NATIONAL INSTITUTE for TRANSPORTATION and COMMUNITIES

TRAX University Line

Salt Lake City, Utah

Do TODs Make a Difference?

THE UNIVERSITY OF UTAH Metropolitan Research Center

OTREC OREGON TRANSPORTATION RESEARCH AND EDUCATION CONSORTIUM

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Disclaimer

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 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 metropolitan 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 was 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 that 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.

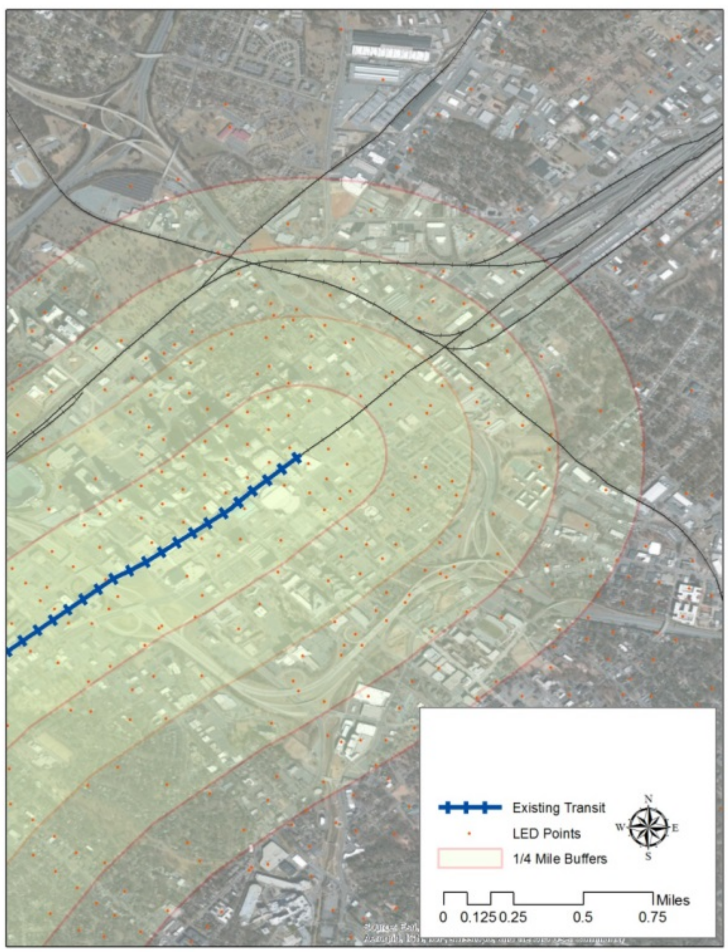

Figure 1: Example corridor, buffers, and LED census block points

Study Area

This study investigates the University line light rail corridor of the UTA TRAX light rail system. It was the second light rail corridor constructed by UTA, with operations beginning in December 2001. Only a portion of the corridor was used, from Main Street to 900 East. The total corridor length used was only 1.3 miles, which included four stations. For a comparable corridor, 2100 South between State Street and 1100 East was used. The land uses are similar in character, if not in scale. Ideally, Sugarhouse (a regional retail center) will balance the retail in downtown malls, and the government offices along 2100 South will help balance offices in downtown Salt Lake. Figure 2 shows the transit and comparable corridors as well as the location of LED points. Both corners have a TRAX station as termini. Because the transit line began operations in 2001, before the LEHD data used for analysis became available, it is not possible to do before and after comparisons.

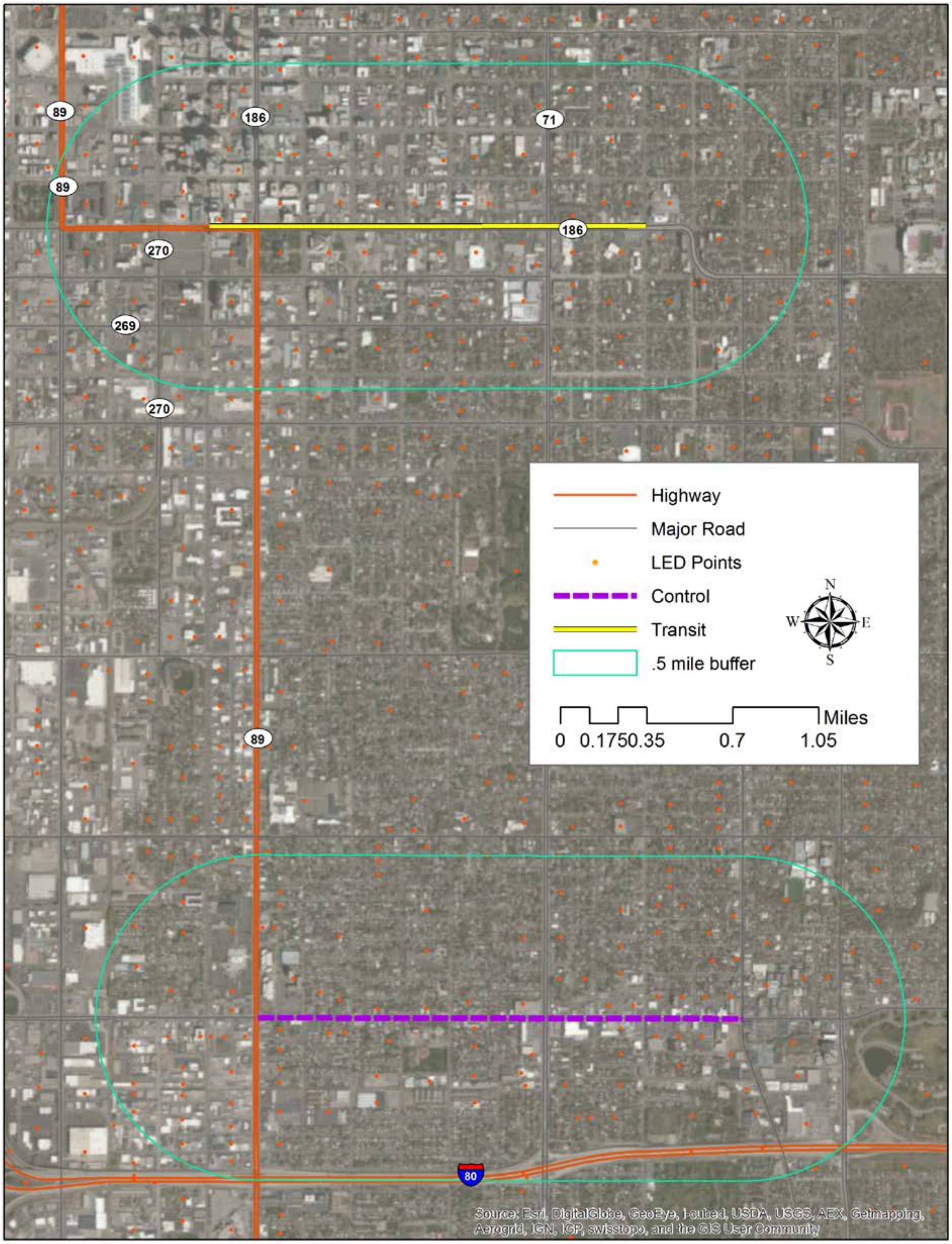

Figure 2: Transit and comparable corridor locations

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 are shown in Table 1. Location quotients are shown for the first and final years, with a sparkline to show trends between the years.

