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Blue Line/South Corridor LRT

Sacramento, California

Do TOD's 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 was 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 enhanced by adding the transit modes for all stations. (Some stations serve more than one mode).

While the CTOD database contained routes, it did not identify the corridor for each station. Most transit routes make use of multiple corridors. While routes change in response to operational needs, a corridor consists of a common length of right-of-way that is shared by a series of stations on the corridor. Typically, all stations along a corridor begin active service at the same time. Transit systems grow by adding additional corridors to the network. Initial systems typically 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 Google Earth, the path of the corridor was traced. The corridor was then exported as a KML file and imported into a geodatabase in ArcGIS.

Creation of Comparable Corridors

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

Comparable Corridors Criteria

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

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

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 additional 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 that are oriented 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.

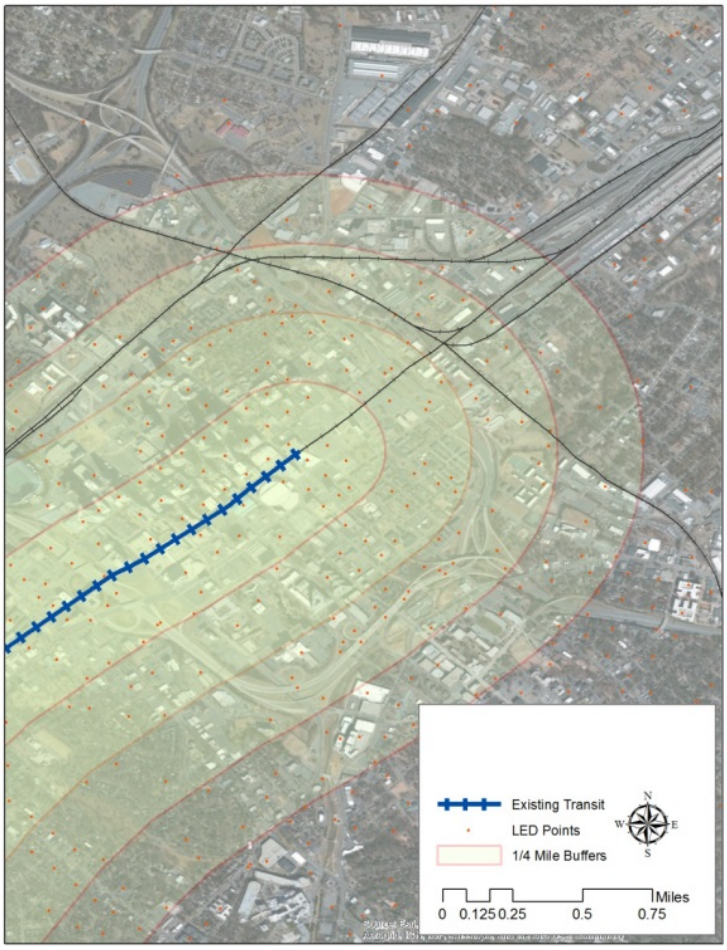

Figure 1: Example corridor, buffers, and LED census block points

Study Area

This study examines Sacramento Regional Transit Districts light rail system. The corridor analyzed is the South Line corridor that was added on to the south of the Blue line. It is small section, about 5.5 miles long, with only 7 stations, characterized by massive park and rides. It began operations in 2003. The comparable corridor was a Southern Pacific railroad corridor running parallel to the line, about 2 miles west of the transit corridor. While there were other comparable rail corridors, the Southern Pacific railroad corridor was judged to have the greatest similarity of land uses. Figure 2 shows the transit and comparable corridors as well as the location of LED points.

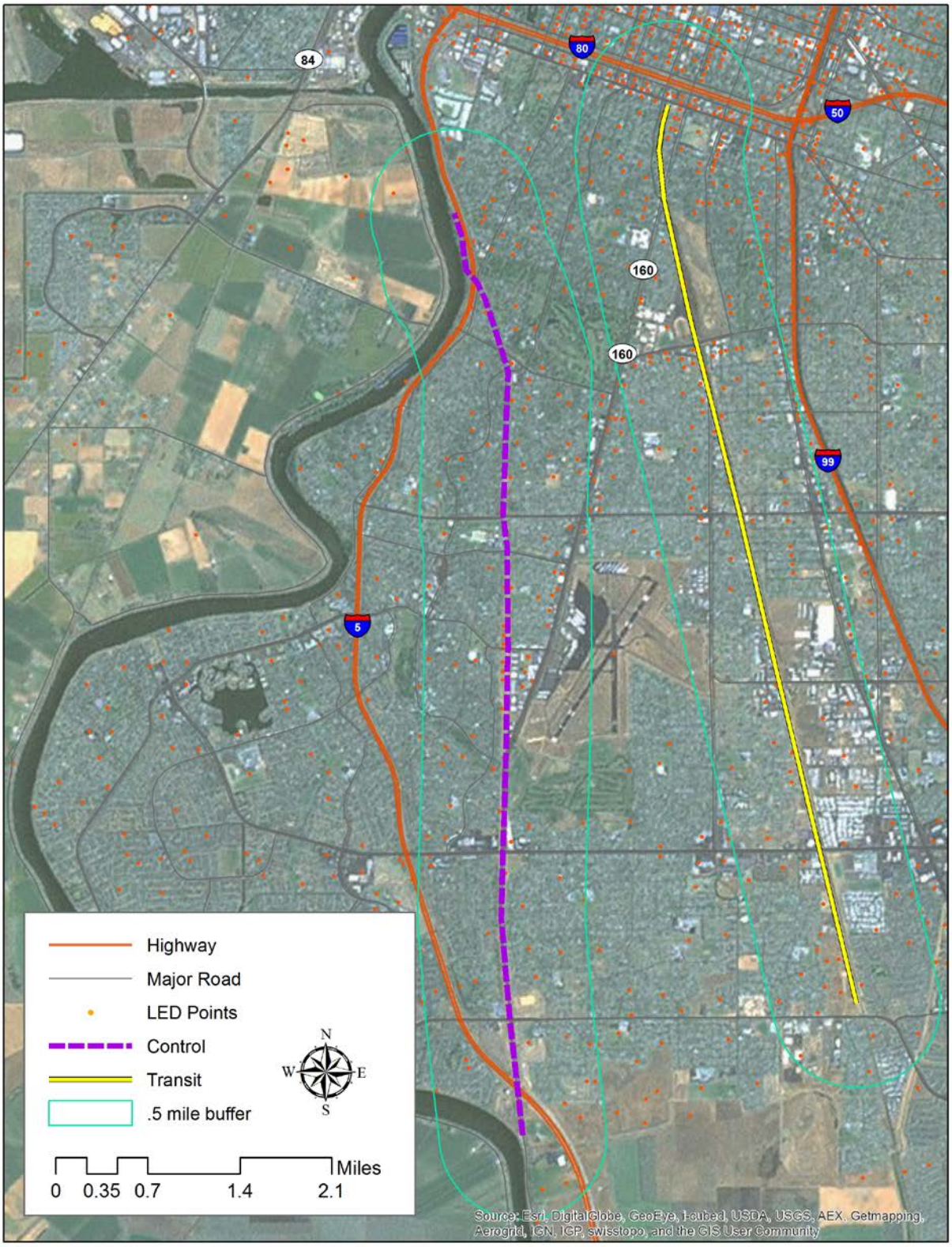

Figure 2: Transit and comparable corridor locations

3-EMPLOYMENT CONCENTRATION

Introduction

This section is intended to determine if TODs are more attractive to certain NAICS 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 0.5mile buffer around each corridor was used as the unit of analysis.

