UTA MAX BRT

Salt Lake City, Utah

Do TODs Make a Difference?

THE UNIVERSITY OF UTAH
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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 happens to occur within the Transit Station Area (TSA), or half 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.

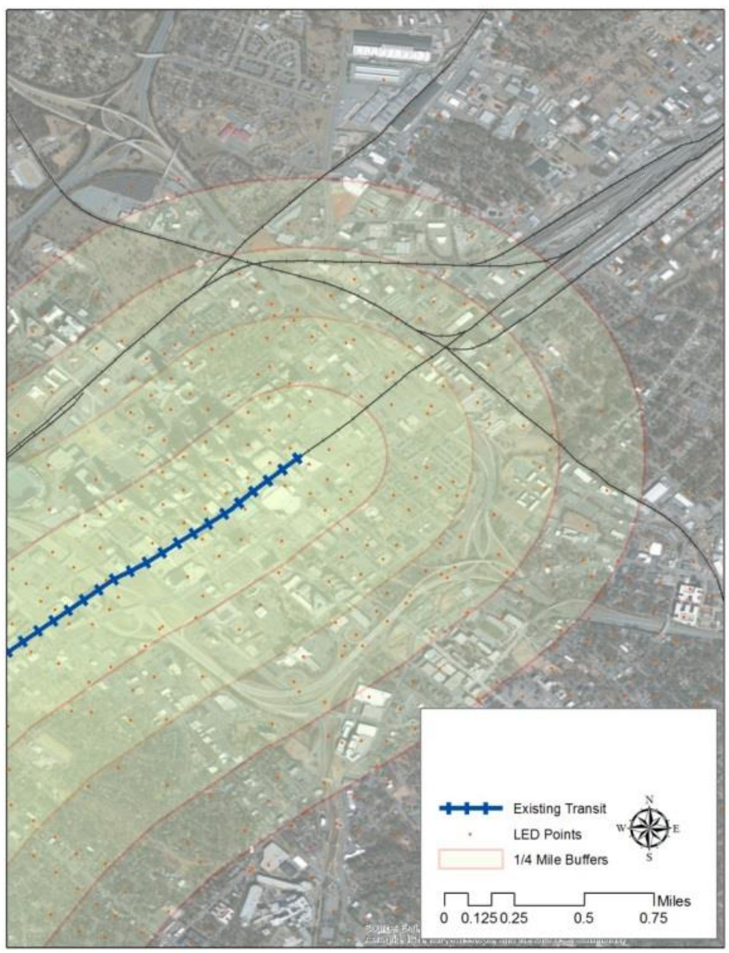

Figure 1: Example corridor, buffers, and LED census block points

Study Area

This study examines the Utah Transit Authority's MAX Bus Rapid Transit (BRT) system. The MAX bus corridor stretches about 14.4 miles from a light rail station to the peripheral mining town of Magna. The right-of-way includes sections of exclusive guide-way, dedicated lanes, and mixed traffic operations. It began operations in 2008. The comparable corridor is 5600 South, a primary arterial to the 3500 South Corridor used by MAX. The comparable corridor also connects to a TRAX light rail station, and uses ATK industries as its western anchor, rather than the town of Magna. Figure 2 shows the transit and comparable corridors as well as the location of LED points.

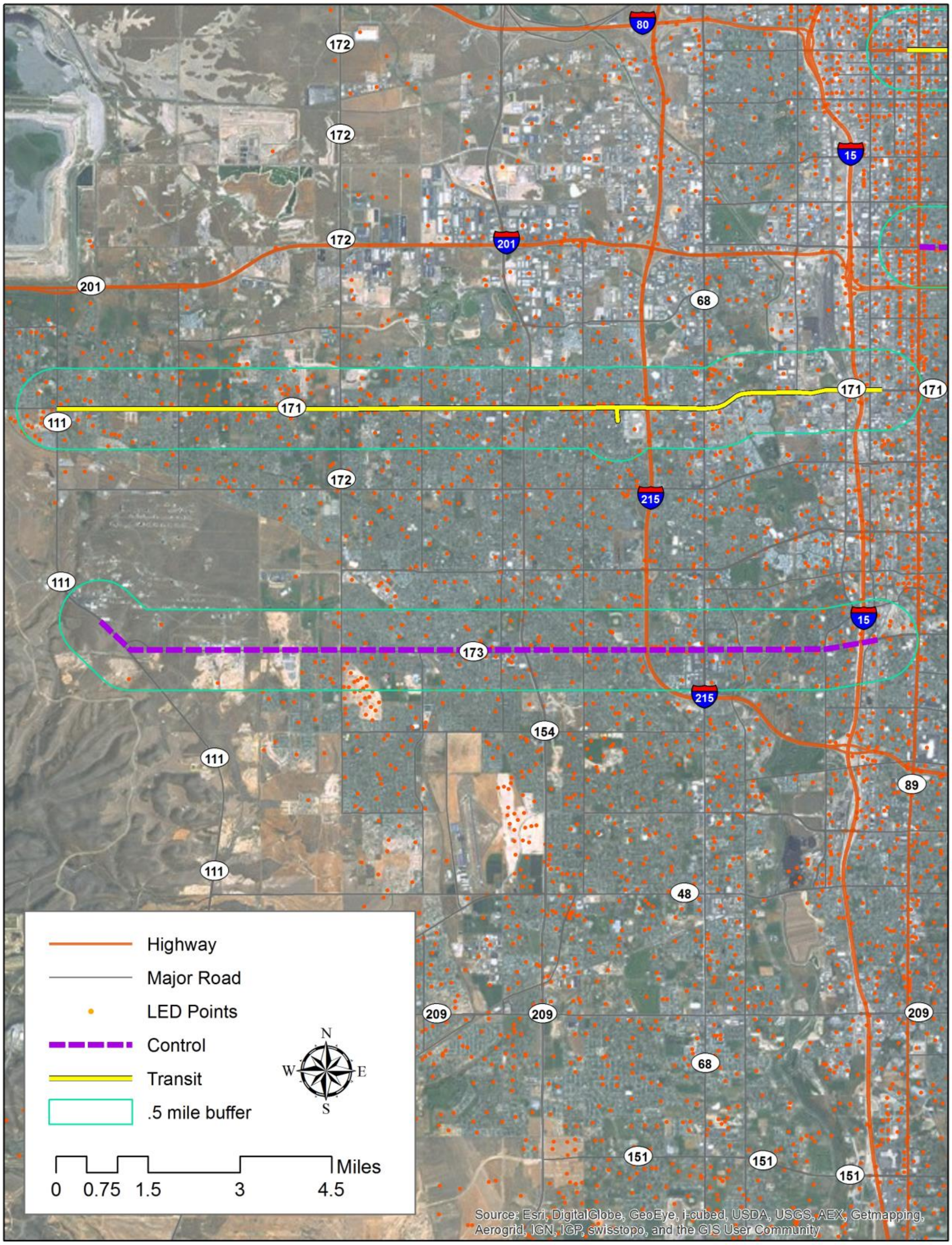

Figure 2: Transit and comparable corridor locations

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 are 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.