Both corridors are located in a pre-existing, built-up urban area, so additional growth must occur through redevelopment of existing urban land, while the urban area that forms the denominator of the location quotient continues to grow through both development and redevelopment. With an expanding urban area, the location quotient for a fixed area would be expected to fall over time. Any increase in location quotient for a corridor should indicate locational advantage.

Industry	Location Quotient			Changes
	2002	2002-2011	2011	Δ 2002-2011
Utilities	2.22		1.74	-0.48
Construction	0.20		0.08	-0.12
Manufacturing	0.08		0.13	0.04
Wholesale	0.42		0.33	-0.09
Retail	0.73		0.57	-0.15
Transportation	0.11		0.17	0.06
Information	1.53		1.48	-0.06
Finance	1.57		1.40	-0.16
Real Estate	0.94		0.96	0.03
Professional	2.27		2.52	0.25
Management	4.21		2.72	-1.49
Administrative	0.70		0.82	0.11
Education	0.22		0.36	0.15
Health Care	0.36		0.54	0.17
Arts, Ent. Rec.	2.87		0.63	-2.24
Lodging & Food	1.88		2.14	0.26
Other Services	0.77		1.07	0.30
Public Admin	2.02		2.76	0.74

Table 1: Location quotients comparison for transit corridor

At the time of the advent of transit, in December 2001, the industry with the highest location quotient was the Management industry, at 4.21. The Utilities, Professional, Arts/Entertainment/Recreation and Public Administration sectors were all also highly concentrated, with location quotients over 2.0.

Between 2002 and 2011, the location quotient fell severely for the Arts/Entertainment/Recreation industry and for the Management industry. The location quotient rose by the largest amount for the Public Administration industry, followed by Other Services and Professional industries.

The trends shown by the sparkline indicate that only a few industries enjoy consistent increases over the study period. The Professional, Health Care, Lodging/Food, Other Services and Public Administration all have consistent upward trends. The Construction, Retail, and Management industries all have consistent downward trends.

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. 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 is numeric change in location quotient.

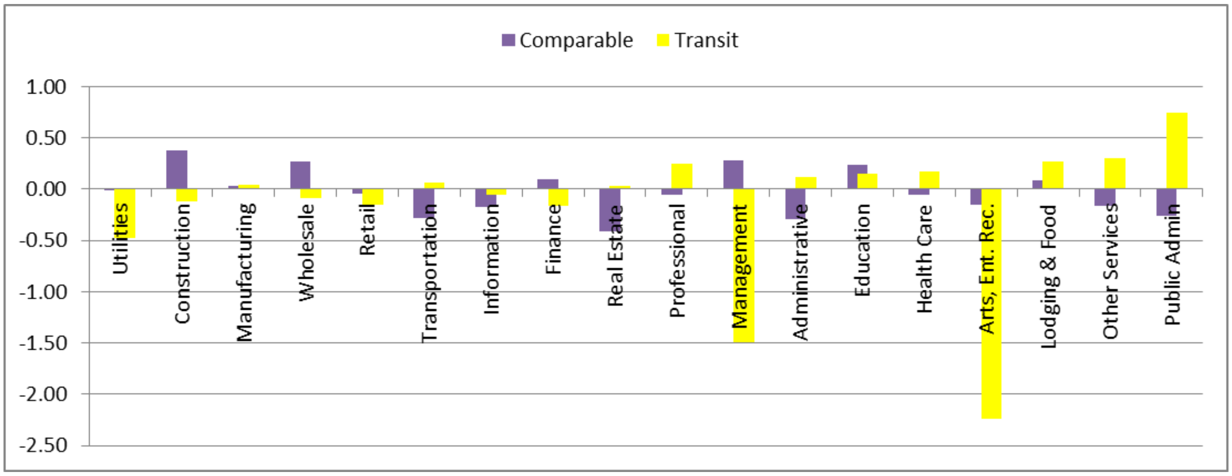

Figure 3: Changes in location quotient by corridor for the time period after the advent of transit

As the graph shows, the changes in location quotients vary significantly by corridor. Barring the Education industry, the changes in location quotients are almost diametrically opposed. For every industry for which it increases in the transit corridor, it declines in the comparable corridor, and vice versa. Arts/Entainment/Recreation is a notable exception. While it declines in both corridors, it declines far more in the transit corridor. The reverse is true for for the Public Adminstration industry, which rises in the transit corridor and falls in the comparable corridor.

Discussion & Implications

A 0.5-mile buffer around the transit corridor represents four Salt Lake City blocks. Four blocks on each side of the transit corridor covers the majority of the original plat of Salt Lake City, including much of the Central Business District. The growth in Public Administration can be explained by this proximity. Many state office buildings are located on the periphery of the CBD. The growth in Lodging/Food can be explained by the development and expansion of the Salt Palace Convention Center, and accompanying hotel development. The sharp decline in the Management industry is unexpected, and may be part of the office development that is relocating away from downtown Salt Lake City and into the Cottonwood Corporate Center. The decline in the Retail industry was likely a temporary phenomenon. Two large downtown malls closed, and were replaced by a large lifestyle center called Gateway Mall further west. Since that time, the malls have been redeveloped into a mixed use retail and office center known as City Creek, but it only opened in 2012. Anticipation of that completion may have suppressed retail development in the area in the interim. The Trolley Square Mall was also under redevelopment at the same time, and may have compounded the effect.

The implication is that very little of the changes in location quotient can be directly imputed to the TRAX University line, rather than developments in the CBD. While the University line provides substantial transportation benefit by linking downtown Salt Lake to the University of Utah, the effect of proximity along the corridor does not appear to be substantial.