Results

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

Industry	Location Quotient			Changes		Differences in Changes
	2002	2002-2011	2011	Δ 2002-2003	Δ 2003-2011	Δ 2002-2003 & Δ 2003-2011
Utilities	0.08		0.13	0.08	-0.03	-0.12
Construction	1.05		0.53	-0.01	-0.52	-0.51
Manufacturing	0.91		0.56	0.15	-0.50	-0.65
Wholesale	0.49		0.41	0.00	-0.07	-0.07
Retail	1.01		0.48	0.02	-0.55	-0.57
Transportation	1.11		1.07	0.15	-0.19	-0.34
Information	0.14		0.34	0.00	0.20	0.20
Finance	2.96		0.16	-0.43	-2.36	-1.93
Real Estate	0.54		0.41	0.03	-0.15	-0.19
Professional	0.63		0.56	-0.01	-0.06	-0.05
Management	0.78		2.00	0.11	1.12	1.02
Administrative	0.75		0.40	0.05	-0.40	-0.46
Education	1.63		1.41	0.03	-0.26	-0.29
Health Care	1.15		0.48	-0.01	-0.65	-0.64
Arts, Ent. Rec.	0.11		0.10	-0.04	0.03	0.06
Lodging & Food	0.82		0.59	0.01	-0.24	-0.25
Other Services	0.82		1.50	-0.10	0.78	0.87
Public Admin	0.00		2.74	0.00	2.74	2.74

Table 1: Location quotients comparison for transit corridor

For the transit corridor, after the advent of transit (2003-2011), the most significant increases in location quotient occur in the Public Administration industry. The Management and Other Services industries also enjoy increases. There is a slight increase in the location quotient for the Information industry.

Differences between the two time periods (2002-2003 and 2003-2011) show the differences in between location quotient differences before and after transit. A positive number indicates that the changes in location quotient after transit are greater than those before. The difference in changes again highlights the industries of Public Administration, Other Services, and Management. Examining the sparklines suggests that the change in the location quotient of Public Administration is unrelated to transit, as it occurs in 2010, years after the advent of transit. Neither the Other Services industry, nor the Management industry show a spike after transit, but the location quotient for the Management shows a steady increase.

Most of the other industries experience a decline in the location quotient, most notably the Finance industry, which is highly concentrated in the area near transit in 2001, but almost absent in 2011. The next most severe declines are in the Health Care and Retail industries, either a result employment losses or as a result of increasing employment elsewhere in the region. The sparklines of the location quotient show no sharp declines in location quotients for the Retail, Finance or Health Care industries, only a general and sustained declined.

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

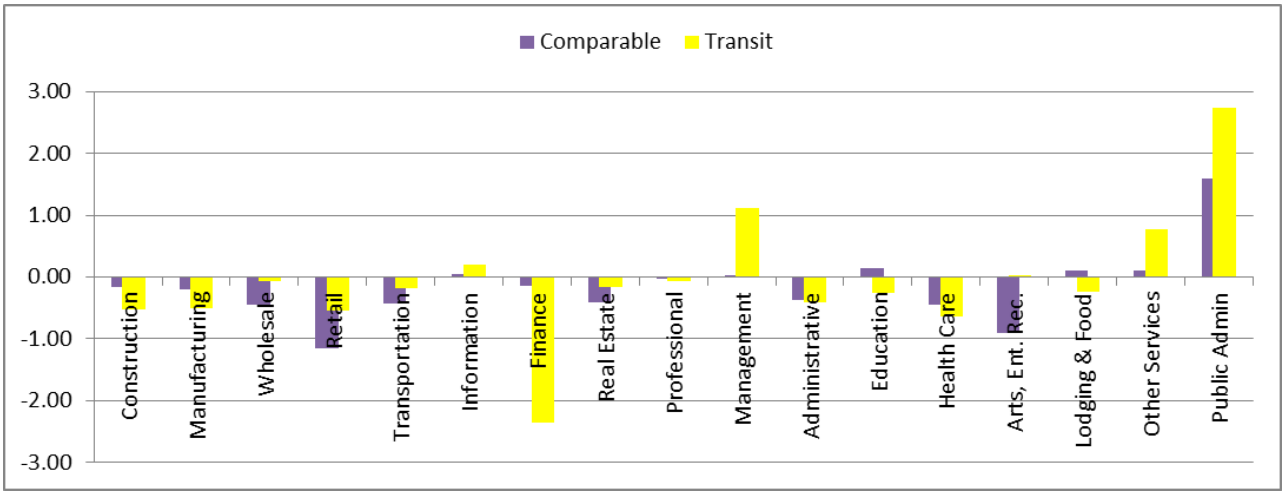

Figure 3: Changes in location quotient by corridor for the time period after the advent of transit

Because the magnitude of effect of the Utilities industry outweights other trends, it has been omitted from the chart to improve the visual comparability between the corridors.

For all industries, the changes in location quotient varies significantly by corridor type. Contrast with the comparable corridor confirms the success of the Public Administration industry, as well as the Other Services and Management industry, all of which experience greater increases in location quotient than the comparable corridor. The relative difference between the two corridors also makes notable the relative success of the Retail and Arts/Entertainment/Recreation industries, which declined less for the Transit corridor than for the Comparable corridor, and reinforces the severity of the decline in the location quotient for the Finance industry, which is much more severe in the transit corridor.

Discussion & Implications

As in most western cities, the presence of a rail corridor predates all other development. Additional development responds to its presence, either directly or indirectly. The commercial development along many rail corridors consists of warehousing and transportation related uses. The pattern of residential development tends to consist of single family homes on cul-de-sacs adjacent to the rail line. For pedestrians, a rail corridor is a barrier. As few streets cross it, its presence decreases connectivity. The lack of street connectivity means that the walking environment around most rail corridors is very poor. Combined with low residential densities, walk to transit access is minimal. Ergo, most access to transit stations is by car. Thus, the land nearest the station, which is the best, most developable land for transit oriented development, is typically used for surface parking lots. The area around the South line exemplifies this pattern. This has implications for development along the line.

Many trips originate along the South Line, but (barring Sacramento City College) there are no destinations. The only other major employment centers are on Broadway. It serves only to connect suburban locations to downtown Sacramento. Lacking a terminal anchor, the South Line is just a commuter corridor. It seems likely that most of the changes in location quotient associated with the South Line actually occur on the north end of the line, where the buffer reaches slightly inside the beltway.

The uptick in the location quotient in the Public Administration and Management industries are common, as both are office-associated uses. The declines in Construction, Manufacturing, and Retail are reasonable, given that they represent low-density uses. But the steady decline in Finance is curious. The concentration of Finance Industry employment near Broadway and 17th, west of the Broadway station, simply faded away over time.

