | 3.87 | | 3.47 | 4.99 | | 5.60 | | 11.63 |
| Manufacturing | 3.05 | | 2.74 | | 2.17 | 2.66 | | 2.11 | | 2.50 |
| Wholesale | 4.12 | | 4.37 | | 3.78 | 4.86 | | 5.86 | | 3.69 |
| Retail | 3.86 | | 3.69 | | 3.06 | 3.79 | | 3.40 | | 2.50 |
| Transportation | 17.46 | | 2.23 | | 3.36 | 6.69 | | 7.28 | | 4.97 |
| Information | 2.88 | | 2.47 | | 2.40 | 13.22 | | 15.38 | | 13.77 |
| Finance | 1.99 | | 2.45 | | 2.79 | 15.36 | | 15.88 | | 12.46 |
| Real Estate | 2.77 | | 2.66 | | 2.28 | 6.90 | | 9.51 | | 9.94 |
| Professional | 6.13 | | 6.52 | | 5.00 | 14.37 | | 14.76 | | 12.57 |
| Management | 1.65 | | 1.83 | | 1.23 | 7.92 | | 7.16 | | 4.30 |
| Administrative | 3.37 | | 2.37 | | 6.10 | 5.71 | | 6.10 | | 5.76 |
| Education | 1.98 | | 1.97 | | 1.77 | 0.81 | | 0.65 | | 1.94 |
| Health Care | 3.07 | | 2.96 | | 3.36 | 2.04 | | 2.99 | | 4.72 |
| Arts, Ent. Rec. | 3.70 | | 4.91 | | 7.68 | 4.92 | | 6.70 | | 7.01 |
| Lodging & Food | 5.73 | | 5.88 | | 5.07 | 4.52 | | 4.92 | | 5.65 |
| Other Services | 5.96 | | 6.53 | | 4.04 | 4.58 | | 5.72 | | 4.45 |
| Public Admin | 1.17 | | 0.89 | | 1.69 | 9.40 | | 15.10 | | 11.01 |

Table 8: Job accessibility trends over time by industry sector and corridor

In 2004, the transit corridor is jobs-rich for all industries, so falling values for the jobs-housing ratio indicate an improvement in the jobs-worker balance, and increasing job accessibility. From the first year of transit operations (2004), the jobs-housing ratio falls for about half of all industry sectors. Evaluation of the sparklines makes a visual determination of the consistency of changing trends possible. The Wholesale industry shows a consistent decline, as does Finances. In contrast, the Education and Health Care industries show consistent increases.

Discussion & Implications

Overall, there is support for the idea that proximity to transit worsens the jobs-housing balance, but there is not a strong consistent trend. The jobs-housing ratio by income does not suggest that transit improves jobs-housing balance, and indeed may aggravate it. Year on year changes are erratic, with no clear trend standing out.

New transit lines are situated to maximize ridership. Maximizing ridership means focusing on density. The more origins and destinations near a transit station, the more likely it is to generate ridership. Employment tends to be concentrated, so that employment densities are almost always greater than residential densities. Thus, transit systems tend to be built in job-rich locations.

The jobs-housing ratio improves toward parity for some industries, but these are the same industries that earlier analysis characterized as experiencing large job losses. So it seems likely that the increase toward parity along the corridor is not a result of more residents matching their place of residence to their place of work, but rather a result of fewer workers in that industry.

Ideally, comparing the jobs-housing ratio for different industries should show which industries are transit compatible, with transit compatible industries showing better matches. At the corridor scale, it seems unable to do so. The jobs-housing ratio is very far from parity for most industries. While improving the job-worker ratio along the corridor towards parity would be a positive result, the failure to do so may not capture the whole story. For many metro areas with a single high capacity transit line, all accessible destinations from transit must be in proximity to that line. The Hiawatha line is not just a transit line, but it is part of a transfer network of transit routes. Effectively gauging the effect on jobs-housing balance would require evaluating the jobs-worker balance over the whole transit network.

The larger the metropolitan area, the more places it is possible to both live and work. Thus, the less likely any given worker will be a resident of any given geography. For any growing and expanding metropolitan area, the match between workplace and residence would be expected to worsen over time. However, the addition of transit would be expected to counteract this, providing a mechanism to assort workers in a way that their residential location better matches their employment location. It seems likely that the magnitude of the effect of transit is insufficient to improve jobs-housing balance.

For a transit system to substantially improve jobs-housing balance by bringing the jobs-housing ratio (by any criteria) into greater conformity with the metropolitan norm, the change in mobility and accessibility provided by that transit system must be sufficient to influence residence location choices for a substantial number of people. Given the limited area within walking distance of transit stations, this implies either very high residential density in proximity to transit stations, or some mechanism that concentrates enough workers to proxy for residential density, such as park and ride lots or transit centers fed by local bus service.

8-SUMMARY OF FINDINGS

Summaries of the results of the analysis for the five policy questions bellow.