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 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		
	2002	2011	# Change	% Change	2002	2011	# Change	% Change	Metro Share	Industry Mix Share	Corridor Effect
Utilities	3,130	3,193	63	2%	575	330	(245)	0%	66	12	(323)
Construction	29,602	29,395	(207)	-1%	485	131	(354)	-73%	56	(3)	(406)
Manufacturing	51,826	52,992	1,166	2%	358	403	45	13%	41	8	(4)
Wholesale	26,753	29,983	3,230	12%	920	584	(336)	-37%	106	111	(553)
Retail	66,450	68,125	1,675	3%	3,988	2,309	(1,679)	-42%	459	101	(2,238)
Transportation	26,568	28,828	2,260	9%	231	287	56	24%	27	20	10
Information	17,278	17,598	320	2%	2,189	1,541	(648)	-30%	252	41	(940)
Finance	36,802	39,123	2,321	6%	4,765	3,261	(1,504)	-32%	548	301	(2,353)
Real Estate	9,200	10,290	1,090	12%	712	589	(123)	-17%	82	84	(289)
Professional	30,312	39,865	9,553	32%	5,688	5,951	263	5%	654	1,793	(2,184)
Management	15,488	15,098	(390)	-3%	5,393	2,438	(2,955)	-55%	620	(136)	(3,439)
Administrative	37,520	43,563	6,043	16%	2,185	2,116	(69)	-3%	251	352	(672)
Education	45,066	51,715	6,649	15%	806	1,111	305	38%	93	119	93
Health Care	48,267	66,780	18,513	38%	1,443	2,122	679	47%	166	553	(40)
Arts, Ent. Rec.	11,893	12,400	507	4%	2,825	465	(2,360)	-84%	325	120	(2,805)
Lodging & Food	44,146	47,956	3,810	9%	6,852	6,092	(760)	-11%	788	591	(2,139)
Other Services	15,031	15,612	581	4%	952	989	37	4%	109	37	(109)
Public Admin	27,204	31,513	4,309	16%	4,540	5,157	617	14%	522	719	(624)
Total	**542,536**	**604,029**	**61,493**	**11%**	**44,907**	**35,876**	**(9,031)**	**-20%**	**5,165**	**4,822**	**(19,018)**

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

The entire metropolitan area enjoys a substantial upswing of 11 percent over the ten years of the analysis period, while the transit corridor suffers a 20 percent loss in employment, representing a loss of almost 10,000 jobs. Numerically, the industries that enjoy the most significant numeric increases are Health Care and Public Administration. The most significant percentage increases occur in the Health Care and Education industries. Significant numeric declines occur in the Management and Arts/Entertainment/Recreation Industries. The Retail and Finance also post the most significant numeric job losses, although the percentage declines are greatest for Arts/Entertainment/Recreation and for Construction.

After using shift-share analysis to disaggregate the cause of change in employment, different patterns emerge. All of the employment losses can be attributed to the corridor effect. Both the metropolitan scale trends (represented by the Metro Share) and the industry trends (represented by Industry Mix) suggest that employment within the corridor should be experiencing substantial increases, versus a staggering decrease. The broad base of the negative effect is notable, affecting all but the Education industry.

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. A value greater than 1 indicates that the Corridor Effect was contrary to the effects of Metro Share and the shift in Industry Mix.

Industry	Comparable			Transit			Transit Advantage		
	# Change	Corridor Effect	Corridor Benefit	# Change	Corridor Effect	Corridor Benefit	Difference, # Change	Difference, Corridor Effect	Difference, Corridor Benefit
Utilities	-1	-1	-1.1	-245	-323	-1.3	-244	-322	-0.2
Construction	250	197	0.8	-354	-406	-1.1	-604	-603	-1.9
Manufacturing	-187	-412	-2.2	45	-4	-0.1	232	407	2.1
Wholesale	210	77	0.4	-336	-553	-1.6	-546	-630	-2.0
Retail	-404	-729	-1.8	-1679	-2238	-1.3	-1275	-1509	0.5
Transportation	-278	-356	-1.3	56	10	0.2	334	365	1.5
Information	-148	-201	-1.4	-648	-940	-1.5	-500	-739	-0.1
Finance	34	-98	-2.9	-1504	-2353	-1.6	-1538	-2254	1.3
Real Estate	-146	-227	-1.6	-123	-289	-2.4	23	-62	-0.8
Professional	-3	-277	-92.3	263	-2184	-8.3	266	-1907	84.0
Management	7	-51	-7.3	-2955	-3439	-1.2	-2962	-3388	6.2
Administrative	-414	-815	-2.0	-69	-672	-9.7	345	143	-7.8
Education	335	168	0.5	305	93	0.3	-30	-74	-0.2
Health Care	53	-480	-9.1	679	-40	-0.1	626	440	9.0
Arts, Ent. Rec.	-82	-113	-1.4	-2360	-2805	-1.2	-2278	-2693	0.2
Lodging & Food	-1	-296	-295.5	-760	-2139	-2.8	-759	-1844	292.7
Other Services	-141	-222	-1.6	37	-109	-3.0	178	113	-1.4
Public Admin	-400	-1963	-4.9	617	-624	-1.0	1017	1339	3.9
Total	**-1220**	**-5702**	**-4.7**	**-9009**	**-19099**	**-2.1**	**-7715**	**-13397**	**2.6**

Table 3: Shifts by corridor and comparison between corridors

Proximity to the transit corridors benefits different industries. In the transit corridor, the Corridor Effect is positive for the Transportation and Education industries. It is negative for all other industries, but most negative for Management and Arts/Entertainment/Recreation industries. The Corridor Benefit provides a metric that is independent of the magnitude of employment. In the transit corridor, the corridor benefit is largest for the Education industry. It is most highly negative for the Administrative and Professional Industries.

That the effect is specific to transit can be discerned by contrasts with the comparable corridor. The difference in Corridor Benefit between the two corridors contradicts the decline in the Lodging/Food and Professional industries. However, the difference in Corridor Effect undermines this, demonstrating that the transit corridor still lost considerably more jobs.

Discussion & Implications

Given the present rude economic health of the Salt Lake City metropolitan area and the strong downtown boosterism, the dramatic decline in employment makes little sense. Even after the opening of a major new office tower at 222 Main Street and the additional office development included in the

City Creek project, office vacancy rates are low, and the construction of a new office tower at 111 Main Street is going forward. A new Broadway-style theatre is under construction, but that is not slated to open until later this year.

However, 2011 represented the post-recessionary nadir of employment in Salt Lake City; although, it was a nadir doubtless worsened by the sheer amount of construction on-going. City Creek Center alone included the complete demolition of two city blocks (over 20 acres), removing two major downtown Malls, the ZCMI center and Crossroads Mall. The Walker Center, a historic office building, was closed for renovations during the same time.

Part of the problem is doubtless caused by the Gateway Mall. As the two downtown malls closed, much of the associated office and retail development migrated a few blocks west, to the newly opened Gateway Mall. However, the sheer scope of decline and number of industries affected is troubling.

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 usual 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.