4-EMPLOYMENT GROWTH BY SECTOR

Introduction

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

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

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

Data and Methods

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

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

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

Results

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

NAICS Sector	Metro				Transit Corridor				Sources of Employment Change		
	2003	2011	# Change	% Change	2003	2011	# Change	% Change	Metro Share	Industry Mix Share	Corridor Effect
Utilities	6,728	7,222	494	7%	18	20	2	0%	2	1	(2)
Construction	62,265	35,974	(26,291)	-42%	1,069	407	(662)	-62%	143	(451)	(354)
Manufacturing	45,453	33,222	(12,231)	-27%	790	398	(392)	-50%	106	(213)	(285)
Wholesale	28,469	26,297	(2,172)	-8%	228	235	7	3%	31	(17)	(6)
Retail	86,423	84,028	(2,395)	-3%	1,467	877	(590)	-40%	197	(41)	(746)
Transportation	20,381	20,552	171	1%	423	475	52	12%	57	4	(8)
Information	15,825	16,257	432	3%	36	119	83	231%	5	1	77
Finance	44,289	36,370	(7,919)	-18%	1,839	127	(1,712)	-93%	247	(329)	(1,630)
Real Estate	14,529	12,310	(2,219)	-15%	136	110	(26)	-19%	18	(21)	(23)
Professional	44,740	55,835	11,095	25%	454	670	216	48%	61	113	42
Management	11,916	12,390	474	4%	173	535	362	209%	23	7	332
Administrative	43,969	43,754	(215)	0%	579	374	(205)	-35%	78	(3)	(280)
Education	83,198	85,991	2,793	3%	2,278	2,610	332	15%	306	76	(50)
Health Care	70,750	101,079	30,329	43%	1,317	1,048	(269)	-20%	177	565	(1,010)
Arts, Ent. Rec.	17,171	18,778	1,607	9%	21	41	20	95%	3	2	15
Lodging & Food	62,454	69,272	6,818	11%	851	874	23	3%	114	93	(184)
Other Services	53,001	53,560	559	1%	633	1,733	1,100	174%	85	7	1,008
Public Admin	30,479	129,412	98,933	325%	-	7,642	7,642	#DIV/0!	0	-	7,642
Total	**742,040**	**842,303**	**100,263**	**14%**	**12,312**	**18,295**	**5,983**	**49%**	**1,652**	**(207)**	**4,538**

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

The entire metropolitan area enjoys a substantial increase in employment of about 14 percent. The transit corridor does yet better, with an increase in employment of 49 percent. This still represents an increase of about 6,000 jobs. In numeric terms, the Public Administration industry enjoys the lion's share of the increase, with the Other Services industry a distant second with 1,100 jobs. In addition, both industries post a significant percentage increase, as does the Management industry. The Information industry also has a high percentage increase, but represents only a small number of jobs.

The Finance industry experiences a dramatic decline in employment of over 1,700 jobs. Construction and Retail industry employment is also reduced by over 500. In addition, both industries suffer substantial percentage declines, as does the Manufacturing industry.

After using Shift-Share analysis to disaggregate the cause of change in employment, different patterns emerge. About a third of the change in employment can be attributed to metro-scale trends, a minimal amount of the mix of industry, and the majority to the corridor effect. The corridor effect has its strongest positive effect on the Public Administration industry, followed by the Other Services industry. Management is the only other industry to benefit from the corridor effect. In contrast, the Finance and Healthcare industries decline can be largely attributed to strongly negative corridor effect. While a

declining industry explains some of the losses in Finance industry employment, Health Care is a robust and growing industry, making the declines within the corridor even more significant.

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. That the Corridor Effect is specific to transit can be discerned by contrasts with the comparable corridor. The Corridor Benefit aids in comparison by providing a metric that is independent of the magnitude of employment. The Corridor Effect is provided for both as a reference.

Industry	Comparable			Transit			Transit Advantage		
	# Change	Corridor Effect	Corridor Benefit	# Change	Corridor Effect	Corridor Benefit	Difference, # Change	Difference, Corridor Effect	Difference, Corridor Benefit
Utilities	460	458	1.0	2	-2	-0.9	-458	-459	-1.0
Construction	-57	-27	-0.5	-662	-354	-0.5	-605	-327	-0.1
Manufacturing	-27	3	0.1	-392	-285	-0.7	-365	-288	-0.8
Wholesale	-27	-36	-1.3	7	-6	-0.9	34	29	0.4
Retail	-250	-353	-1.4	-590	-746	-1.3	-340	-393	0.1
Transportation	-38	-45	-1.2	52	-8	-0.2	90	37	1.0
Information	39	29	0.7	83	77	0.9	44	48	0.2
Finance	-1	6	6.1	-1712	-1630	-1.0	-1711	-1636	-7.0
Real Estate	-3	-1	-0.3	-26	-23	-0.9	-23	-23	-0.6
Professional	122	63	0.5	216	42	0.2	94	-21	-0.3
Management	3	3	1.0	362	332	0.9	359	329	-0.1
Administrative	7	-26	-3.7	-205	-280	-1.4	-212	-254	2.3
Education	168	145	0.9	332	-50	-0.2	164	-195	-1.0
Health Care	102	-105	-1.0	-269	-1010	-3.8	-371	-906	-2.7
Arts, Ent. Rec.	-8	-49	-6.1	20	15	0.8	28	64	6.8
Lodging & Food	310	216	0.7	23	-184	-8.0	-287	-400	-8.7
Other Services	177	140	0.8	1100	1008	0.9	923	868	0.1
Public Admin	1528	1504	1.0	7642	7642	1.0	6114	6138	0.0
Total	**2505**	**1926**	**na**	**5983**	**4538**	**na**	**3478**	**2611**	**na**

Table 3: Shifts by corridor and comparison between corridors

For the transit corridor, the Corridor Benefit for the transit corridor is largest for the Public Administration industry at 1.0. Four other industries (Information, Management, Arts/Entertainment/Recreation, and Other Services) also have high Corridor Benefits of 0.9. Lodging and Food and Healthcare have Corridor Benefit numbers that are strongly negative. The Corridor Benefit for Retail and Finance are also negative (-1.3 and -1.0, respectively), and represent substantial numbers of employees.

Contrast with the comparable corridor shows that the Corridor Benefit is substantially greater in the transit corridor for the Arts/Entertainment/Recreation industry, and the Administrative industry. In both cases, the Corridor Benefit is a relative one, a consequence of the very poor showing in the comparable corridor. The Information industry shows that the difference in Corridor Benefit favors the transit corridor, despite both corridors having benefitted from their respective corridor effects. Finally,

differences in the Corridor Benefit suggest that presence in the transit corridor is detrimental to the Lodging & Food industry.

Discussion & Implications

As with many transit lines, the greatest increase in employment along transit lines is in Public Administration. Typically, this is because it is the type of employment that policy can most directly affect, by relocating employment to be near transit stations by fiat. The second great growth area along the transit corridor is for 'Other Services', which represent a heterogenous variety of services that share only a common only in being low-rent uses making use of depreciated buildings. Such firms may be making use of older office, retail establishments or warehouses near the transit line. Whether they represent bottom feeders, extracting residual value from decaying structures, or 'pioneer species', heralding an area revitalization, is uncertain. The decline in Finance is difficult to attribute causally to transit, as it appears to be contained within two buildings some distance from the Broadway station, and proceeds steadily 2002-2011. The increase in employment in the Management industry is the next most significant, both as a percent increase and as a numeric increase. It is likely unrelated to transit. While impossible to establish with certainty, it seems likely the increased employment occurs at Conway Freight, on Franklin Boulevard. While it falls within the half mile buffer of the corridor, it has no relation to the transit station. The decline in Manufacturing industry employment seems to occur in the same industrial, so the switch may merely represent employment reclassification. The reduction in health care employment seems to be caused by the loss of a number of pharmacies near the corridor. Also notable are the changes in Information and Arts/Entertainment/Recreation employment. While they represent small changes, much of the change can be attributed to the Corridor Benefit, and for the Information industry, are confirmed by comparison to the comparable corridor. Finally, both Lodging/Food and the Retail industry have high negative Corridor Benefits, suggesting locations in the corridor are detrimental to both. Given that the greatest recent land use change has been clearance for park and rides, this suggests they may have been on the land cleared to provide parking for the transit stations.

5-EMPLOYMENT RESILIENCE

Introduction

Resilience is a characteristic 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 2008.