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		Differences in Changes
	2002	2002-2011	2011	Δ 2002-2008	Δ 2008-2011	Δ 2002-2008 & Δ 2008-2011
Utilities	0.49		0.55	-0.03	0.09	0.12
Construction	1.07		1.38	0.04	0.27	0.23
Manufacturing	0.89		1.08	0.20	-0.01	-0.21
Wholesale	1.26		1.28	0.41	-0.39	-0.79
Retail	1.69		1.54	-0.09	-0.06	0.04
Transportation	0.97		0.40	-0.21	-0.36	-0.16
Information	0.74		0.45	0.01	-0.30	-0.30
Finance	0.24		0.78	0.08	0.46	0.39
Real Estate	0.70		0.52	-0.07	-0.12	-0.05
Professional	0.80		0.42	-0.38	0.00	0.38
Management	0.69		0.28	-0.22	-0.18	0.04
Administrative	1.39		1.25	0.02	-0.16	-0.18
Education	0.75		0.82	0.07	0.00	-0.07
Health Care	0.60		0.57	-0.02	-0.01	0.01
Arts, Ent. Rec.	0.86		1.13	0.13	0.14	0.01
Lodging & Food	1.47		1.25	-0.12	-0.11	0.01
Other Services	1.00		1.00	-0.12	0.11	0.23
Public Admin	0.91		1.83	0.08	0.84	0.76

Table 1: Location quotients comparison for transit corridor

For the transit corridor, the sparklines show that the Transportation and Professional industries have declining trends that begin about the same time as the opening of transit. Numerous industries see significant changes in location quotient. The Public Administration, Finance, and Construction industries see the most significant increases, while the Wholesale, Transportation and Information industries see the most significant decreases.

Comparing the two time periods before and after the advent of the MAX BRT gives the differences in changes. A positive number indicates that the trend in location quotient is better after transit than before. The difference in changes strongly suggests that the MAX BRT has had a strong positive effect on the Public Administration, Finance, and Professional industries, and a less significant effect on the Other Services and Construction industries. This may indicate an increase in employment for those industries within the corridor, or a decline in employment in those industries outside the corridor.

The difference in changes also indicates a large decline in the location quotient of the Wholesale industry. The difference is large because of a strong positive trend prior to 2008 and a strong negative trend thereafter. The Information and Administrative industries also do poorly.

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.

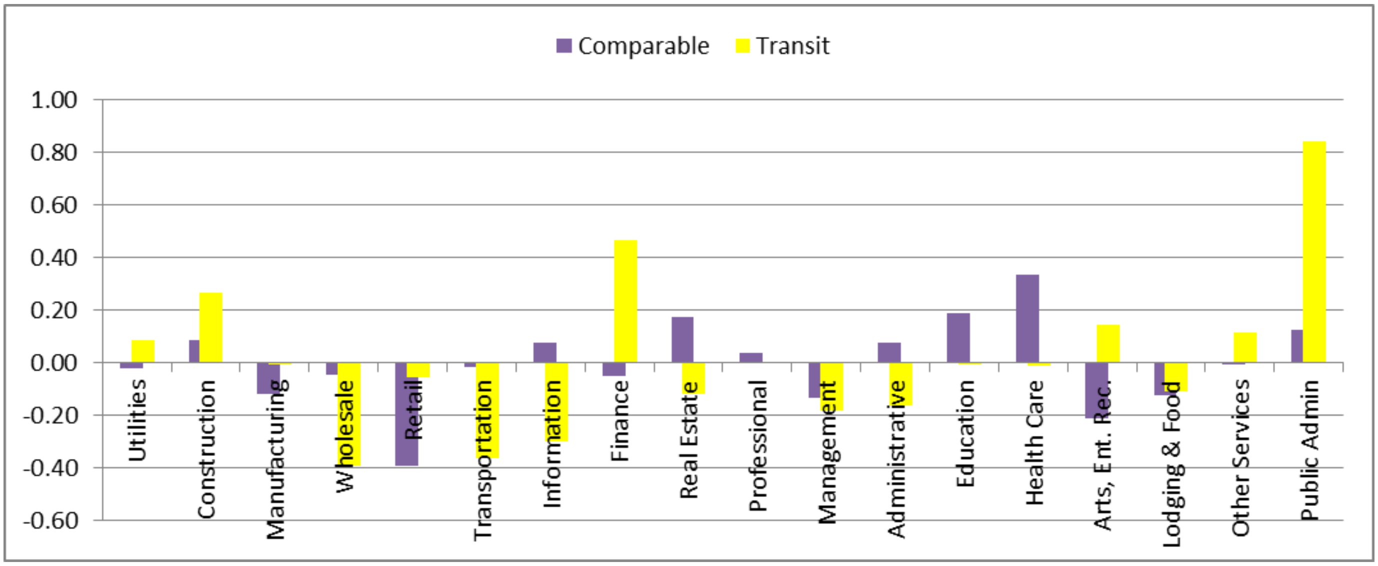

Figure 3: Changes in location quotient by corridor for the time period after the advent of transit

As the graph shows, the changes in location quotients vary significantly by corridor, after the advent of transit operations in 2008. The location quotient declined for most industries in the transit corridor, and for the comparable corridor. Very few industries experienced an increase in location quotient for both corridors, with the notable exception of Construction and Public Administration, both of which did better in the transit corridor. The transit corridor experienced more severe reductions in location quotient than the comparable corridor in the Wholesale and Management industries. Finance and Arts/Entertainment/Recreation did well in the transit corridor while doing poorly in the comparable corridor.

Discussion & Implications

The increase in the location quotient for the Construction industry is also somewhat of a red herring. Construction employment is strongly concentrated along I-15, especially near the 3300 South interchange. However, the MAX BRT may be providing a competitive advantage to these areas. The MAX BRT runs along a corridor characterized by low land values, industrial and farm sites, and low-cost housing. For industries associated with higher incomes, minor improvements in transportation accessibility might not be significant, but for a household dependent on transit, employment accessible to transit has great utility.

Growth in Public Administration is due to the County Jail and the construction of a new West Valley City Hall. In the latter case, the effect is confounded because the City Hall was located adjacent to the terminal station on the Green line light rail. The same line confounds changes in the location quotient for Finance, as the main sources of employment in that industry as they are closer to the light rail then the BRT. The same can be said for the Professional sector employment, which is concentrated around the (unrelated) Decker Lake Boulevard area and around the I-15 and main north-south light rail corridor.

The Arts/Entertainment/Recreation employment is largely clustered around the intersection of 3500 South and I-215, making it another confounder.

The presence of so many confounders suggests that the 0.5-mile buffer around a corridor is an inappropriate analytical geography for transit analysis. It is a buffer established less by empirical evidence than by custom and data limitations. That some people walk distances greater than 0.5 miles to transit has been rigorously established, as has a negative binomial relationship between distance and number of people willing to walk to transit, so any buffer distance is somewhat arbitrary. Using a smaller buffer would reduce the number of confounders.