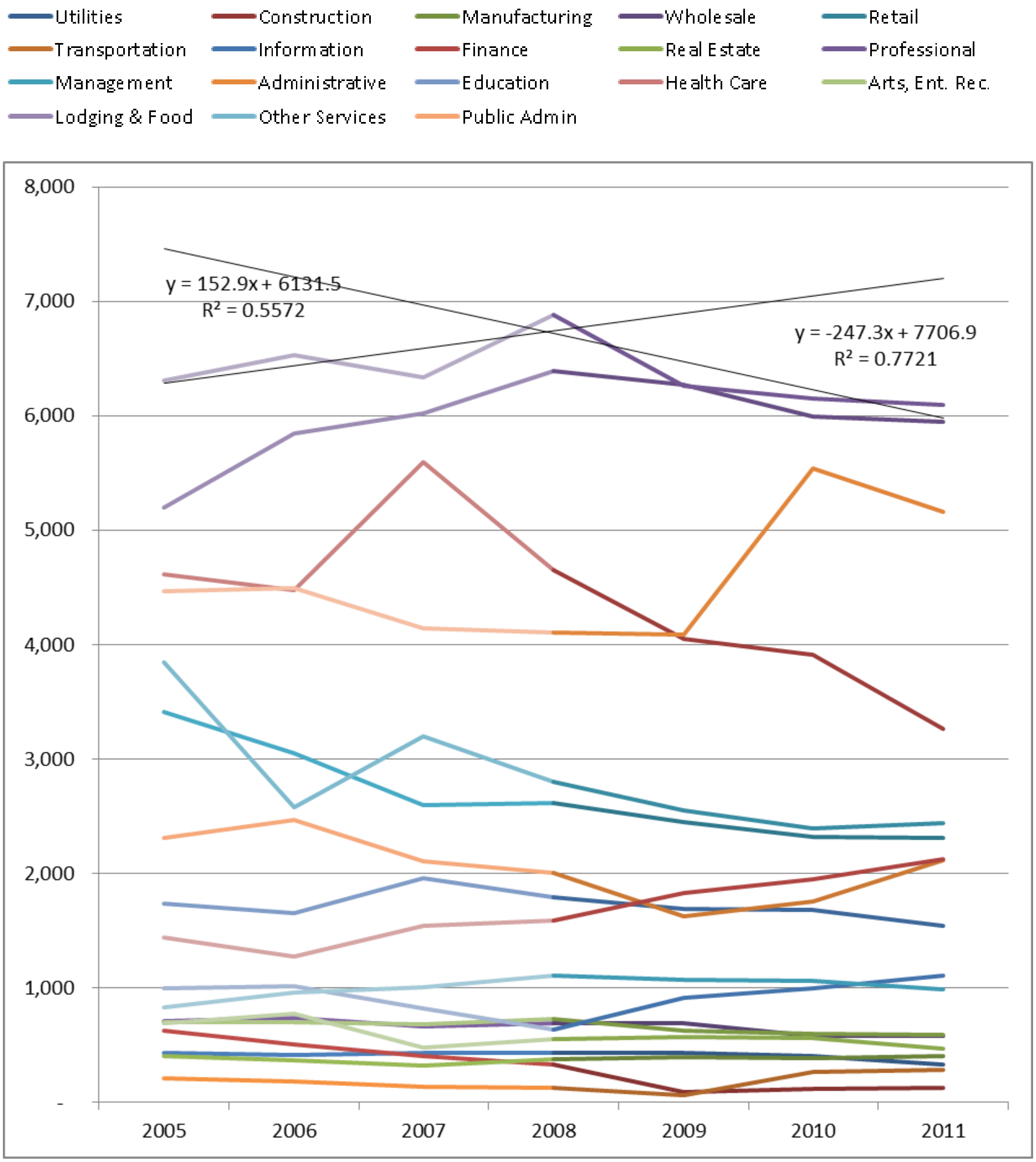

Figure 4: Regression trend lines and R-squared values for different industries

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 R2 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	2	1%	0.07	-35	-9%	0.82	-37	-9%	0.75
Construction	-98	-21%	0.99	-58	-34%	0.46	40	-13%	-0.53
Manufacturing	-12	-3%	0.18	6	2%	0.73	18	5%	0.55
Wholesale	-11	-2%	0.27	-44	-7%	0.78	-33	-5%	0.51
Retail	-285	-10%	0.89	-105	-4%	0.90	180	5%	0.01
Transportation	-29	-18%	0.93	69	37%	0.65	98	55%	-0.28
Information	49	3%	0.23	-78	-5%	0.92	-126	-7%	0.68
Finance	124	3%	0.10	-432	-11%	0.95	-555	-13%	0.86
Real Estate	5	1%	0.14	-44	-7%	0.82	-48	-8%	0.68
Professional	376	6%	0.94	-160	-3%	0.93	-536	-9%	-0.02
Management	-253	-8%	0.34	-125	-5%	0.78	128	3%	0.44
Administrative	-128	-6%	0.64	45	2%	0.07	174	8%	-0.57
Education	-128	-15%	0.87	150	16%	0.92	278	31%	0.05
Health Care	72	5%	0.43	171	9%	0.98	99	4%	0.55
Arts, Ent. Rec.	-70	-11%	0.48	-26	-5%	0.50	44	6%	0.02
Lodging & Food	153	2%	0.56	-247	-4%	0.77	-400	-6%	0.21
Other Services	88	9%	0.97	-37	-4%	0.92	-125	-12%	-0.05
Public Admin	-142	-3%	0.80	461	10%	0.65	603	13%	-0.15
Total	-289	-1%	0.57	-478	-1%	0.41	-188	-1%	-0.16

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

The total employment change is -1 percent both before and after the recession. For both time periods, employment continued to decline. The R^2 for the post-recessionary period is low, indicating very erratic trends and a highly uncertain recovery.

2008 represents the nadir of the recession. Prior to that nadir, the Professional and Lodging/Food industries were growing rapidly. The Professional and Other Services industries both had very strong growth trends. In contrast, after the recession, the successful industries have almost completely shifted. Post 2008, the Public Administration industry had the best trend, followed by the Health Care and Education industries. The industries with the best Trend % were the Transportation industry, followed by the Education industry. Both the Education and Health Care industries had very strong trends after the recession, with almost perfect R^2 values. Both the Transportation and Public Administration industries had reasonable R^2 values of about 0.65.

The Differences column highlights the changes between the pre-recessionary and post-recessionary periods. Of the numeric trends, many industries that were in decline before the recession, such as Public Administration, grew enormously after it. Differences in Trend % shows that the Transportation and Education industries also experienced dramatic post-recessionary changes.

