NITC NATIONAL INSTITUTE for TRANSPORTATION and COMMUNITIES

METRO Light Rail

Phoenix, Arizona

Do TODs Make a Difference?

THE UNIVERSITY OF UTAH Metropolitan Research Center

OTREC OREGON TRANSPORTATION RESEARCH AND EDUCATION CONSORTIUM

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Disclaimer

PROJECT TITLE

Project Title: **DO TODs MAKE A DIFFERENCE?**

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1-INTRODUCTION

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

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

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

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

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

Report Structure

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

2-DATA AND METHODS

Data from before and after the opening of a transit line 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 enriched with the addition of transit modes for all stations since many transit stations serve more than one mode.

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

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

Creation of Comparable Corridors

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

Comparable Corridors Criteria

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

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

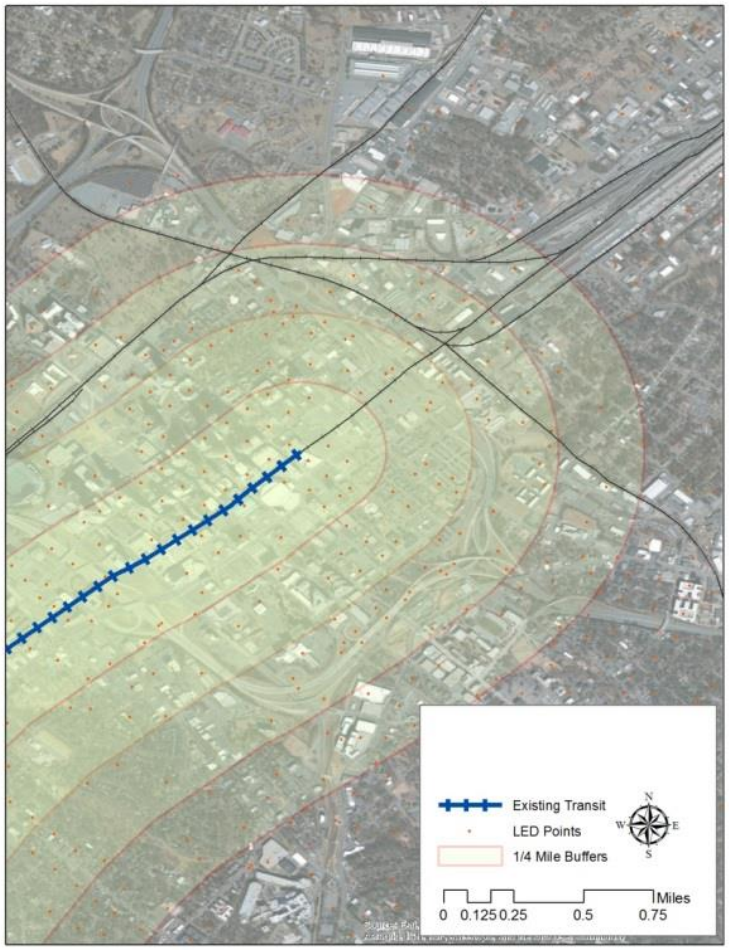

Figure 1: Example corridor, buffers, and LED census block points

Study Area

This study examines the Metro Light Rail in Phoenix, Arizona. The initial (and only currently operating) line was 20

miles long. Operations began in 2008. It stretches from the city of Glendale in the north, where it is anchored by a Walmart, through downtown Phoenix, past Sky Harbor international airport, past Arizona State University's main campus, and into downtown Mesa. The comparable corridor starts in downtown Phoenix at the Government Mall. It then runs eastward through a portion of downtown, then south along Central Avenue, following the path of the "South Central Corridor" Study area, past the Ed Pastor Transit Center, to Baseline Road. From there it continues east along Baseline Road past the Arizona Mills Mall, then north on Dobson and over the freeway to the Banner Desert Medical Center, and Mesa Community college before finally heading east on Southern to the Fiesta Mall. Figure 2 shows the transit and comparable corridors as well as the location of LED points.