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		
	2008	2011	# Change	% Change	2008	2011	# Change	% Change	Metro Share	Industry Mix Share	Corridor Effect
Utilities	3,243	3,193	(50)	-2%	64	79	15	0%	-1	(1)	17
Construction	40,323	29,395	(10,928)	-27%	1,919	1,827	(92)	-5%	-42	(520)	470
Manufacturing	57,330	52,992	(4,338)	-8%	2,677	2,584	(93)	-3%	-59	(203)	168
Wholesale	30,304	29,983	(321)	-1%	2,172	1,733	(439)	-20%	-48	(23)	(368)
Retail	72,955	68,125	(4,830)	-7%	4,994	4,730	(264)	-5%	-110	(331)	177
Transportation	29,762	28,828	(934)	-3%	978	524	(454)	-46%	-22	(31)	(402)
Information	17,443	17,598	155	1%	557	354	(203)	-36%	-12	5	(196)
Finance	40,436	39,123	(1,313)	-3%	541	1,369	828	153%	-12	(18)	857
Real Estate	11,362	10,290	(1,072)	-9%	310	241	(69)	-22%	-7	(29)	(33)
Professional	40,494	39,865	(629)	-2%	724	753	29	4%	-16	(11)	56
Management	15,734	15,098	(636)	-4%	312	192	(120)	-38%	-7	(13)	(101)
Administrative	43,398	43,563	165	0%	2,636	2,461	(175)	-7%	-58	10	(127)
Education	50,024	51,715	1,691	3%	1,765	1,918	153	9%	-39	60	132
Health Care	57,778	66,780	9,002	16%	1,448	1,722	274	19%	-32	226	80
Arts, Ent. Rec.	12,472	12,400	(72)	-1%	530	635	105	20%	-12	(3)	120
Lodging & Food	50,336	47,956	(2,380)	-5%	2,927	2,700	(227)	-8%	-64	(138)	(24)
Other Services	16,155	15,612	(543)	-3%	612	702	90	15%	-13	(21)	124
Public Admin	28,345	31,513	3,168	11%	1,204	2,603	1,399	116%	-26	135	1,291
Total	**617,894**	**604,029**	**(13,865)**	**-2%**	**26,370**	**27,127**	**757**	**3%**	**(580)**	**(906)**	**2,243**

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

The entire metropolitan area suffers a minor decline in employment of about 2 percent. The transit corridor does much better, with an increase in employment of about 3 percent. This represents an increase of 757 jobs. In numeric terms, the industries that enjoy the most significant numeric increases are Public Administration followed by Finance. The Health Care, Education and Arts/Entertainment/Recreation industries also add jobs. The most significant percentage increases in employment occur in the aforementioned industries, and also in the Other Services sector. For reasons discussed earlier, Finance and Public Administration can be disregarded, as they are more likely responding to proximity to the Green line light rail. Significant numeric declines occur in the Transportation and Wholesale industries, and significant percentage declines occur in the Transportation and Information industries.

After using shift-share analysis to disaggregate the cause of change in employment, different patterns emerge. All of the employment growth 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 declines, versus a notable increase. The broad base of the positive effect is notable, affecting all but five industries. Disregarding the confounding effects of the Green line light rail on Finance and Public Administration, the net effect is still positive.

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 employment 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 zero 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	3	2.7	15	17	1.2	14	15	-1.6
Construction	-197	198	1.0	-92	470	5.1	105	272	4.1
Manufacturing	-185	50	-0.3	-93	168	1.8	92	218	2.1
Wholesale	-21	12	-0.5	-439	-368	-0.8	-418	-357	-0.3
Retail	-781	-464	-0.6	-264	177	0.7	517	640	1.3
Transportation	-12	-9	-0.7	-454	-402	-0.9	-442	-393	-0.2
Information	81	86	1.1	-203	-196	-1.0	-284	-282	-2.0
Finance	-14	36	2.6	828	857	1.0	842	822	-1.5
Real Estate	55	77	1.4	-69	-33	-0.5	-124	-109	-1.9
Professional	149	202	1.4	29	56	1.9	-120	-146	0.6
Management	-56	-47	-0.8	-120	-101	-0.8	-64	-54	0.0
Administrative	211	231	1.1	-175	-127	-0.7	-386	-358	-1.8
Education	576	551	1.0	153	132	0.9	-423	-419	-0.1
Health Care	1430	1060	0.7	274	80	0.3	-1156	-979	-0.4
Arts, Ent. Rec.	-68	-63	-0.9	105	120	1.1	173	183	2.1
Lodging & Food	-129	-29	-0.2	-227	-24	-0.1	-98	5	0.1
Other Services	17	36	2.1	90	124	1.4	73	88	-0.7
Public Admin	172	153	0.9	1399	1291	0.9	1227	1138	0.0
Total	**1192**	**1915**	**1.6**	**760**	**2228**	**2.9**	**-472**	**312**	**1.3**

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 largest for the Public Administration and Finance industries, and most negative for the Information industry.

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 Construction, Manufacturing and Professional industries, and it is highly negative for Information, Wholesale, Management, and Administration.

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 confirms that the Construction industry does much better in the transit corridor, as do Manufacturing and Arts/Entertainment/Recreation.

Discussion & Implications

Two light rail lines (Green and Blue) and the MAX BRT make a triangle containing interchanges between three different Interstates (I-15, I-80, and I-215), so that the 0.5-mile buffer around the MAX BRT represents a highly accessible area for either commuters or freight. A highly accessible central location would typically be highly congested by through traffic, but more transit means fewer cars and thus, less congestion. Transit benefits those who do not ride it, after all. This may explain the relative strength of the Retail industry, which is highly sensitive to accessibility and congestion.

While it is easy to disregard the corridor effect on Finance and Public Administration as result of proximity to the TRAX light rail Green line, the benefits of congestion mitigation effects on the surrounding area cannot be ignored. While employment in Public Administration can be moved by dictate, employment in the Finance industry is more sensitive to market considerations.

The numeric and percent changes in the employment for the Transportation and Wholesale industries suggests that low rent uses are being relocated outside the corridor, but the corridor effect contradicts this, with strong positive corridor effects for the Construction and Manufacturing industries.

The MAX BRT enjoys high ridership, indicating a high level of use. Part of this can be attributed to its high level of network connectivity, linking two light rail lines together. But it can also be attributed to the transportation benefit it provides on its own. Most rail transit is built for commuters as a response to limitations on freeway capacity, and tends to be situated to serve office workers in peripheral suburbs that consume the largest volume of freeway lane capacity. In contrast, the MAX BRT represents a 'best bus', upgrading an existing bus route to a higher standard of service. The MAX BRT serves a lower income portion of the valley, for who quality transit offers an alternative to more costly, less reliable automobile transportation. Cheaper cars are typically older and less reliable. Firms in auto-dependent locations have auto-dependent employees. Firms in transit accessible locations likely enjoy lower labor costs through non-wage advantages such as reduced absenteeism/lateness caused by unreliable transportation.