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 (Education). The trend lines and associated R^2 values for all industry sectors can be found in Table 4. For ease of visual comparison, Public Administration has been omitted.

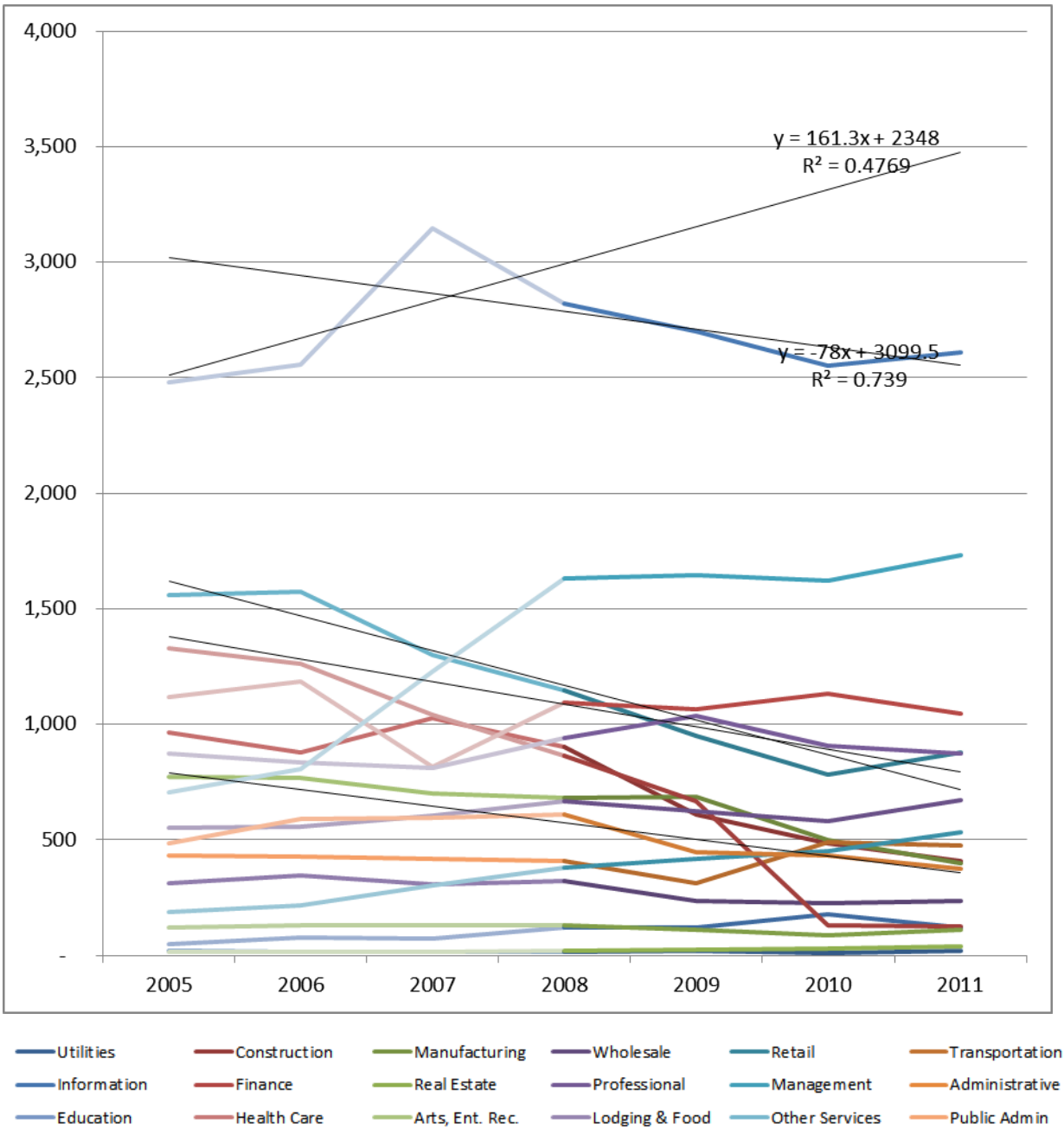

Figure 4: Regression trend lines and R-squared values for different industries

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. Trend indicates whether total employment increases or decreases during each time period. A negative trend indicates overall loss of employment while a positive trend indicates overall 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	-12%	0.95	1	6%	0.07	3	18%	-0.89
Construction	-4	0%	0.01	-161	-27%	0.91	-157	-26%	0.91
Manufacturing	-33	-5%	0.90	-105	-18%	0.89	-72	-14%	0.00
Wholesale	-3	-1%	0.03	-26	-10%	0.60	-24	-10%	0.56
Retail	-151	-11%	0.88	-98	-10%	0.67	53	0%	-0.21
Transportation	-8	-2%	0.99	38	9%	0.38	46	11%	-0.61
Information	21	27%	0.84	5	4%	0.06	-16	-23%	-0.79
Finance	-162	-14%	0.96	-274	-61%	0.89	-113	-47%	-0.07
Real Estate	2	2%	0.48	-8	-7%	0.35	-10	-9%	-0.13
Professional	39	7%	0.91	-3	-1%	0.01	-43	-7%	-0.90
Management	67	25%	0.97	50	11%	0.95	-17	-13%	-0.02
Administrative	38	7%	0.72	-72	-15%	0.85	-110	-22%	0.13
Education	161	6%	0.48	-78	-3%	0.74	-239	-9%	0.26
Health Care	-44	-4%	0.12	-7	-1%	0.06	37	4%	-0.06
Arts, Ent. Rec.	2	12%	0.58	7	24%	0.99	6	13%	0.41
Lodging & Food	19	2%	0.18	-33	-4%	0.38	-52	-6%	0.20
Other Services	319	29%	0.95	28	2%	0.52	-291	-28%	-0.42
Public Admin	12	120%	0.60	2997	81%	0.82	2985	-39%	0.22
Total	274	2%	1.00	2262	15%	0.74	1988	13%	-0.26

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

In the pre-recessionary period (prior to 2008), only a few industries had falling employment, although those which did had very negative trends, notable the Finance and Retail industries. The Education and Other Services industries were adding employment at the fastest rate. In addition to the Public Administration industry, the Information, Management, and Other Services industries all experienced

high growth rates. The R2 value indicates that the trends for the Information and Management industries were consistent. During the 2008 to 2011 (recessionary) period, many industries had falling employment, but a number of industries continued to have strong positive trends, notably the Public Administration industry. While many industries have high growth rates (Trend %), contrasting them with the number of employees (Trend #) added shows that only the Transportation and Management industries add a substantial number of jobs. The R2 value for each industry indicates that growth in employment was a consistent pattern only for the Management and Public Administration industries.

Difference between the pre- and post- recessionary periods should reveal which industries are resilient. For employment in an industry to be resilient, the post-recessionary trend should be both positive, and equal to or greater than the pre-recessionary trend. Only the Public Administration industry meets these criteria.

Emergent industries are those industries that actually do better in the psot-recessionary period. They may represent a phase shift or transition away from a pre-recession industrial ecology and toward a new and different one. Emergent industries are characterized by flat or falling trends prior to the recession, but large positive trends following the recession. The Transportation industry follows this pattern.

Comparing R2 values of different industries before and after the Great Recession makes it possible to determine the consistency of trends. Trend #'s represent a line fitted to the data points, an averaging value of sorts, which only track general trends. R2 is a kind of meta-measure of that measure. It indicates that the trend consistency increases for the Public Administration industry.