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	-37	-9%	0.75	0	#DIV/0!	#DIV/0!	-37	#DIV/0!	#DIV/0!
Construction	40	-13%	-0.53	-26	-7%	-0.65	66	-7%	0.12
Manufacturing	18	5%	0.55	58	4%	-0.96	-40	1%	1.51
Wholesale	-33	-5%	0.51	5	0%	0.00	-38	-6%	0.51
Retail	180	5%	0.01	-5	0%	-0.25	185	6%	0.26
Transportation	98	55%	-0.28	3	-20%	0.03	95	74%	-0.31
Information	-126	-7%	0.68	17	6%	-0.38	-143	-13%	1.06
Finance	-555	-13%	0.86	-19	-2%	0.24	-536	-11%	0.62
Real Estate	-48	-8%	0.68	-57	-23%	0.62	8	16%	0.06
Professional	-536	-9%	-0.02	-55	-8%	-0.33	-481	-1%	0.32
Management	128	3%	0.44	58	10%	0.23	70	-7%	0.21
Administrative	174	8%	-0.57	-11	-2%	0.10	185	10%	-0.67
Education	278	31%	0.05	34	3%	0.07	243	28%	-0.02
Health Care	99	4%	0.55	382	52%	0.52	-283	-48%	0.03
Arts, Ent. Rec.	44	6%	0.02	8	6%	-0.65	36	1%	0.67
Lodging & Food	-400	-6%	0.21	14	1%	-0.25	-415	-7%	0.46
Other Services	-125	-12%	-0.05	-72	-16%	0.29	-53	4%	-0.34
Public Admin	603	13%	-0.15	-255	-5%	0.16	858	18%	-0.31
Total	-188	-1%	-0.16	110	1%	-0.80	-299	-1%	0.63

Table 5: Comparison of resilience by corridor

Comparison of the two corridors suggests that the transit corridor did disproportionately badly. Resilient industries near transit should have a greater or equal positive trend after the recession than before. Only the Health Care industry meets that criteria. The comparable corridor puts that into context, for the Health Care industry did substantially better there, with a higher positive trend in employment, a better Trend %, and a higher R^2, indicating a stronger trend.

However, there are several industries that prospered more in the transit corridor than in the comparable corridor. These industries most notably include Transportation, Education, and Public Administration. This suggests that the growth in these industries may be attributed to their proximity to the transit corridor.

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. Within the transit corridor buffer, only the Health Care industry can be called resilient. For the corridor, the Great Recession represented a catastrophic event inducing a phase change in employment in the corridor. Industries that had previously done well suddenly went into decline, and industries that were in decline were suddenly successful.

It is unlikely that the University Light Rail line was the cause of the phase shift. Rather, when the shock of the Great Recession affected employment, it meant that the underlying conditions, the industrial ecology of the corridor area, had changed. As old industries cleared out because of the Great Recession, they were replaced by a new and different set of industries thereafter.

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 has been extensively researched, the effects of non-heavy rail TOD on housing affordability is 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 1.0 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 of 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.

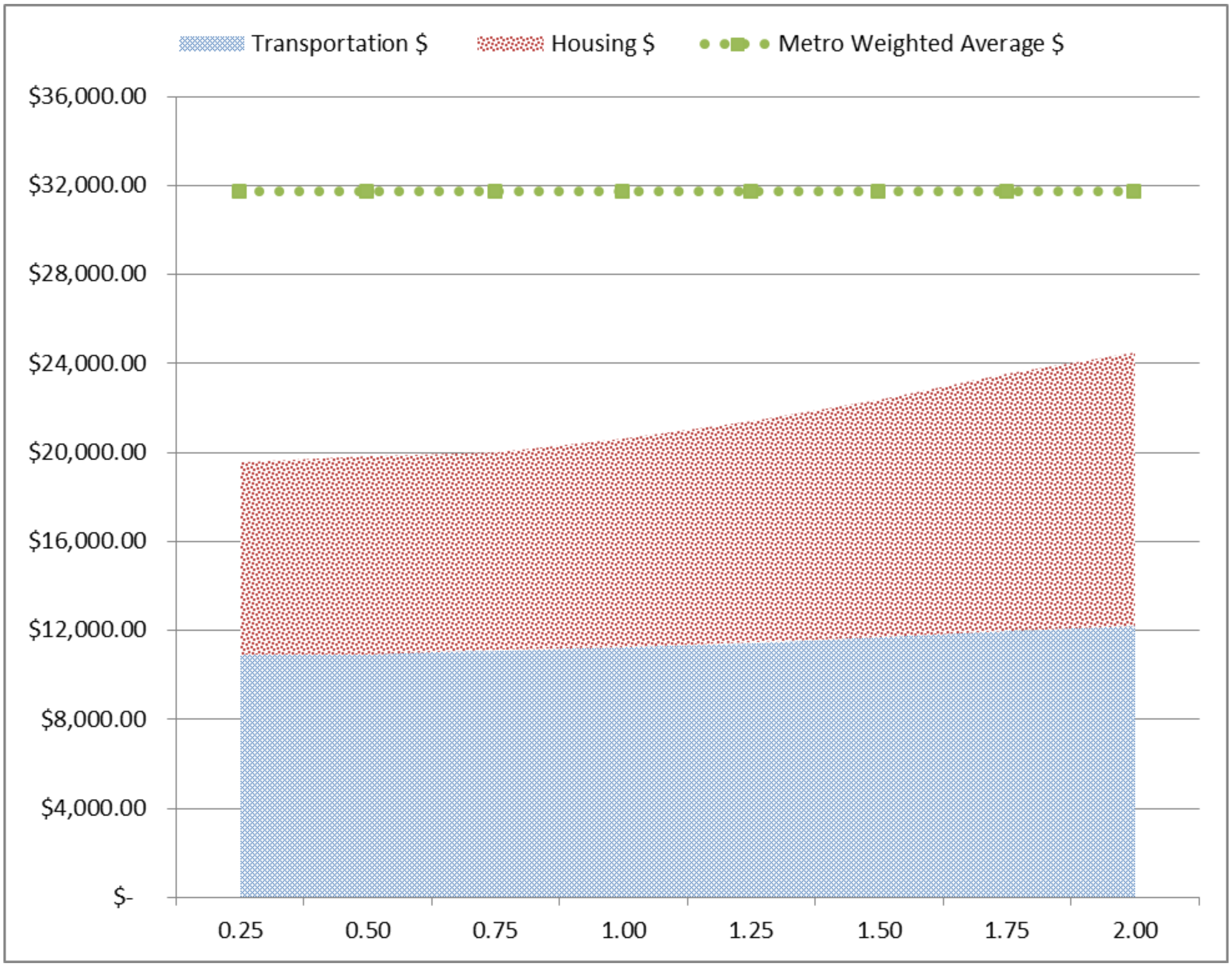

Figure 5: Housing, transportation, and H+T costs for the transit corridor, 2009, by buffer distance

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. While differences in transportation costs are not as significant as differences in housing cost, they appear to be marginally 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.