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.

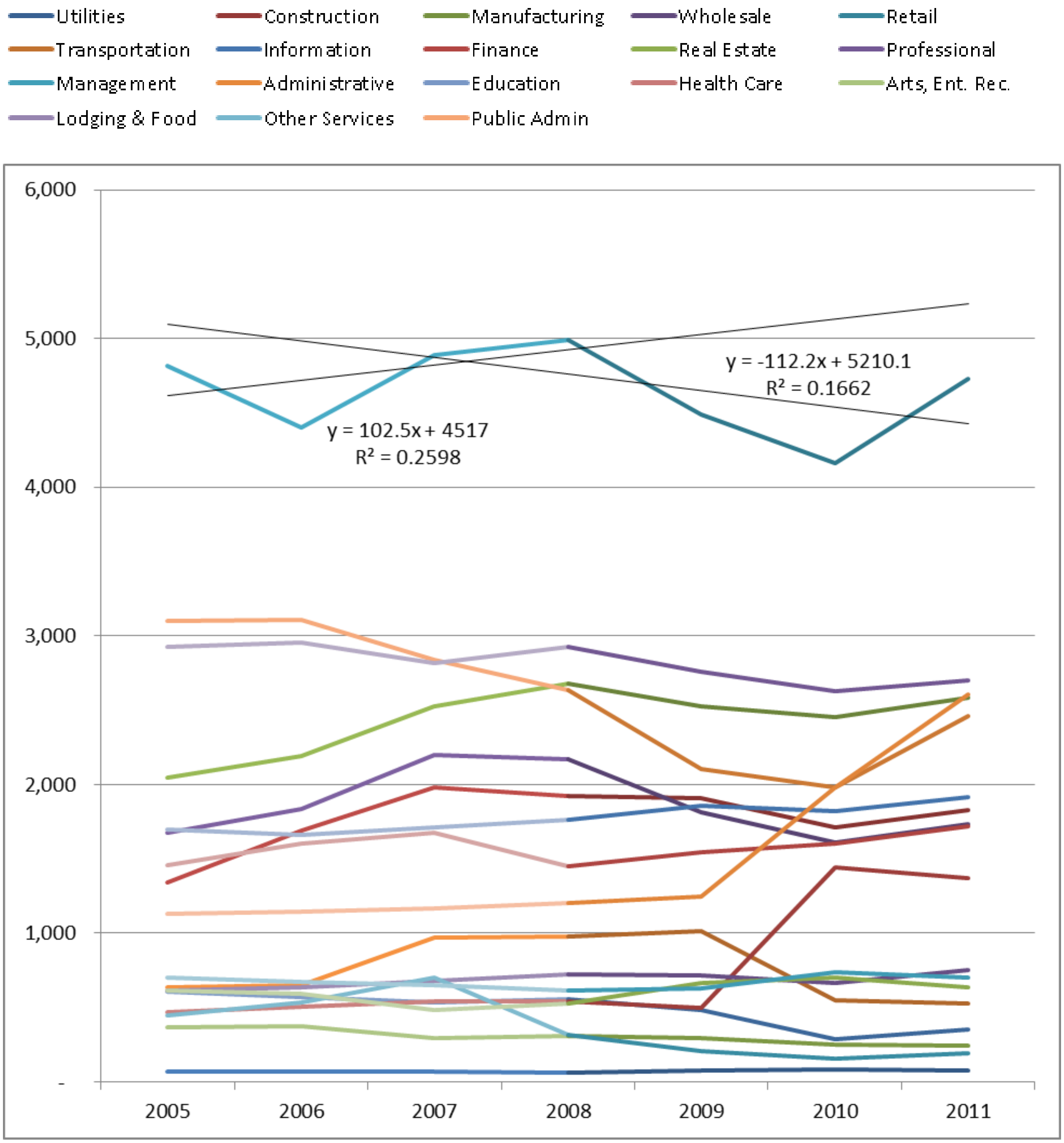

Figure 4: Regression trend lines and R-squared values for different industries

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	-1	-1%	0.07	5	6%	0.60	5	7%	0.53
Construction	202	12%	0.82	-47	-3%	0.41	-249	-14%	-0.41
Manufacturing	223	9%	0.97	-35	-1%	0.23	-258	-11%	-0.74
Wholesale	186	9%	0.86	-152	-8%	0.66	-338	-18%	-0.20
Retail	103	2%	0.26	-112	-2%	0.17	-215	-5%	-0.09
Transportation	133	16%	0.83	-183	-24%	0.78	-317	-40%	-0.04
Information	-17	-3%	0.59	-81	-19%	0.73	-64	-16%	0.13
Finance	25	5%	0.90	343	36%	0.74	318	31%	-0.16
Real Estate	-23	-7%	0.65	-25	-9%	0.92	-2	-2%	0.27
Professional	37	6%	0.97	3	0%	0.01	-34	-5%	-0.96
Management	-23	-5%	0.03	-41	-19%	0.62	-17	-14%	0.59
Administrative	-166	-6%	0.89	-65	-3%	0.08	101	3%	-0.81
Education	27	2%	0.61	42	2%	0.68	15	1%	0.07
Health Care	4	0%	0.00	88	6%	0.98	83	5%	0.98
Arts, Ent. Rec.	-36	-6%	0.62	35	6%	0.38	71	12%	-0.24
Lodging & Food	-13	0%	0.07	-81	-3%	0.68	-69	-3%	0.61
Other Services	-29	-4%	0.98	38	6%	0.69	67	10%	-0.29
Public Admin	23	2%	0.93	494	28%	0.91	470	26%	-0.02
Total	763	3%	0.79	230	1%	0.07	-532	-2%	-0.72

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

At 1 percent, total employment growth after the nadir in 2008 is about a third of its pre-recessionary level, 2 percentage points lower. Employment continued to grow, but at a much lower rate, and on a very uncertain basis. The R^2 for the post-recessionary period is almost zero, indicating very erratic trends and a highly uncertain recovery.

Many industries that were growing prior to the recession fail to do so afterward. Only seven industries had positive trends after the recession, of which only four had positive trends prior to the recession. In addition to Finance and Public Administration, the Education and Health Care industries had positive trends in employment both before and after the recession. A number of industries in the corridor appear to have been strengthened by the recession, with negative trends before and positive trends after. The Utilities, Arts/Entertainment/Recreation and Other Services industries all display this behavior.

Comparing the differences between the two time periods illustrates which industries were resilient. Resilient industries should do at least as well after the recession as before. The differences in Trend % show that the most resilient industries were Finance, followed by Public Administration. Comparing the difference in R^2 provides of measure of the strength of these trends. While the Finance industry shows some weakening in trend, the trend is rock solid for Public Administration. The Health Care and Utilities industries show significant upticks in the R^2, indicating previously erratic trends become much more consistent. Industries with positive trends but negative changes in R^2, such as the Arts/Education/Entertainment and Other Services industries changed from negative trends to positive trends.