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	3	18%	-0.89	139	110%	0.61	-136	-93%	-1.49
Construction	-157	-26%	0.91	-85	-56%	0.27	-73	30%	0.64
Manufacturing	-72	-14%	0.00	90	65%	-0.23	-161	-79%	0.23
Wholesale	-24	-10%	0.56	13	11%	-0.42	-36	-20%	0.98
Retail	53	0%	-0.21	6	0%	-0.30	48	1%	0.08
Transportation	46	11%	-0.61	10	22%	-0.69	37	-11%	0.08
Information	-16	-23%	-0.79	-10	-13%	-0.81	-6	-10%	0.02
Finance	-113	-47%	-0.07	15	9%	0.17	-128	-56%	-0.25
Real Estate	-10	-9%	-0.13	-6	-4%	0.57	-5	-5%	-0.70
Professional	-43	-7%	-0.90	-52	-26%	0.10	10	19%	-1.00
Management	-17	-13%	-0.02	0	-23%	-0.29	-17	9%	0.27
Administrative	-110	-22%	0.13	78	40%	0.43	-188	-63%	-0.30
Education	-239	-9%	0.26	-124	-38%	-0.08	-115	29%	0.34
Health Care	37	4%	-0.06	3	0%	0.65	34	3%	-0.71
Arts, Ent. Rec.	6	13%	0.41	3	1%	0.07	3	12%	0.34
Lodging & Food	-52	-6%	0.20	33	5%	0.61	-85	-11%	-0.41
Other Services	-291	-28%	-0.42	-90	-26%	-0.41	-201	-1%	-0.01
Public Admin	2985	-39%	0.22	456	-6%	0.02	2529	-33%	0.20
Total	1988	13%	-0.26	491	10%	-0.15	1497	3%	-0.11

Table 5: Comparison of resilience by corridor

Comparison of the two corridors suggests that employment in the transit corridor is overall more resilient than the comparable corridor, with similar overall changes in employment. However, the transit corridor has the advantage in a large number of industries, most notably Public Administration.

Comparison with the comparable corridor provides additional insight. While the Retail industry in the transit corridor is only minimally resilient, it does much better than the comparable corridor. The same can be said for the Health Care and Art/Entertainment/Recreation industry. Comparing R2 values between the two corridors suggests that the trend for the Arts/Entertainment/Recreation industry is stronger in the transit corridor.

Discussion & Implications

To be resilient is to have the capacity to endure shocks and recover to a previous equilibrium. This implies return to a prior level of employment. However, prior to recession, employment was increasing for most metropolitan areas, so a return to prior conditions implies a return to a prior trend.

Prior to the recession, the Education, Other Services, Public Administration, and Management industries were all doing well. In the Recession and post-recessionary period, only the Management, Public Administration, and Information industries continued to add jobs, and only the Management industry continued to do so consistently.

Examination of the area suggests that that the expansion of employment in the Management industry can be attributed soley to Southgate Industrial Park, and the expansion of employment in Public Administration can be attributed to the Catholic Diocese of Sacramento. A large 5-story office building office building at about Broadway and 24th Avenue was also the location of many new jobs. The location just outside the beltway surrounding the Sacramento CBD, and the presence of a freeway exit/entrance ramp on Broadway suggests that none of this development is transit oriented, but rather responding to existing configuration of the roadway system.

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

6-HOUSING AFFORDABILITY

Introduction

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

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

While the effects of heavy rail transit on housing affordability 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 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 a half mile, 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 by non-walk modes such as bicycle, bus, and automobile. The characteristics of the built environment within a mile buffer of a station can still affect transit ridership (Guerra, Cervero, & Tischler 2011).

Data and Methods

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

Data Source and Geography

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

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

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

Data Processing

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

For the purpose of comparison, a metro H+T Index was devised. Because the metropolitan area contains all census blocks, characteristics could not be weighted by area. Nor would it have been appropriate to do so. Census block groups are intended to contain similar amounts of population, rather than acreage, so the area of Census block groups may vary 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.

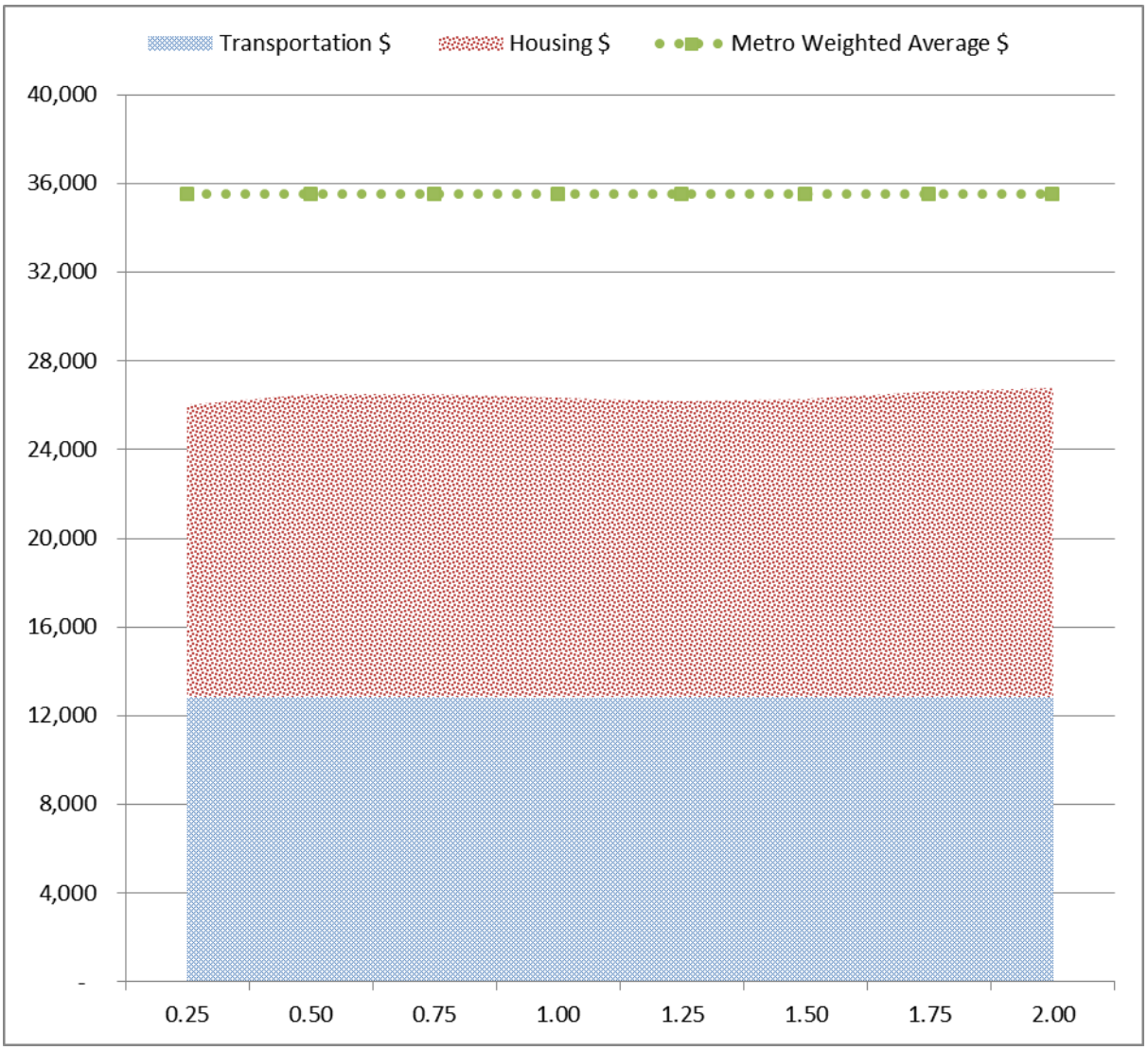

Figure 5: Housing, transportation, and H+T costs for the transit corridor, 2009, by buffer distance

As the above graph shows, H+T costs for the areas near the transit line are lower than the metropolitan average. There are minor variations in housing costs near the transit line, with housing costs slightly lower within .25 mile buffer than for the .50 mile buffer.