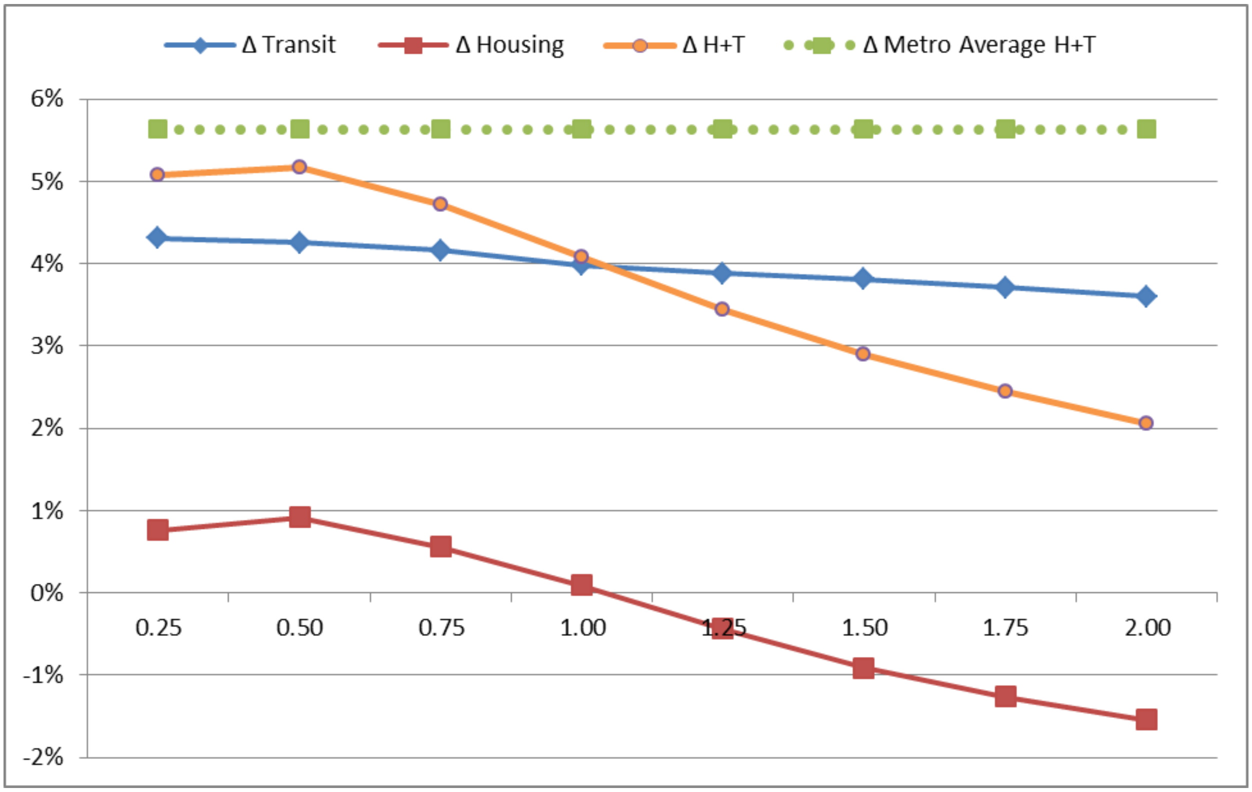

Figure 6: Change in housing and transportation costs, 2000-2009, for transit corridor, by buffer distance

The changes in H+T costs for the transit corridor are significantly different than the metropolitan area as a whole. Changes in H+T costs vary with distance to the transit corridor, and the change is much greater nearer to the transit corridor. This majority of this change can be attributed not to changes in transportation costs but to changes in housing costs. The change in housing cost is actually negative within 1.0 miles of the transit corridor. However, an unexpectedly large portion of the change in H+T costs can be attributed to transportation, and are actually slightly higher near the transit corridor contrary to expectations and earlier appearances.

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.

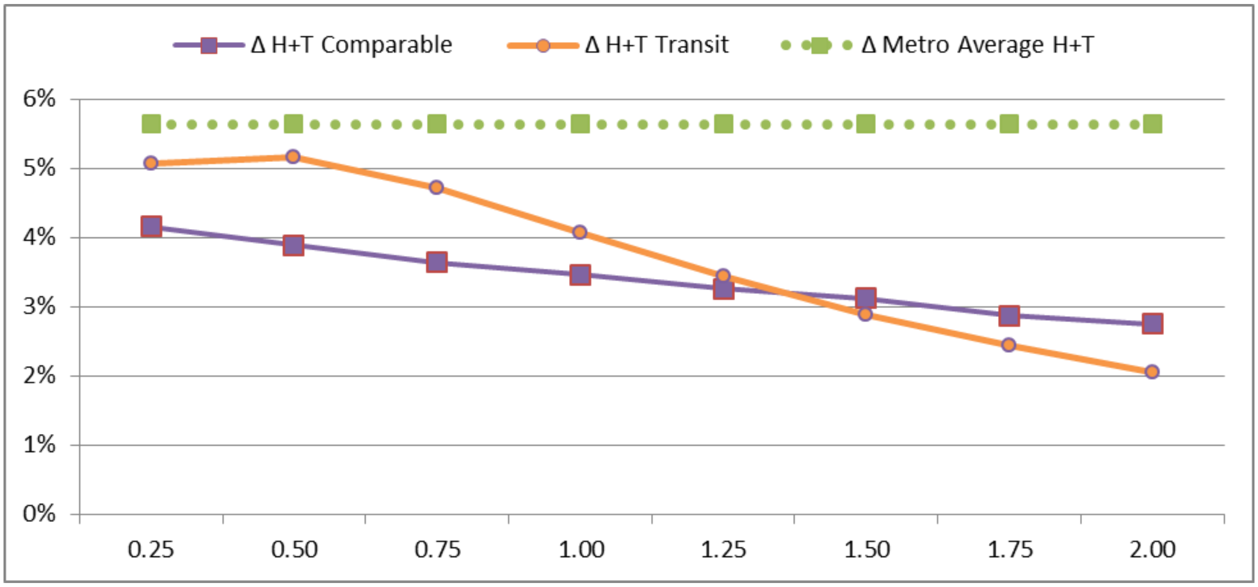

Figure 7: Changes in H+T, 2000-2009, for transit and comparable corridors, by buffer distance

The transit and comparable corridors display similar patterns in changes in H+T costs. However, the changes in H+T costs for the transit corridor are larger for the within 1.25 miles of transit corridor, while the increase is greater for the comparable corridor for greater distances.

Discussion & Implications

TOD is typically planned on the basis of 0.5 mile circles, which are supposed to represent the maximum acceptable walk radius. The reality is more complex. While some people are willing to walk much further for access to high quality transit, up to 2 miles, the majority walk far less. This shows an inverse relationship: The greater the distance, the fewer people are willing to walk. Correspondingly, the strongest response to transit should be in the areas closest to the transit station. The pattern of increases in H+T costs fails to match this relationship. Instead, transportation costs are actually higher nearer to the transit corridor.

Housing costs also rise with proximity to the transit corridor. Theoretically, the value of the additional accessibility generated by proximity to transit should be capitalized into property value, resulting in rising housing costs. Housing costs do rise with proximity to the transit, line, but not within a 0.25 mile buffer of the line, where housing costs increases would be expected to be greatest. However, Salt Lake City has been extremely active in promoting multifamily development near the transit line, with a focus on guaranteeing a supply of affordable housing, which may be mitigating this.