- Are TODs attractive to certain NAICS sectors?**
- Do TODs generate more jobs in certain NAICS sectors?**
- Are firms in TODs more resilient to economic downturns?**
- Do TODs create more affordable housing measured as H+T?**
- Do TODs improve job accessibility for those living in or near them?**

Q1: Attractiveness to NAICS sectors (Location quotient)

Transit corridor

- Substantial Increases: Utilities and Construction
- Minor Increases: Health Care, Education and Real Estate
- Substantial Reductions: Public Administration
- Minor Reductions: Information and Retail
- Transit induced reductions: Retail

Transit advantage over comparable corridor

- Substantial: Utilities
- Minor: Health Care, Education and Real Estate

Q2: Do TODs generate more jobs in certain NAICS sectors? (Shift-share analysis)

Numeric Change in Transit corridor

- Employment in transit corridor grew more than metropolitan area
- Substantial numeric increases: Health Care, Utilities, Construction and Professional
- Substantial percent increases: Education, Construction and Health Care
- Substantial reductions: Numerous

Effect of corridor, as per shift-share

- Health Care benefits the most.
- Utilities and Construction also benefit.
- Strong negative corridor effect on Management and Public Administration.

Transit advantage over comparable corridor

- Corridor Effect is strongest for Health Care, Construction, and Education.
- Corridor benefit is especially beneficial for Professional, Education, and Lodging/Food.

Q3: Are firms in TODs more resilient to economic downturns? (Interrupted Time Series)

In this example, resilience is defined as the capacity to maintain a positive trend despite the economic shock of the 'Great Recession'. The R^2 values measure the amount of variation in trends before and after the recession. More resilient industries will have more comparable R^2 values.

Transit corridor after 2008

- Major positive trends: Health Care, Public Administration and Construction.
- Consistent trends, as per R^2 : Health Care, Public Administration and Construction.
- Resilient (Positive trend before and after): Health Care

Transit Corridor Differences before and after Great Recession

- Declined before, improved afterward: Construction, Real Estate, and Public Administration
- Declined: Transportation, Management and Utilities

Advantage over Comparable corridor:

- Better trends: Health Care, Public Administration and Construction.
- Did well by comparison: Information

Q4: Do TODs create more affordable housing measured as H+T? (Housing affordability)

Unlike other analyses in this report, this analysis measures changes in more than just the 0.5-mile buffers. The magnitude of the effect of transit should be proportional to proximity to transit.

Transit corridor

- H+T costs for the transit corridor are less than the metropolitan average
- H+T costs fall with proximity, barring the area within 0.25 miles
- Transportation costs are notably lower nearer to the transit corridor

Transit corridor changes in H+T costs 2000-2009

- H+T costs for the transit corridor change more than the metropolitan average for distances under 1.0 miles from the transit corridor.
- Transportation costs change less than housing costs.
- Changes in transportation costs are lower with greater proximity to the transit corridor
- Housing costs rise with proximity to the transit corridor
- The change in H+T costs are larger for the transit corridor than for the comparable corridor for all distances
- H+T costs in comparable corridor show no relationship to proximity to corridor

Q5: Do TODs improve job accessibility for those living in or near them?

Jobs accessibility was operationalized as the balance between number of workers and number of workers residing in the corridor, using the jobs-housing ratio as a comparison. The jobs-housing ratio for the metro was used as the preferred ratio. The differences were compared for all workers in the corridor, for workers by earnings, and for workers by industry.

- Job rich at start of study period, with jobs-housing ratio greater than that of the metropolitan area.
- Erratic trends, big year on year changes.
- Changes in jobs-housing ratio caused by both declining number of workers, and declining number of workers resident in the corridor.
- There is no clear trend in the jobs-housing ratio for low or medium income workers.
- The jobs-housing ratio rises for high income workers.
- Jobs-housing ratio improves for most industries as a result of employment losses.
- Job balance improves for two industries: Education and Health Care.

9-REFERENCES

Arrington, G.B. and Robert Cervero. 2008. Effects of TOD on Housing, Parking, and Travel. TCRP Report 128. Washington, DC: Transportation Research Board.

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

Cervero, Robert, et al. 2004. TCRP Report 102: Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects. Washington, DC: Transportation Research Board.

US Census Bureau. Table 643, Annual Total Compensation and Wages and Salary Accruals Per Full-Time Equivalent Employee, by Industry: 2000 to 2009. <

http://www.census.gov/compendia/statab/cats/labor_force_employment_earnings/compensation_wages_and_earnings.html>

Center for Neighborhood Technology. 'About the Index'. <http://htaindex.cnt.org/about.php>

CTOD. 2011. Transit and Regional Economic Development. Chicago, IL: Center for TOD.

CTOD. 2009. Mixed-Income Housing Near Transit. Chicago, IL: Center for TOD.