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.

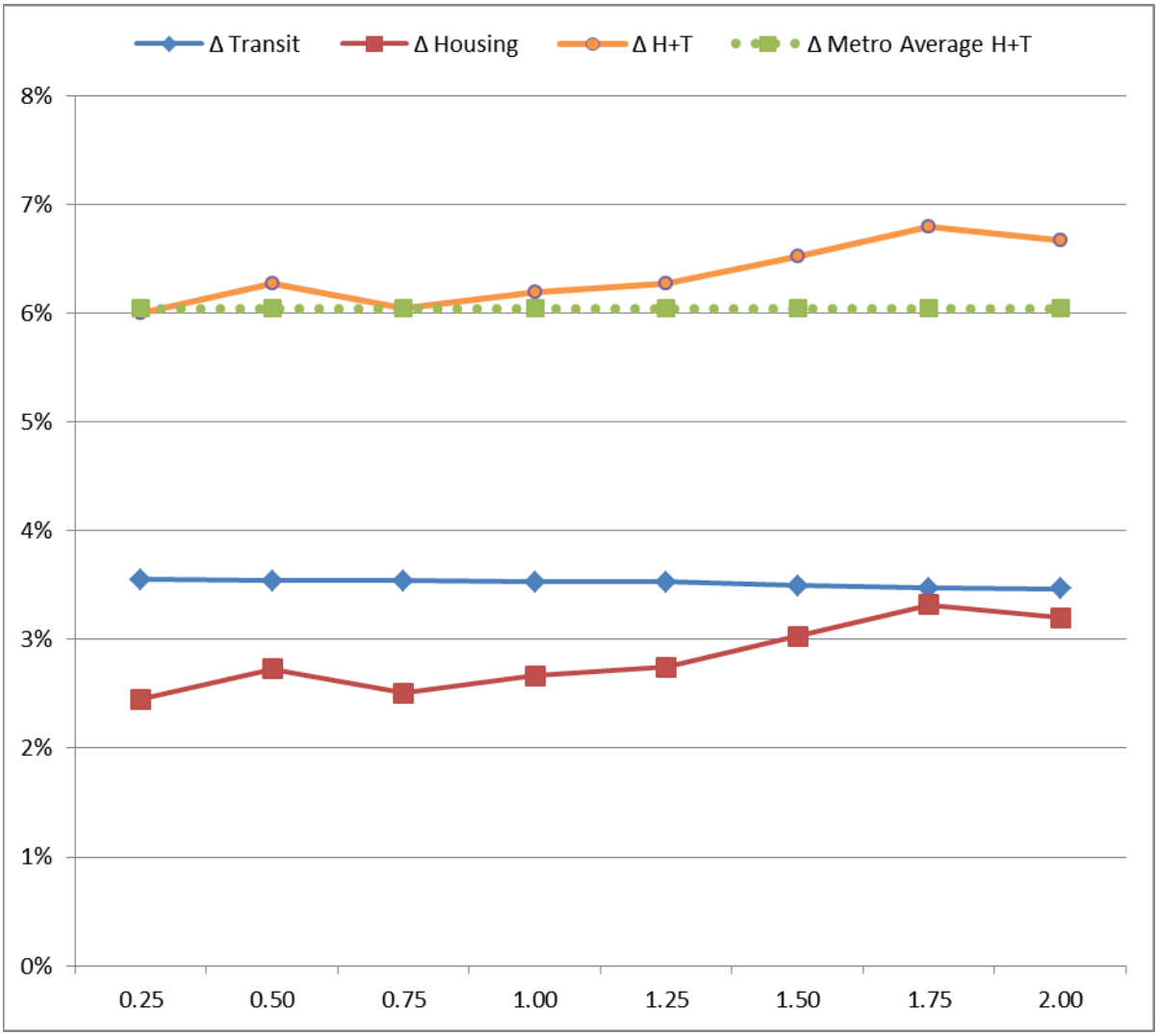

Figure 6: Change in housing and transportation costs, 2000-2009, for transit corridor, by buffer distance

The changes in H+T costs for the transit corridor are very similar to the metropolitan area average. Changes in H+T costs vary slightly with distance to the corridor, with housing costs rising slightly more than the metropolitan average within the .50 mile buffer, and for buffers greater than 1.25 miles. Changes in transportation costs along the corridor exhibit no significant change between 2000 and 2009.

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

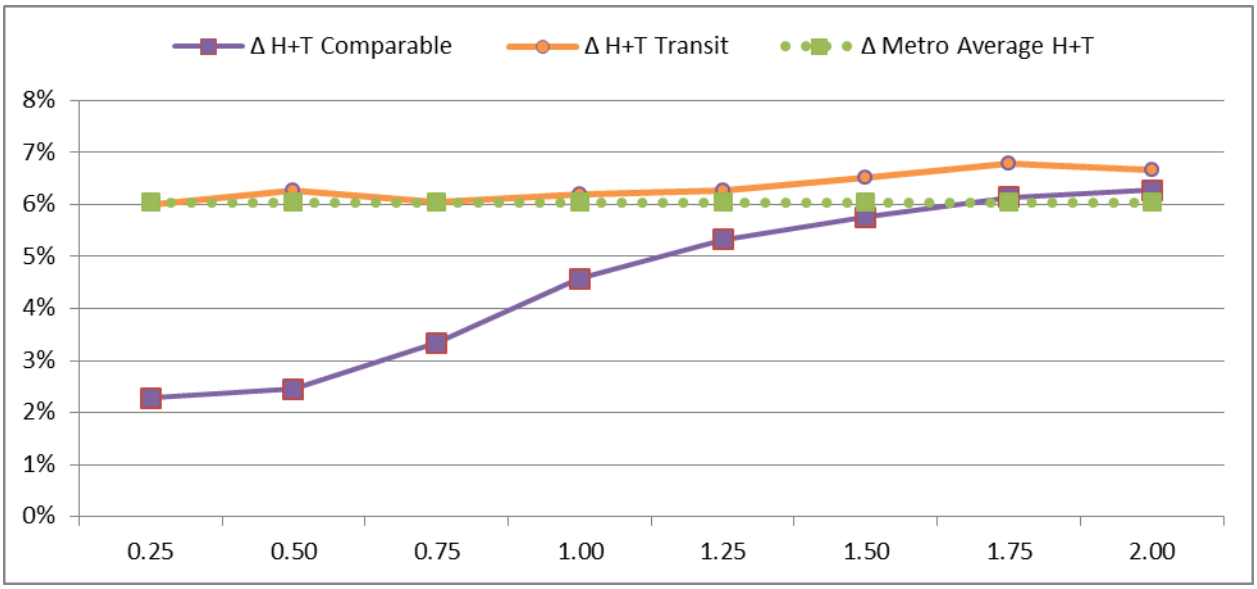

Figure 7: Changes in H+T, 2000-2009, for transit and comparable corridors, by buffer distance

The transit and comparable corridors display significantly different patterns in changes in H+T costs. The transit corridor experiences much higher increases in H+T costs than the comparable corridor for all buffer distances. For the transit corridor, the change in H+T cost is largest near the transit station. While for the comparable corridor, the increased in H+T cost lowest nearest the corridor, and the increase is inversely proportional to distance from the corridor.