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, TOD 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 contain 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	545	473	1.15	19.2	7.0	2.76	0.00	45.0	6.6	6.78	0.00	2002
2003	533	468	1.14	19.1	6.8	2.79	0.03	40.8	6.3	6.45	-0.33	2003
2004	544	483	1.13	18.9	7.0	2.70	-0.09	39.9	6.7	5.96	-0.49	2004
2005	563	498	1.13	18.4	7.2	2.54	-0.16	39.0	6.7	5.83	-0.13	2005
2006	587	554	1.06	18.0	7.8	2.31	-0.23	38.1	7.5	5.09	-0.74	2006
2007	612	533	1.15	18.1	7.6	2.37	0.07	38.6	7.5	5.17	0.08	2007
2008	621	535	1.16	17.8	7.6	2.35	-0.03	37.9	7.7	4.90	-0.27	2008
2009	587	499	1.18	18.2	7.8	2.33	-0.02	35.8	7.9	4.55	-0.34	2009
2010	593	498	1.19	16.8	6.8	2.48	0.15	36.8	6.8	5.44	0.88	2010
2011	607	508	1.20	18.0	6.3	2.84	0.36	36	7.4	4.90	-0.54	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 highly job-rich. The transit corridor has 4 to 6 times as many jobs per worker than the metropolitan area. The ratio does improve with the advent of transit in 2002, and fairly steadily, barring a deviation in 2010. The number of workers in the corridor falls steadily from 2002 to 2011, barring an uptick in 2010. In contrast, the number of workers resident in the corridor rises steadily between 2002 and 2009, falls in 2010, and rebounds in 2011. The comparable corridor is also less job-rich, and displays little improvement toward parity. While the sparkline shows dramatic shifts, the actual year on year changes are minor compared to the transit corridor. The metropolitan area also displays radical shifts, with a jobs-housing ratio varying between 1.06 and 1.20 between 2006 and 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	184	161.29	1.14	7.4	2.5	3.02	0.00	14.7	2.6	5.65	0.00	2002
2003	176	156.50	1.12	7.2	2.3	3.08	0.06	11.9	2.5	4.70	-0.95	2003
2004	177	159.44	1.11	6.9	2.3	2.95	-0.13	11.2	2.7	4.19	-0.51	2004
2005	177	159.52	1.11	6.7	2.4	2.76	-0.18	10.7	2.6	4.11	-0.08	2005
2006	180	171.32	1.05	6.3	2.6	2.47	-0.29	10.3	2.9	3.58	-0.53	2006
2007	179	159.39	1.13	6.2	2.3	2.75	0.28	9.9	2.6	3.84	0.26	2007
2008	177	155.08	1.14	6.0	2.2	2.72	-0.03	9.6	2.6	3.70	-0.14	2008
2009	161	140.35	1.15	5.9	2.2	2.62	-0.09	8.9	2.5	3.60	-0.10	2009
2010	160	137.81	1.16	5.4	1.9	2.77	0.15	8.7	2.1	4.13	0.53	2010
2011	161	138.54	1.16	5.8	1.7	3.31	0.54	8.3	2.3	3.61	-0.53	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	226	199	1.14	0.8	3.2	0.24	0.00	16.8	2.9	5.76	0.00	2002
2003	221	196	1.13	0.8	3.1	0.25	0.00	15.8	2.7	5.84	0.07	2003
2004	223	200	1.12	0.8	3.2	0.24	-0.01	15.3	2.8	5.39	-0.44	2004
2005	230	206	1.12	0.7	3.2	0.22	-0.02	14.8	2.7	5.48	0.08	2005
2006	232	221	1.05	0.7	3.4	0.20	-0.02	13.3	3.0	4.52	-0.96	2006
2007	237	210	1.13	0.7	3.3	0.20	0.00	13.4	3.1	4.35	-0.17	2007
2008	236	208	1.14	0.6	3.2	0.20	0.00	12.8	3.2	4.04	-0.31	2008
2009	223	194	1.15	0.6	3.3	0.19	-0.01	11.7	3.3	3.57	-0.47	2009
2010	221	190	1.16	0.6	2.8	0.22	0.03	12.1	2.7	4.40	0.83	2010
2011	222	190	1.17	0.62	2.51	0.25	0.03	11.8	2.8	4.13	-0.26	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	134	113	1.18	4.0	1.3	3.07	0.00	13.6	1.1	11.90	0.00	2002
2003	137	116	1.18	4.2	1.4	3.05	-0.02	13.2	1.1	11.90	0.00	2003
2004	144	123	1.16	4.4	1.5	2.96	-0.09	13.5	1.2	11.21	-0.69	2004
2005	155	133	1.17	4.5	1.6	2.90	-0.06	13.5	1.4	9.79	-1.42	2005
2006	175	162	1.08	4.9	1.9	2.62	-0.28	14.5	1.7	8.74	-1.04	2006
2007	195	164	1.19	5.2	2.0	2.57	-0.05	15.3	1.8	8.49	-0.26	2007
2008	208	173	1.20	5.5	2.2	2.53	-0.04	15.5	2.0	7.85	-0.64	2008
2009	203	165	1.23	6.1	2.3	2.66	0.13	15.2	2.1	7.19	-0.66	2009
2010	211	171	1.24	5.4	2.1	2.63	-0.03	16.0	1.9	8.35	1.16	2010
2011	224	180	1.25	6.0	2.1	2.90	0.26	16.0	2.2	7.24	-1.11	2011
Trend												Trend

Table 7: Jobs-housing balance by income category

For low income workers, the following patterns emerge: In the transit corridor, the jobs-housing ratio improves dramatically, although this is product of the drop in the number of low income workers rather than an increase in the number of low income workers living in the corridor. The number of workers living in the 0.5 mile buffer around the corridor also declines from its height in 2006. The pattern of changes in the year on year changes displays no pattern. In the comparable corridor, the number of low income workers employed in the corridor continues to drop, even after it began to recover in the transit corridor.

The pattern in the jobs-housing ratio for medium income workers mimics that of low income workers, improving toward parity with the metropolitan jobs-housing ratio, but only as a result of a decline in the number of workers. Some deviation exists as a result of a spike in the number of medium income workers resident in the corridor, circa 2009, but this is insufficient to make a pattern.

For high income workers in the transit corridor, the pattern is dramatically different. The number of high income workers continued to rise steadily throughout the study period, although the post-recessionary trend is flatter. More surprisingly, the number of high income workers residing in the corridor also rose, and rose faster than the number of employees, resulting in jobs-housing ratio that improves toward parity with the metropolitan jobs-housing ratio, barring a spike in 2010.

Contrast with the comparable corridor for high income workers shows a similar pattern to the transit corridor, but number of workers resident in the comparable corridor peaks in 2009, so the jobs-housing ratio begins to move further from parity from that time forward.