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	5	7%	0.53	-3	-6%	-0.36	8	13%	0.89
Construction	-249	-14%	-0.41	-121	-9%	0.48	-128	-5%	-0.89
Manufacturing	-258	-11%	-0.74	-209	-17%	-0.25	-49	6%	-0.49
Wholesale	-338	-18%	-0.20	-25	-9%	0.08	-313	-9%	-0.28
Retail	-215	-5%	-0.09	-398	-13%	-0.06	184	8%	-0.03
Transportation	-317	-40%	-0.04	3	3%	-0.20	-320	-44%	0.15
Information	-64	-16%	0.13	98	20%	-0.17	-162	-36%	0.31
Finance	318	31%	-0.16	-90	-12%	-0.93	408	43%	0.77
Real Estate	-2	-2%	0.27	34	15%	-0.01	-36	-18%	0.27
Professional	-34	-5%	-0.96	-72	-8%	0.12	39	3%	-1.08
Management	-17	-14%	0.59	-12	-10%	0.47	-5	-4%	0.11
Administrative	101	3%	-0.81	56	5%	0.30	46	-3%	-1.12
Education	15	1%	0.07	147	6%	0.25	-132	-5%	-0.18
Health Care	83	5%	0.98	-125	-24%	0.13	208	29%	0.85
Arts, Ent. Rec.	71	12%	-0.24	-48	-31%	0.14	119	43%	-0.38
Lodging & Food	-69	-3%	0.61	-95	-7%	-0.62	26	5%	1.23
Other Services	67	10%	-0.29	12	3%	0.25	55	7%	-0.54
Public Admin	470	26%	-0.02	21	7%	-0.40	449	19%	0.38
Total	-532	-2%	-0.72	-852	-6%	-0.48	320	4%	-0.24

Table 5: Comparison of resilience by corridor

Comparison of the two corridors suggests that the transit corridor has the advantage in a large number of industries. Resilient industries near transit should have a greater or equal positive trend after the recession than before. Determining which industries are more resilient in the transit corridor requires comparing Trend % between the two corridors. The difference in Trend % is very large for a number of industries, notably Finance, Arts/Entertainment/Recreation, and Health Care, but the differences are largely the result of bad 'Trend % in the comparable corridor. In the few industries in which both corridors have a positive trend, the comparable corridor has better Trend % than the transit corridor for the Education and Administration industries, while the transit corridor does much better for the Other Services and Public Administration industries. The differences furnish a final piece of analysis, with R^2 values that suggest that the trend for the Other Services industry is weak in contrast to the comparable corridor, while that for Public Administration is quite 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. In the transit corridor, the Finance, Public Administration, Education, and Health Care industries all meet this criterion. Comparison suggests that the resilience of the Education industry is overstated. The resilience of the Financial Industry has less to do with the resilience of existing employment, and much to do with new office development along Decker Lake Boulevard. The resilience of Health Care and Education employment make theoretical sense. The health care providers along the transit corridor include Pioneer Valley Hospital and two 'urgent care' facilities, both of which are focused on providing emergency medical care, which tends to be non-discretionary. Education is one of the few industries to have enjoyed a general uptick during the Great Recession, as the unemployed elected to increase employability with additional credentials. The actual sources of Education employment along the transit corridor are diverse. They include a number of local primary and secondary schools, as well as technical academies for dental, pharmacy and driving, preparatory/preschools and a large number of martial arts studios. The school employment reflects the age of the street, which has been an important East-West route for decades. The location of the academies and martial arts studios reflect the age of the street in another way, as it is lined with aging retail strip malls. No longer able to attract prime tenants, they have become leasable space for quasi-office uses. Old buildings are cheap buildings.

Finally, while some of the resilience of Public Administration can be explained by the relocation of the city hall for West Valley City. The Salt Lake County Jail, Oxbow Jail, and Juvenile Justice Services are all near 3300 South. Economic downturns cause hard times, leading to additional crime, leading to additional need for prisons, and for prison guards.

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.