Discussion & Implications

The evidence suggests that the South corridor has had minimal effect on housing affordability. While it is has no substantially increased housing prices, nor has it substantially reduced transportation costs. The changes in housing costs for the 1.25 mile buffer and beyond are likely confounded by a large number of uncontrolled for variables, and likely unrelated to transit. The increase in housing prices within the .50 mile buffer is interesting, indicating a slight premium for being close to transit without being too close. This is consistent with other findings for single family detached homes, which almost uniformly make up the residential development near the corridor.

The most notable deviation from the metropolitan norm is for the comparable corridor. The comparable corridor was a parallel railway corridor. However, unlike the light rail corridor, it remains an active freight corridor. Evidence strongly suggests that proximity to the freight corridor is a nuisance that is holding down costs and maintaining affordability. Whatever the effects of light rail, it does not seem to impose a substantial nuisance penalty for any associated nuisance.

The South corridor is effectively a commuter rail line, serving the Sacramento CBD. As such, it is characterized by large parking lots (47th Avenue, Florin Avenue, & Meadowview Road) for use as park and rides. Sacramento City College is the only major destination along the corridor, and also provides park and ride capacity due to a proximate parking garage. The combination of low density (single family detached homes) and park and rides suggests that the primary mode of access to transit stations is the personal automobile. Auto accessed transit stations draw from substantially more distance commuter-sheds, so that the benefits of proximity to transit are dispersed over a wider area. This suggests the increases in housing costs at greater buffer distances may actually be transit related, but more rigorous analysis, controlling for proximity to highways and other factors would be required. Any study doing so will need to control for the current extension in the Blue Line/South Corridor to Cosumnes River College. By providing a terminal anchor to the Blue line, the extension attracts riders traveling in either direction, increasing the value of station proximity, which should theoretically be capitalized into rising housing costs.

7-JOB ACCESSIBILITY

Introduction

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

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

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

Data & Methods

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

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

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

The categories have been treated as low-medium-high income classifications. The actual monthly values are less significant than changes over time in the distribution of each of the categories in proximity to the transit corridor. LED employment data are also classified by industry using 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, on 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	728	721	1.01	3.4	8.8	0.39	0.00	12.6	13.6	0.93	0.00	2002
2003	749	733	1.02	3.6	8.9	0.40	0.01	12.3	13.8	0.89	-0.04	2003
2004	764	747	1.02	3.6	9.1	0.40	0.00	12.3	13.8	0.89	0.00	2004
2005	782	756	1.03	3.7	9.2	0.40	0.00	12.0	13.5	0.89	-0.01	2005
2006	795	781	1.02	3.7	9.3	0.40	0.00	12.3	14.7	0.83	-0.05	2006
2007	784	796	0.99	4.1	8.7	0.47	0.07	12.5	12.7	0.98	0.15	2007
2008	792	800	0.99	4.1	8.7	0.46	0.00	12.8	13.8	0.93	-0.06	2008
2009	753	762	0.99	4.0	8.8	0.46	-0.01	11.7	13.6	0.86	-0.07	2009
2010	841	838	1.00	4.3	9.9	0.43	-0.02	17.8	14.6	1.22	0.36	2010
2011	850	840	1.01	6.1	7.2	0.85	0.41	18	12.7	1.44	0.23	2011
Trend												Trend

Table 6: Jobs-housing balance for all income categories

The overall jobs-housing ratio for the transit corridor stars at near parity, declines for several years, and then rises precipitously in the last two years, becoming job rich. The job-worker ratio does not significantly change with the advent of transit in 2003. There are big changes in 2011, which can be attributed to an increase in the number of number of workers employed in the transit the corridor,

which rises by almost half. The comparable corridor sees a spike in the job-worker ratio in 2011, but not in 2010. The rise in the ratio can again, be attributed to an increasing number of employees.

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	231	221	1.05	1.5	2.9	0.52	0.00	3.5	4.9	0.72	0.00	2002
2003	233	220	1.06	1.5	2.8	0.55	0.02	3.3	4.7	0.70	-0.02	2003
2004	231	217	1.06	1.5	2.9	0.51	-0.04	3.3	4.5	0.73	0.03	2004
2005	230	214	1.07	1.4	2.8	0.52	0.01	3.2	4.2	0.76	0.03	2005
2006	230	218	1.06	1.4	2.8	0.50	-0.02	3.3	4.6	0.71	-0.06	2006
2007	212	213	1.00	1.6	2.5	0.66	0.16	3.4	3.7	0.91	0.21	2007
2008	211	210	1.00	1.6	2.4	0.68	0.02	3.5	4.0	0.88	-0.03	2008
2009	202	199	1.01	1.6	2.4	0.66	-0.02	3.5	3.9	0.91	0.02	2009
2010	195	196	1.00	1.6	2.1	0.76	0.11	3.5	3.8	0.93	0.02	2010
2011	201	197	1.02	2.0	1.6	1.28	0.52	3.6	3.2	1.12	0.19	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	279	281	0.99	0.1	3.5	0.04	0.00	5.2	5.7	0.92	0.00	2002
2003	287	285	1.01	0.1	3.6	0.04	0.00	5.1	5.9	0.87	-0.05	2003
2004	288	285	1.01	0.2	3.6	0.04	0.00	5.0	5.8	0.87	0.00	2004
2005	291	285	1.02	0.2	3.6	0.04	0.00	4.7	5.6	0.83	-0.04	2005
2006	286	285	1.00	0.2	3.5	0.05	0.00	4.9	6.0	0.81	-0.02	2006
2007	279	283	0.99	0.2	3.2	0.05	0.00	4.7	5.2	0.90	0.09	2007
2008	275	278	0.99	0.2	3.2	0.05	0.00	4.7	5.4	0.87	-0.03	2008
2009	254	258	0.99	0.2	3.0	0.05	0.01	4.1	5.1	0.81	-0.06	2009
2010	274	274	1.00	0.2	3.3	0.05	0.00	7.1	5.4	1.32	0.51	2010
2011	268	267	1.00	0.18	2.14	0.08	0.03	6.8	4.4	1.54	0.22	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	218	219	1.00	0.6	2.4	0.24	0.00	3.8	2.9	1.30	0.00	2002
2003	229	228	1.00	0.6	2.6	0.24	0.00	3.9	3.2	1.20	-0.09	2003
2004	246	245	1.00	0.7	2.7	0.24	0.00	4.0	3.4	1.15	-0.05	2004
2005	261	257	1.02	0.7	2.9	0.24	-0.01	4.1	3.6	1.12	-0.03	2005
2006	279	277	1.00	0.7	3.0	0.25	0.01	4.1	4.1	1.00	-0.12	2006
2007	293	300	0.98	0.8	3.0	0.28	0.03	4.5	3.9	1.16	0.16	2007
2008	306	312	0.98	0.9	3.2	0.28	0.00	4.6	4.4	1.04	-0.13	2008
2009	297	305	0.98	0.8	3.5	0.24	-0.04	4.1	4.7	0.87	-0.17	2009
2010	372	368	1.01	0.9	4.4	0.21	-0.03	7.2	5.5	1.31	0.44	2010
2011	381	376	1.01	2.3	3.5	0.66	0.44	7.9	5.0	1.57	0.26	2011
Trend												Trend

Table 7: Jobs-housing balance by income category

The job-worker ratio shows no immediate change in response to the advent of rail operations in 2003, for any income class.

In 2002, the transit corridor is job-poor for low income workers, but moves toward parity over time, becoming job-rich in 2011. The move toward parity can be attributed to both a rising number low income workers employed in the corridor, and a falling number resident in the corridor. A similar pattern prevails in the comparable corridor, although the trend is less steady.