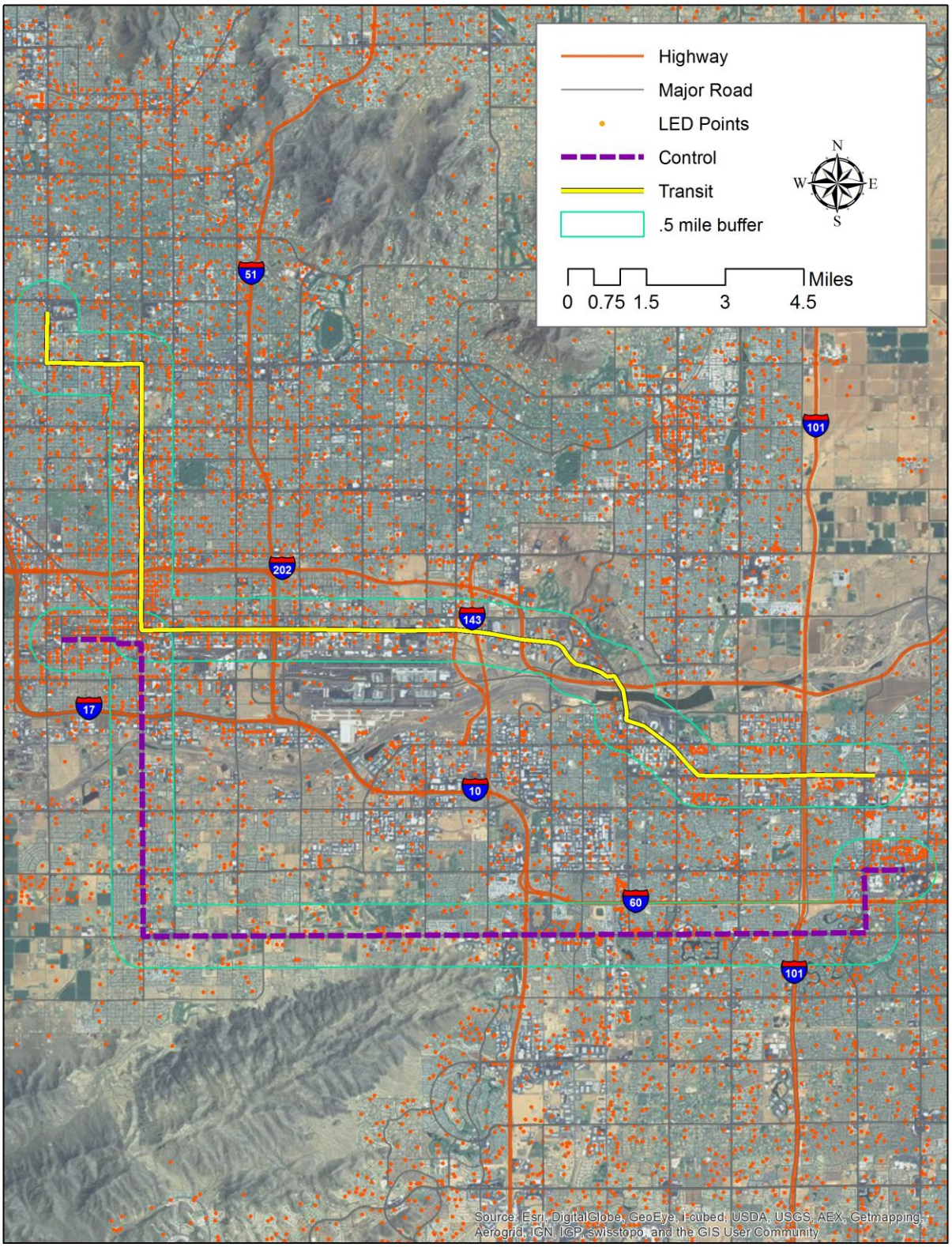

Figure 2: Transit and comparable corridor locations

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 0.5mile 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 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	5.62		5.74	0.34	-0.22	-0.56
Construction	0.38		0.44	0.08	-0.02	-0.09
Manufacturing	0.63		0.50	-0.34	0.21	0.55
Wholesale	0.53		0.57	0.05	-0.01	-0.06
Retail	0.40		0.39	-0.05	0.04	0.10
Transportation	1.45		1.08	0.27	-0.64	-0.91
Information	1.90		1.76	0.52	-0.66	-1.18
Finance	1.08		1.15	0.03	0.05	0.02
Real Estate	0.88		1.09	-0.09	0.30	0.39
Professional	1.42		1.21	0.07	-0.28	-0.34
Management	1.24		0.92	-0.21	-0.11	0.10
Administrative	0.87		0.81	-0.08	0.02	0.10
Education	0.98		0.95	-0.07	0.05	0.12
Health Care	1.13		1.31	0.02	0.16	0.13
Arts, Ent. Rec.	1.29		1.10	0.15	-0.34	-0.49
Lodging & Food	0.97		0.65	-0.10	-0.22	-0.13
Other Services	1.19		1.21	0.07	-0.05	-0.12
Public Admin	2.54		2.73	0.31	-0.12	-0.43

Table 1: Location quotients comparison for transit corridor

For the transit corridor, after the advent of transit, the most significant increases in location quotient occur in the Real Estate, Manufacturing, and Health Care industries. In contrast, the most significant declines occur in the Transportation and Information industries. Differences between the two time periods show that a number of sectors experience substantial changes in location quotient before and after transit. A positive number indicates that the trend in location quotient is better after transit than before. Industries that had the largest change in location quotient trend after transit include Manufacturing and Real Estate. This may indicate a sharper decline in employment in those industries near the transit corridor, or an increase in employment in those industries near the corridor. The location quotient trend for the Transportation and Information industries was strongly positive before the advent of transit, and strongly negative thereafter. The sparklines show that the Transportation and Professional industries have declining trends that begin about the same time as the opening of transit.

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.