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 2011	2011	2002	2002 to 2011	2011
Utilities	0.05		0.00	20.54		14.35
Construction	1.91		3.32	2.49		0.64
Manufacturing	2.91		3.44	1.14		1.01
Wholesale	1.90		3.03	4.77		2.49
Retail	2.79		2.98	6.02		2.79
Transportation	1.35		0.47	1.11		1.22
Information	1.72		1.35	9.20		6.73
Finance	1.66		2.00	10.40		7.15
Real Estate	2.92		1.86	5.56		4.33
Professional	1.58		1.39	12.42		10.53
Management	2.93		3.68	24.97		14.17
Administrative	3.03		2.21	4.51		4.25
Education	0.98		1.30	1.08		1.29
Health Care	1.38		1.36	1.78		2.12
Arts, Ent. Rec.	1.18		0.88	13.02		2.55
Lodging & Food	2.25		2.53	9.41		7.83
Other Services	2.61		2.16	4.62		4.90
Public Admin	16.38		18.52	13.55		17.19

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

Prior to the advent of transit, the transit corridor was extremely jobs-rich for a very large number of industries. The Management and Utilities industries had jobs-housing ratios over 20:1, and the Finance, Professional and Public Administration had ratios over 13:1.

Between 2002 and 2011, the jobs-housing ratio fell for almost all industries, with the notable exception of the Public Administration industry. The Education and Health Care industries also moved further from parity. The most dramatic changes toward parity occurred in the Management industry, which dropped from over almost 25 to just over 14. The only industries in the 0.5 mile buffer around the transit corridor not to improve toward parity were Construction and Manufacturing, both of which declined from greater than parity to below parity.

Discussion & Implications

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. It is difficult to draw any conclusion about the effects of transit on the jobs-housing balance because of the confounding effect of the Great Recession. Overall, there is minimal support for the idea that the University light rail line substantially improved jobs-housing balance.

Metropolitan regions grow outward from historic cores, with residential development taking place along the periphery, and employment and commercial development congregating in central locations and along highly accessible corridors. Over time, as the metropolitan region expands outward, so does the roadway network. As employment continues to concentrate along network corridors, the jobs-worker balance tends to improve, bringing areas into better jobs-worker parity with the metropolitan region. Thus, the jobs-worker balance is more likely affected by relative location within a metropolis than by the presence of transit.

The high jobs-worker ratio at the metropolitan level has problematic implications. Initially, it suggests that a very large number of workers are holding more than one job. The ratio comes closest to parity during 2006, at the height of the economic expansion, and declines rapidly with the Great Recession. This implies that for many, full-time work is no longer available, and the demand for additional wages is being met by taking on additional part-time jobs. While this phenomenon is partially explained by Utah's high dependency ratio, with a large number of children per adult, another explanation is needed.

Further investigation reveals the actual reason: Poor Core-Based Statistical Area boundaries. The Salt Lake Metro Area contains three counties: Tooele, Salt Lake, and Wasatch counties, running west to east. Yet the primary corridor for commuting, I-15, runs North-south, as does the Frontrunner Commuter Rail, connecting Davis County to the North, and Utah County to the South. While metropolitan areas are supposed to be independent containers for economic activity, it is clear that the Salt Lake CBSA is not, with significant commuting inflows from outside the metro area. The artificial division between Salt Lake and the others is explainable, as the three counties are politically and culturally different, but the division represents a major source of bias from a technical perspective. Davis County, in particular, is nearer to the transit corridor than most of Salt Lake County. This has unknowable impacts on the jobs-housing income and industry balance.

8-SUMMARY OF FINDINGS

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

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 Reduction: Arts/Entertainment/Recreation and Management
- Substantial Increase: Public Administration, Finance, Other Services, and Finances

Transit advantage over comparable corridor

- Major: Public Administration
- Did less badly: Arts/Entertainment/Recreation

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

Numeric Change in Transit corridor

- Change in employment is negative in the transit corridor, but positive for the metro
- Substantial numeric increases: Health Care and Public Administration
- Substantial percent increases: Health Care and Education
- Substantial reductions: Management and Arts/Entertainment/Recreation

Effect of corridor, as per shift-share

- Corridor effects very strongly negative
- Corridor Effect negative for industries except Education
- Corridor Effect most negative for Management
- Corridor Effect also strongly negative for: Retail, Finance, Professional, Arts/Entertainment/ Recreation, and Lodging/Food

Transit advantage over comparable corridor

- Education superior in transit corridor
- Transit corridor does less badly than the comparable corridor in Public Administration.

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: Transportation, Education, Health Care, Public Administration
- Strong trends: Health Care and Education

Transit Corridor Differences before and after Great Recession

- Phase Shift: Complete reversal of almost all trends
- Health Care only industry with positive trends before and after

- Health Care Trend stronger after 2008

Advantage over Comparable corridor:

- Better trends: Health Care
- More Resilient: Health Care
- Did less badly: Transportation, Education and Public Administration

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, largely as a result of housing.
- Transportation costs are higher nearer to the transit corridor.

Transit corridor changes in H+T costs 2000-2009

- H+T costs for the transit corridor change less than the metropolitan average.
- Transportation costs change more than housing costs, within 1.0 miles.
- Changes in transportation costs are higher nearer the transit corridor.
- Changes in housing costs negative beyond 1.0 miles of corridor.

Contrasts between transit and comparable corridors

- Change in H+T costs both less than metropolitan average.
- Change in H+T costs higher for transit corridor within 1.25 mile buffer.

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 metropolitan area 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.

Overall

- Highly job-rich at start of study period, with jobs-housing ratio 5 to 7 times greater than that of the metropolitan area.
- Erratic trends, big year on year changes, general decline.
- Changes in jobs-housing ratio caused by both declining number of workers and declining number of workers resident in the corridor.

Income

- Transit Corridor is job-rich for all income, most extremely for high income.
- Jobs-housing ratio improves for all income categories.
- Ratio is closest to parity for low-income workers.

Industry

- Most industries extremely job-rich in 2002, most still job-rich in 2011.
- Almost all industries have jobs-housing ratios that improve toward parity.
- Job-housing ratio increased: Public Administration
- Job-housing imbalance increased: Health Care and Education

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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	=[(b2+d2+f2-(a2+c2+e2)]/(a2+c2+e2)	=a*[(b2-a2)/a2]	=[(b-a)]-CS+IM for Sector A
Sector B	c	d	=(d-c)	=(d-c)/c	c2	d2	=(d2-c2)	=(d2-c2)/c2	=[(b2+d2+f2-(a2+c2+e2)]/(a2+c2+e2)	=b*[(d2-c2)/c2]	=[(b-a)]-CS+IM for Sector B
Sector C	e	f	=(f-e)	=(f-e)/e	e2	f2	=(f2-e2)	=(f2-e2)/e2	=[(b2+d2+f2-(a2+c2+e2)]/(a2+c2+e2)	=c*[(f2-e2)/e2]	=[(b-a)]-CS+IM for Sector C
Totals	a+c+e	b+d+f	=(b+d+f)-(a+c+e)	=[(b+d+f-(a+c+e)] / (a+c+e)	a2+c2+e2	b2+d2+f2	=(b2+d2+f2)-(a2+c2+e2)	=[(b2+d2+f2-(a2+c2+e2)] / (a2+c2+e2)	na	na	Sum of LEE for Sectors A, B & C