For medium income workers, the transit corridor is nearly balanced if slighly job-poor 2002-2009, before becoming job-rich in 2010 and 2011. While the number of medium income workers resident in the corridor shows a falling trend, most of the chagne can be attributed to increases in the number of medium income workers. The pattern in the jobs-housing ratio is similar in the comparable corridor, although the increase in the numbers of workers occurrs more steadily.

For high income workers, the corridor is job-rich between 2002-2011, with a minot deviation in 2009. The number of works shows the same 2010-2011 spike in workers as the other two income categories, but the numbers of workers resident, in contrast, increases steadily. However, the same pattern of increasing number of high-income workers resident in the corridor can also be observed in the comparable corridor.

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.

	Comparable					Transit						
Industry	2002	2002 to 2003	2003	2003 to 2011	2011	2002	2002 to 2003	2003	2003 to 2011	2011	# Change	% Change
Utilities	0.10		0.14		8.74	0.09		0.17		0.19	0.02	11%
Construction	0.17		0.18		0.27	1.14		1.12		1.14	0.02	2%
Manufacturing	0.43		0.44		0.79	0.84		0.90		0.73	-0.17	-19%
Wholesale	0.45		0.44		0.69	0.47		0.48		0.62	0.14	29%
Retail	0.98		0.93		1.68	0.98		0.96		0.78	-0.18	-19%
Transportation	0.25		0.21		0.06	1.00		1.07		1.41	0.33	31%
Information	0.32		0.32		0.80	0.11		0.11		0.55	0.45	424%
Finance	0.34		0.37		0.74	3.44		2.96		0.35	-2.61	-88%
Real Estate	0.56		0.76		1.23	0.53		0.48		0.78	0.30	62%
Professional	0.25		0.27		0.69	0.61		0.54		0.85	0.32	59%
Management	0.00		0.00		0.04	0.66		0.67		3.06	2.39	356%
Administrative	0.26		0.47		0.77	0.61		0.61		0.52	-0.09	-15%
Education	0.15		0.12		0.34	1.75		1.69		2.02	0.32	19%
Health Care	0.41		0.44		0.58	0.99		0.98		0.71	-0.27	-28%
Arts, Ent. Rec.	0.97		0.98		1.24	0.12		0.07		0.17	0.10	137%
Lodging & Food	0.54		0.57		1.43	0.70		0.72		0.81	0.09	12%
Other Services	0.43		0.35		0.81	0.57		0.51		1.60	1.10	217%
Public Admin	0.01		0.01		0.84	0.00		0.00		3.54	3.54	#DIV/0!

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

In 2003, the transit corridor is jobs-poor for all industries, so increasing values for the jobs-housing ratio indicate an improvement in the job-worker balance, and thus increasing job accessibility. Contrasting the differences for the transit corridor between 2003 and 2011, the Management and Public Information industries see substantial increases in the job-worker ratio, but to such a degree that it significantly overshoots parity. Only the Lodging/Food and Information industries manage to make progress toward parity without overshooting it.

Evaluation of the sparklines makes possible a visual determination of trend consistency. In the transit corridor, it shows a consistent drop for the Finance industry, and a consistent rise for the Information industry. However, the comparable corridor shows as similar pattern in the Information industry, indicating that the trend is likely unrelated to transit. The Wholesale industry shows a steady increase for several years, before dropping and then rising again.

Discussion & Implications

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

The South Corridor is only part of the Blue Line, which in turn is only part of the transit network in Sacramento. Origins on any part of the network may be paired to destinations at any other destination on the network. Analyzing balance at the corridor level may represent an inappropriate geography for analysis. Effectively gauging the effect on jobs-housing balance would require evaluating the jobs-worker balance over the whole transit network.

The use of a ratio for job-housing balance is also problematic as such a scale. Statistics making use of divisors are volatile, making trend assessments more difficult. The LEHD provides only annual datapoints, making many time series analysis techniques (ARIMA, etc) inappropriate. More complex techniques such as the use of Vector Auto-Regression (VAR) may prove necessary.

The use of a buffer to aggregate employment also loses information about the degree of distance within the buffer. Near things should be more closely related than distant things, so employment changes near transit stations are more important than more distant changes. This is especially so for light rail transit, where stations are placed in infill locations in already built up urban environments, where the use of a Euclidian distance buffer to measure association ignores street network connectivity. As this analysis shows, employment changes within the buffer often occurr at locations that fall within the buffer, but which cannot be causally related to the transit station itself.

The larger the metropolitan area, the more places it possible to both live and work. Thus, the less likely any given worker will be a resident of any given geography. For any growing and expanding metropolitan area, the match between workplace and residence would be expected to worsen over time. However, the addition of transit would be expected to counteract this, providing a mechanism to assort workers in a way that their residential location better matches their employment location. But given the relative paucity of rail transit, and the relatively few origin-destination pairs it is able to match in a low density environment, it seems unlikely that a single rail transit line will dramatically improve jobs-housing balance.

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

8-SUMMARY OF FINDINGS

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

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

Q1: Attractiveness to NAICS sectors (Location quotient)

Transit corridor

- Substantial Increases: Public Administration
- Major Increases: Management and Other Services
- Minor Increases: Information
- Substantial Reductions: Finance
- Minor Reductions: Health Care, Retail

Transit advantage over comparable corridor

- Substantial: Utilities
- Major: Public Administration, Management, and Other Services

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

Numeric Change in Transit corridor

- Employment in transit corridor grew more than metropolitan area
- Substantial numeric increases: Public Administration & Other Services
- Most Substantial percent increase: Public Administration
- Substantial reductions: Finance, Construction & Manufacturing

Effect of corridor, as per shift-share

- Public Administration benefits the most
- Other Services also benefits
- Strong negative corridor effect for Finance and Health Care

Transit advantage over comparable corridor

- Corridor Effect is strongest for Public Administration & Other Services
- Corridor Benefit is (relatively) greatest for 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: Public Administration and Arts/Entertainment/Recreation
- Consistent trends, as per R2: Public Administration and Arts/Entertainment/Recreation

Transit Corridor Differences before and after Great Recession

- Resilient (Positive trend before and after): Arts/Entertainment/Recreation
- Declined: Finance, Retail, & Manufacturing

Advantage over Comparable corridor:

- Better trends: Public Administration
- Minorly: Retail and Transportation
- Did well by comparison: Arts/Entertainment/Recreation

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 .50mile 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 unrelated to proximity
- Transportation costs nearly constant for all distances.

Transit corridor changes in H+T costs 2000-2009

- Greater than metropolitan area for all buffer distances
- Transportation costs change more than housing costs.
- Changes in transportation costs constant with proximity to transit corridor
- Housing costs rise in proportion to distance from the transit corridor

Comparable Corridor

- H+T costs for comparable corridor rise less than the transit corridor
- H+T costs in comparable corridor show strong relationship to proximity to corridor

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

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

Overall

- Near parity with metro area in 2002, becomes more jobs rich in 2010-2011
- Changes in jobs-housing ratio caused by increasing number of workers in the corridor

By Income

- Starts job-rich in 2002 for high income, job-poor for low and medium income.
- Becomes more job-rich for all incomes over time
- Sharp rise in number of medium and high income jobs in 2010-2011

By Industry

- Movement toward parity: All others
- Job-poor to job-rich (>1 to <1): Management, Other Services, & Public Administration
- Increasing imbalance: Construction, Manufacturing, Retail, Transportation, Administrative, and Healthcare

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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