CTOD. 2012. TOD Database. <http://toddata.cnt.org/>

Fan, Y., Guthrie, A., and Levinson, D. 2012. Impact of light rail implementation on labor market accessibility: A transportation equity perspective. *Journal of Transport and Land Use*, 5(3).

Glaeser, Edward L., Matthew E. Kahn, and Jordan Rappaport. 2008. Why do the poor live in cities? The role of public transportation. *Journal of Urban Economics* 63, no. 1: 1-24.

Kolko, Jed. 2011. Making the Most of Transit: Density, Employment Growth, and Ridership around New Stations. San Francisco, CA: Public Policy Institute of California.

NAHB. 2010. The Economic Impact of Low Income Housing Tax Credit Development Along Transit Corridors in Metro Denver. Washington, DC: National Association of Home Builders.

Nelson, Arthur C. 2011. The New California Dream. Washington, DC: The Urban Land Institute.

Schuetz, Jenny and Jed Kolko. 2010. Does Rail Transit Investment Encourage Retail Activity? Project 11-04. Los Angeles, CA: University of Southern California, Metrans Transportation Center.

Tobler W., (1970) "A computer movie simulating urban growth in the Detroit region". *Economic Geography*, 46(2): 234-240.

Victoria Transport Policy Institute (VPTI). Evaluating Transportation Resilience. Online TDM Encyclopedia, 31 March 2014. www.vtpi.org. Accessed 31 March 2014.

Victoria Transport Policy Institute (VPTI). Transportation Affordability. Online TDM Encyclopedia, 10 September 2012. www.vtpi.org. Accessed July 2, 2013.

Vinha, Katja Pauliina. 2005. The impact of the Washington Metro on development patterns. College Park, MD: University of Maryland.

10-APPENDIX A

LEHD

The Longitudinal Employer-Household Dynamics (LEHD) program is part of the Center for Economic Studies at the U.S. Census Bureau. The LEHD program produces new, cost effective, public-use information combining federal, state and Census Bureau data on employers and employees under the Local Employment Dynamics (LED) Partnership. State and local authorities increasingly need detailed local information about their economies to make informed decisions. The LED Partnership works to fill critical data gaps and provide indicators needed by state and local authorities.

Under the LED Partnership, states agree to share Unemployment Insurance earnings data and the Quarterly Census of Employment and Wages (QCEW) data with the Census Bureau. The LEHD program combines these administrative data, additional administrative data and data from censuses and surveys. From these data, the program creates statistics on employment, earnings, and job flows at detailed levels of geography and industry and for different demographic groups. In addition, the LEHD program uses these data to create partially synthetic data on workers' residential patterns.

All 50 states, the District of Columbia, Puerto Rico, and the U.S. Virgin Islands have joined the LED Partnership, although the LEHD program is not yet producing public-use statistics for Massachusetts, Puerto Rico, or the U.S. Virgin Islands. The LEHD program staff includes geographers, programmers, and economists.

Source: <http://lehd.ces.census.gov/>

Shift-Share Calculations

| | Local Economy | | | | Reference Economy | | | | | | |
|--------------|---------------|------------|---|---------------------------|-------------------|------------|---|---------------------------------|--------------------------|----------------------------------|---|
| NAICS SECTOR | Initial Year | Final year | # Change | % Change | Initial Year | Final year | # Change | % Change | County Share (CS) | Industry Mix (IM) | Local Economy Effect (LEE) |
| Sector A | a | b | =(b-a) | =(b-a)/a | a2 | b2 | =(b2-a2) | =(b2-a2)/a2 | $\frac{b2-a2}{a2+c2+e2}$ | $a \cdot \frac{b2-a2}{a2+c2+e2}$ | $\frac{b2-a2}{a2+c2+e2} - CS + IM$ for Sector A |
| Sector B | c | d | =(d-c) | =(d-c)/c | c2 | d2 | =(d2-c2) | =(d2-c2)/c2 | $\frac{d2-c2}{a2+c2+e2}$ | $b \cdot \frac{d2-c2}{a2+c2+e2}$ | $\frac{d2-c2}{a2+c2+e2} - CS + IM$ for Sector B |
| Sector C | e | f | =(f-e) | =(f-e)/e | e2 | f2 | =(f2-e2) | =(f2-e2)/e2 | $\frac{f2-e2}{a2+c2+e2}$ | $c \cdot \frac{f2-e2}{a2+c2+e2}$ | $\frac{f2-e2}{a2+c2+e2} - CS + IM$ for Sector C |
| Totals | a+c+e | b+d+f | $\frac{b+d+f}{a+c+e} - \frac{a+c+e}{a+c+e}$ | $\frac{b+d+f}{a+c+e} - 1$ | a2+c2+e2 | b2+d2+f2 | $\frac{b2+d2+f2}{a2+c2+e2} - \frac{a2+c2+e2}{a2+c2+e2}$ | $\frac{b2+d2+f2}{a2+c2+e2} - 1$ | na | na | Sum of LEE for Sectors A, B & C |