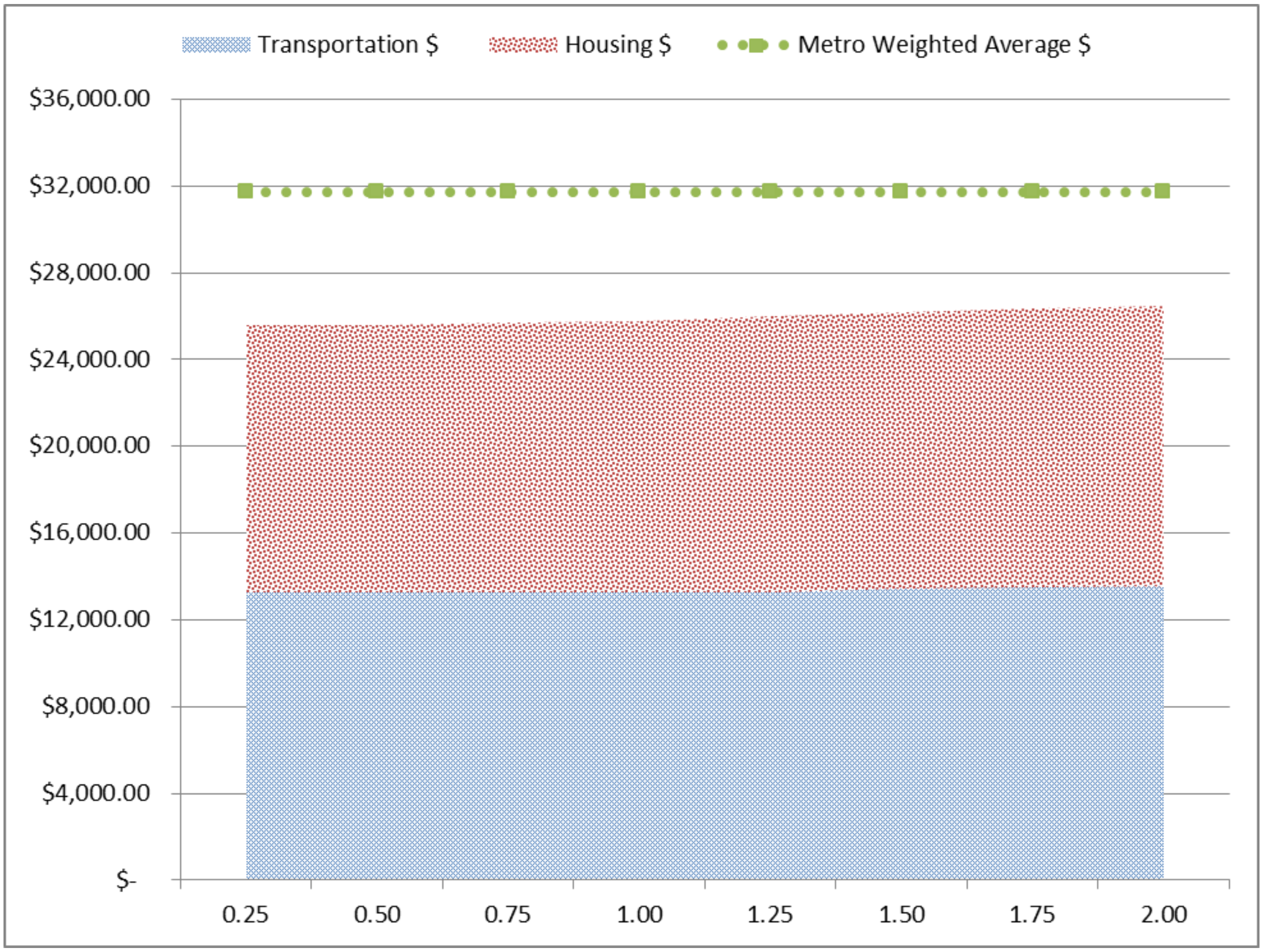

Figure 5: Housing, transportation, and H+T costs for the transit corridor, 2009, by buffer distance

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.

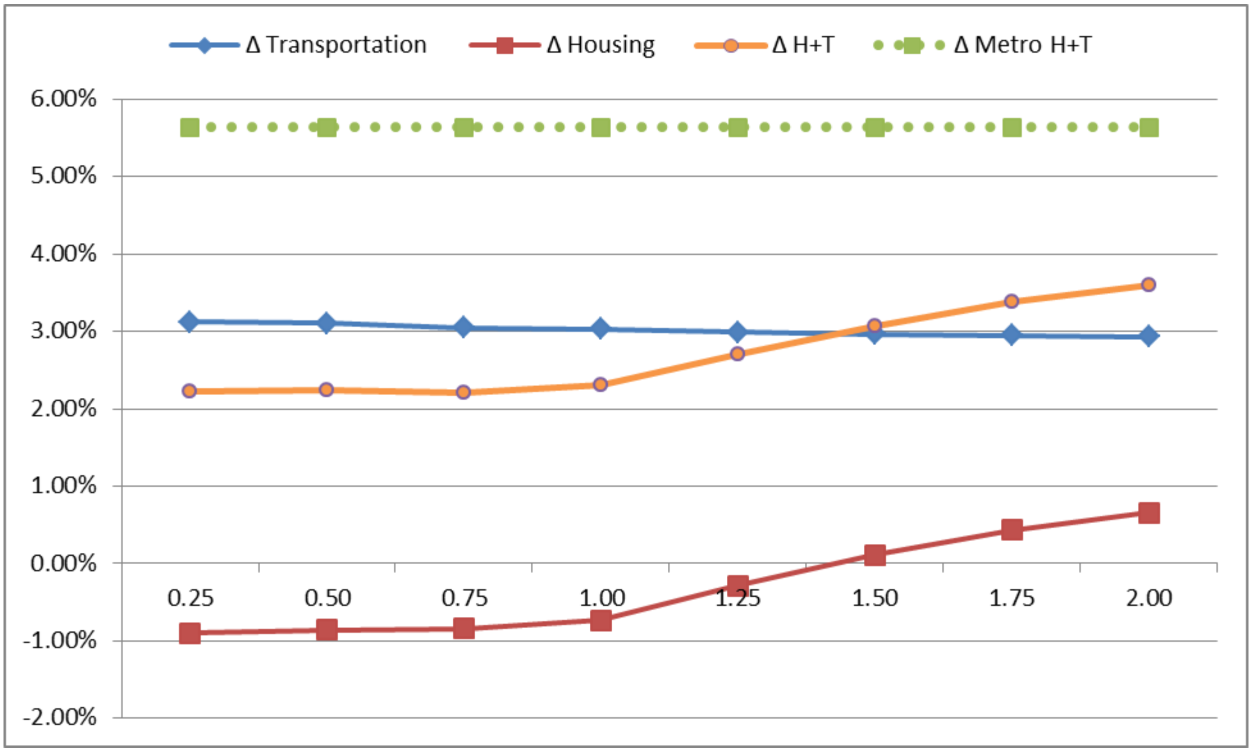

Figure 6: Change in housing and transportation costs, 2000-2009, for transit corridor, by buffer distance

The changes in H+T costs for the transit corridor are significantly different than the metro as a whole. Changes in H+T costs vary with distance to the transit corridor, and the change is less nearer the transit corridor. This is due not to transportation costs but to changes in housing costs. The change in housing cost is actually negative within 1.5 miles of the transit corridor, and rises with distance from the corridor. Changes in the transportation costs in the transit corridor are much larger than the changes in housing costs. Changes in transportation costs 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.

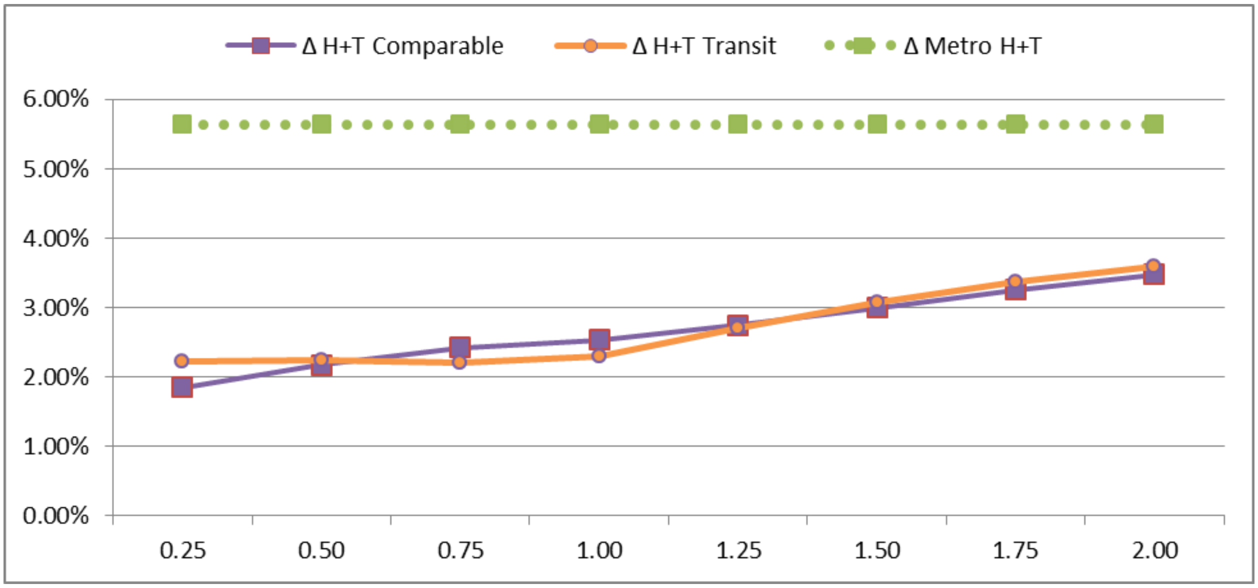

Figure 7: Changes in H+T, 2000-2009, for transit and comparable corridors, by buffer distance

The transit and comparable corridors display almost similar patterns in changes in H+T costs. While the increase in H+T costs is slightly higher within the 0.25 mile buffer, it is slightly lower for the 0.75 and 1.00 mile buffers. For other distances, it tracks the comparable corridor almost exactly.

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

While housing costs are lower nearer the transit line, transportation costs are not. Almost all of the lower H+T costs associated with proximity to the MAX can be assigned to lower housing costs. The area along 3500 South does not represent a desirable neighborhood. The west side of the Salt Lake Valley has historically been the location for industrial and noxious uses, and for lower-income housing. The reason for difference in changes in housing cost with proximity to the MAX BRT is likely actually responding to 3500 South. 3500 South has been a state highway connecting the outlying town of Magna to the rest of the valley for decades. As the primary corridor, it has accumulated substantial amounts of automobile-oriented strip development, intermixed with aging houses and semi-vacant lots. As the area was long outside the development horizon of local planners, no alternatives streets were planned for the area for decades. As the area has developed and traffic has grown, 3500 South has been forced to shoulder the majority of traffic, growing steadily wider, busier, and more congested. The competition with the TRAX light rail for transit oriented development may also play a role. With limited resources, local cities have concentrated their efforts on creating TOD around TRAX station. The regulation, financial incentives, and direct investment have been directed toward the TRAX stations.

Additionally, the MAX is not characterized by visible infrastructure investment. While some of the stations are undeniably substantial, not all are, and some are little more than bus shelters. While the route has a dedicated lane on the western half of the route, where traffic is light, MAX must operate in mixed traffic on the congested eastern half of the route, where the saving from a dedicated lane would be greatest. In contrast, TRAX right of way is concrete (rather than asphalt), with dedicated curbs.

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 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 the North American Industrial Classification System (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.

	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	Year
2002	545	473	1.15	13.1	21.4	0.61	0.00	24.7	25.4	0.97	0.00	2002
2003	533	468	1.14	13.7	20.7	0.66	0.05	24.4	24.7	0.99	0.01	2003
2004	544	483	1.13	13.7	21.7	0.63	-0.03	23.6	26.1	0.90	-0.08	2004
2005	563	498	1.13	14.3	22.7	0.63	0.00	24.7	26.4	0.94	0.03	2005
2006	587	554	1.06	15.5	25.6	0.61	-0.02	25.2	29.0	0.87	-0.07	2006
2007	612	533	1.15	16.7	23.3	0.72	0.11	27.0	28.2	0.96	0.09	2007
2008	621	535	1.16	18.1	23.0	0.79	0.07	26.7	28.7	0.93	-0.03	2008
2009	587	499	1.18	17.6	23.3	0.75	-0.03	25.1	26.0	0.97	0.04	2009
2010	593	498	1.19	18.0	20.0	0.90	0.15	25.2	24.4	1.03	0.06	2010
2011	607	508	1.20	19.3	19.5	0.99	0.09	27	26.8	1.02	-0.01	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 slightly job-poor. The transit corridor has 15-20 percent fewer jobs per worker than the metropolitan area. The ratio does improve with the advent of transit in 2008, but erratically. The ratio improves the year prior to the advent of transit, but falls in 2008. The number of workers in the corridor fell steadily from 2007 to 2010. The number of workers resident in the corridor fell as well, but shows after the advent of transit. The comparable corridor is also less job-rich, but has moved steadily toward parity, moving from 0.61 to 0.99 over time. It has much large and more consistent year on year changes than the transit corridor.

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												
	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	Year
2002	184	161.29	1.14	5.4	7.1	0.76	0.00	10.3	8.4	1.22	0.00	2002
2003	176	156.50	1.12	5.6	6.7	0.83	0.07	10.0	8.0	1.24	0.02	2003
2004	177	159.44	1.11	5.4	6.9	0.77	-0.06	9.9	8.4	1.19	-0.06	2004
2005	177	159.52	1.11	5.4	7.1	0.77	-0.01	9.8	8.2	1.19	0.00	2005
2006	180	171.32	1.05	5.7	7.7	0.74	-0.02	9.5	8.6	1.11	-0.08	2006
2007	179	159.39	1.13	6.0	6.7	0.90	0.16	9.3	8.1	1.14	0.03	2007
2008	177	155.08	1.14	6.1	6.3	0.97	0.07	9.3	7.8	1.19	0.05	2008
2009	161	140.35	1.15	5.4	6.3	0.86	-0.12	8.5	6.8	1.25	0.06	2009
2010	160	137.81	1.16	5.4	5.4	1.00	0.14	8.0	6.4	1.25	-0.01	2010
2011	161	138.54	1.16	5.9	5.3	1.12	0.12	8.7	7.2	1.21	-0.04	2011
Trend												Trend

Medium Income												
	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	Year
2002	226	199	1.14	0.5	10.2	0.05	0.00	9.5	13.0	0.73	0.00	2002
2003	221	196	1.13	0.5	9.9	0.05	0.00	9.5	12.7	0.75	0.02	2003
2004	223	200	1.12	0.5	10.2	0.05	0.00	9.0	13.5	0.67	-0.08	2004
2005	230	206	1.12	0.5	10.7	0.05	0.00	9.4	13.6	0.69	0.02	2005
2006	232	221	1.05	0.6	11.7	0.05	0.00	9.7	14.5	0.67	-0.02	2006
2007	237	210	1.13	0.6	10.5	0.06	0.01	10.4	13.7	0.76	0.09	2007
2008	236	208	1.14	0.7	10.2	0.07	0.01	10.2	13.9	0.74	-0.02	2008
2009	223	194	1.15	0.7	10.4	0.07	0.00	9.4	12.8	0.73	0.00	2009
2010	221	190	1.16	0.7	8.7	0.08	0.01	9.2	11.7	0.79	0.05	2010
2011	222	190	1.17	0.70	8.45	0.08	0.01	9.9	12.6	0.78	0.00	2011
Trend												Trend

High Income												
	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	Year
2002	134	113	1.18	3.0	4.2	0.71	0.00	4.8	3.9	1.24	0.00	2002
2003	137	116	1.18	3.2	4.0	0.79	0.08	4.9	4.0	1.24	0.00	2003
2004	144	123	1.16	3.4	4.6	0.74	-0.05	4.6	4.3	1.09	-0.15	2004
2005	155	133	1.17	3.6	4.9	0.73	-0.01	5.5	4.5	1.22	0.13	2005
2006	175	162	1.08	4.0	6.2	0.65	-0.08	6.0	5.9	1.01	-0.21	2006
2007	195	164	1.19	4.5	6.2	0.73	0.08	7.3	6.4	1.14	0.14	2007
2008	208	173	1.20	5.2	6.4	0.81	0.07	7.2	7.0	1.03	-0.12	2008
2009	203	165	1.23	5.3	6.6	0.80	-0.01	7.2	6.4	1.12	0.09	2009
2010	211	171	1.24	5.9	5.8	1.01	0.21	7.9	6.3	1.26	0.14	2010
2011	224	180	1.25	6.3	5.8	1.09	0.08	8.9	7.0	1.27	0.00	2011
Trend												Trend

Table 7: Jobs-housing balance by income category

In the transit corridor, the number of workers displays a characteristic pattern induced by the recession, declining from a high point in 2007, and only beginning to recover in 2011 (with higher income workers recovering first). The number of worker-residents in the corridor follows the same pattern, lagging by about a year. The transit corridor is slightly job-rich for low income workers, job-poor for medium income workers, and nearly balanced for high income workers. None of the income categories display a consistent pattern in reaction to the beginning of the operation of the MAX BRT.

The pattern of changes in the number of workers (shown by the sparkline) is not significantly different from the metropolitan area, with the exception of the number of low income workers, which declined more steadily in the transit corridor. The pattern of number of low income worker residing within the half mile buffer around the transit corridor is likewise similar.

Contrast with the comparable corridor shows little relationship to the transit corridor. While the jobs-housing ratio for low income workers is similar prior to the advent of transit, the comparable corridor also shows large year on year improvements toward parity between workers living in the corridor and working in the corridor. The number of medium income workers in the comparable corridor does not permit a reasonable comparison. The jobs-housing ratio for high income workers in the comparable corridor shows no relationship to transit. The comparable corridor also posts strong year on year changes toward parity after 2008.

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 2008	2008	2008 to 2011	2011	2002	2002 to 2008	2008	2008 to 2011	2011
Utilities	0.00		0.32		0.48	0.59		0.43		0.58
Construction	0.71		0.77		0.99	0.83		0.80		1.13
Manufacturing	0.30		0.52		0.59	0.55		0.64		0.71
Wholesale	0.20		0.24		0.25	1.07		1.35		1.20
Retail	1.19		1.23		1.20	1.74		1.44		1.48
Transportation	0.05		0.06		0.05	0.79		0.56		0.33
Information	1.22		0.63		0.95	0.87		0.80		0.60
Finance	0.45		0.69		0.83	0.23		0.33		0.98
Real Estate	0.39		0.50		0.85	0.77		0.77		0.60
Professional	0.97		1.20		1.48	1.09		0.54		0.63
Management	0.35		0.31		0.21	0.78		0.59		0.36
Administrative	0.37		0.65		0.90	1.32		1.24		1.13
Education	1.07		1.21		1.60	0.90		0.95		0.96
Health Care	0.42		1.34		2.07	0.73		0.63		0.68
Arts, Ent. Rec.	0.27		0.57		0.40	1.49		1.70		2.00
Lodging & Food	0.99		0.89		0.89	1.54		1.52		1.27
Other Services	0.70		0.57		0.80	0.99		0.97		1.05
Public Admin	0.11		0.23		0.43	0.97		1.08		2.46

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

Prior to the advent of transit, the transit corridor is jobs-rich for the following industries: Wholesale, Retail, Arts/Entertainment/Recreation, and Lodging/Food, and job-poor for all others. Following the advent of transit, the jobs-worker ratio for Retail and Arts/Entertainment/Recreation industries became less balanced, while the Wholesale and Lodging/Food industries experience an improvement in jobs-housing balance, toward parity. Construction experienced a dramatic improvement in the jobs-worker ratio, as did Finance. The ratio became dramatically less balanced for Public Administration.

Contrast with the comparable corridor shows that it also experienced an improvement in the jobs-worker ratio for Construction and Finance, although not as strongly as the transit corridor. The job-worker balance improved for Public Administration, but remained well 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 for the MAX BRT because both the number of employees and number of employees resident in the transit corridor only show signs of recovery in 2011.

Overall, there is minimal support for the idea that BRT substantially improves jobs-housing balance. Year on year changes are erratic, with no clear trend standing out. The transit corridor moves toward parity with the metropolitan area for the jobs-worker ratio, but the comparable corridor does so, and much more strongly.

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 jobs-housing ratio improves to become more balanced for only a small number of industries, and 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 MAX BRT is not just a transit line, but it is part of a transfer network of transit routes. In addition to intersecting the Red, Blue and Green TRAX light rail lines, it is also possible to transfer to three additional frequent (15 min headway) bus routes (33, 217, 41) and seven additional bus routes. In addition to the MAX bus (signed 35M), UTA also runs a local bus (bus 35) along the same street. Effectively gauging the effect on jobs-housing balance would require evaluating the jobs-worker balance over the whole transit network.

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

- Declines: Transportation and Professional
- Substantial Increase: Public Administration, Finance, & Construction
- Substantial Reductions: Wholesale, Transportation, & Information
- Transit induced increases: Public Administration, Finance, & Professional
- Transit induced reductions: Wholesale, Information, Administrative

Transit advantage over comparable corridor

- Substantial: Finance, Arts/Entertainment/Recreation
- Minor: Construction, Public Administration

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

Numeric Change in Transit corridor

- Change in employment is positive in the transit corridor, but negative for the metro.
- Substantial numeric increases: Public Administration & Finance
- Substantial percent increases: Public Administration & Finance
- Substantial reductions: Transportation, Wholesale & Information

Effect of corridor, as per shift-share

- All employment growth attributable to corridor effect.
- Corridor Effect largest for Public Administration, Finance, & Construction.
- Corridor Effect strongly negative corridor effect on Wholesale & Transportation.
- Corridor Benefit largest for Construction, Manufacturing, & Professional.

Transit advantage over comparable corridor

- Public Administration similar for both.
- Finance inferior in transit corridor.
- Construction, Manufacturing, and Arts/Entertainment/Recreation

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: Finance and Public Administration

- Strong trend strength but minor trend: Healthcare

Transit Corridor Differences before and after Great Recession

- Significantly Improved Trend: Finance & Public Administration
- Significantly Worsened Trend: Transportation

- Trend Strength weaker after Great Recession: Finance & Other Services

Advantage over Comparable corridor:

- Better trends: Finance, Arts/Entertainment/Recreation, & Health Care
- Better positive trends: Other Services & Public Administration
- More Resilient: Education and Health Care

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 slightly 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 1.5 miles.
- Changes in transportation costs are slightly higher nearer the transit corridor.
- Changes in housing costs negative within 1.25 miles of corridor.

Contrasts between transit and comparable corridors

- Change in H+T costs for transit and comparable corridors near identical.
- Change in H+T costs slightly higher for transit within 0.25 miles.

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.

- Slightly job-poor 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 any income category.
- Job-rich before, became more balanced after: Wholesale & Lodging/Food
- Job-poor before, became more balanced after: Construction & Finance
- Contrast with comparable corridor confirms Construction & Finance

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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