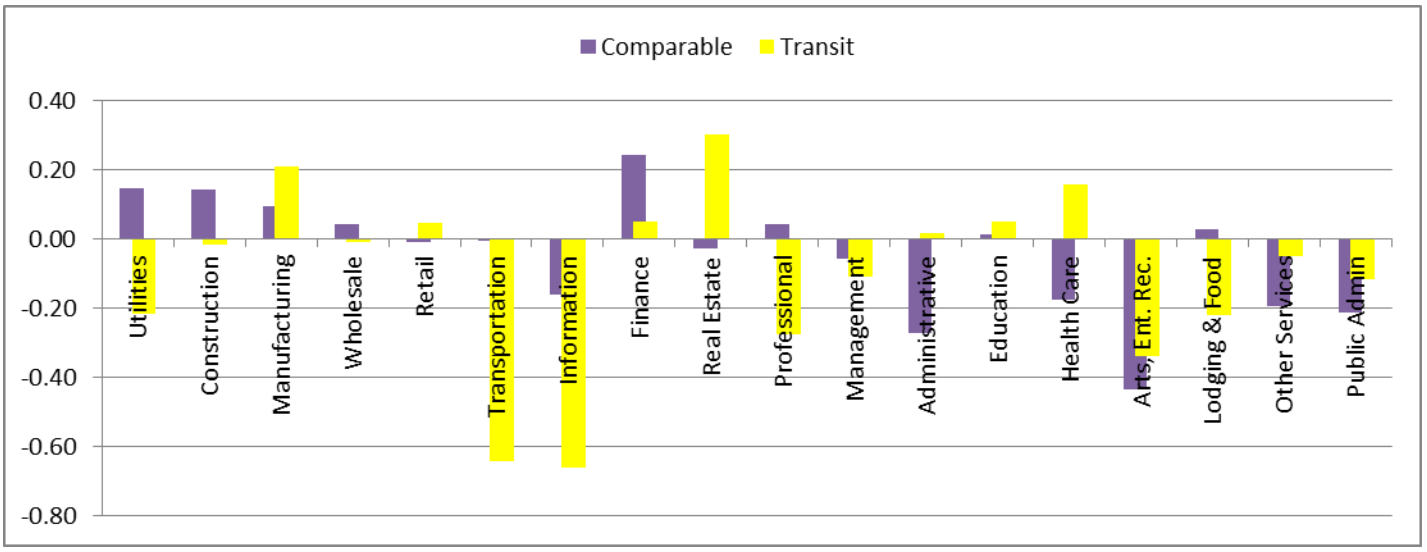

Figure 3: Changes in location quotient by corridor for the time period after the advent of transit

After 2008, when the Metro Light Rail began operations, the location quotients for all industries varied significantly by corridor. The location quotient declined for most industries in the transit corridor. Notable exceptions includes Real Estate, and Manufacturing. The transit corridor experience substantially greater increases in location quotient thant the comparable corridor for the Manufacturing, Real Esate, and Health Care industries. The location quotients for the transit corridor increased slightly for the Retail, Finance, and Education industries, although the Finance industry increased substantially more for the comparable corridor.

Discussion & Implications

The METRO light rail displays some highly atypical results for a transit line. Manufacturing employment is associated with low-density industrial land, rather than transit oriented development. More typically, industrial development is displaced by denser, higher value land uses when transit is developed nearby. Closer inspection shows that the majority of manufacturing employment consists of a single very large development between the Red Mountain Freeway and Hohokam Expressway, adjacent to the transit corridor, but a substantial distance from a light rail station.

The other industries to experience substantial location quotient increases near transit were Real Estate and Health Care. Attributing causal effect to transit lines is always problematic. Designing successful transit networks is largely a game of connect-the-dots, linking together major employment centers with employee housing along congested corridors. Many stations are co-established with new campuses for

major institutions, or at public events venues, so increases in Healthcare makes sense. There is a station directly in front of the St. Joseph's Hospital and Medical Center, for example.

The increase in the location quotient for Real Estate is initially curious, but closer inspection shows that employment in the real estate industry is concentrated along Center Street in downtown Phoenix, with a series of large office towers. In an already premium location, proximity to transit offers an additional amenity: reliable access. Even during the worst traffic, the Metro Light Rail offers consistent travel times. The decline in Professional is unexpected. Other industries associated with multistory offices, such as Finance and Real Estate do well. The Professional industry may simply be growing outside the transit corridor. Contrasting the transit corridor with the comparable corridor only makes the decline in the Information and Transportation industries more curious.

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

4-EMPLOYMENT GROWTH BY SECTOR

Introduction

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

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

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

Data and Methods

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

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

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

Results

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

NAICS Sector	Metro				Transit Corridor				Sources of Employment Change		
	2008	2011	# Change	% Change	2008	2011	# Change	% Change	Metro Share	Industry Mix Share	Corridor Effect
Utilities	15,769	15,294	(475)	-3%	11,625	11,045	(580)	0%	-721	(350)	491
Construction	146,482	82,834	(63,648)	-43%	8,281	4,576	(3,705)	-45%	-514	(3,598)	407
Manufacturing	131,286	117,141	(14,145)	-11%	4,744	7,363	2,619	55%	-294	(511)	3,424
Wholesale	89,876	81,452	(8,424)	-9%	6,414	5,803	(611)	-10%	-398	(601)	388
Retail	215,136	201,502	(13,634)	-6%	9,111	9,790	679	7%	-565	(577)	1,822
Transportation	60,298	58,070	(2,228)	-4%	12,845	7,889	(4,956)	-39%	-797	(475)	(3,684)
Information	33,331	29,815	(3,516)	-11%	9,976	6,591	(3,385)	-34%	-619	(1,052)	(1,714)
Finance	109,197	108,774	(423)	0%	14,944	15,800	856	6%	-927	(58)	1,841
Real Estate	41,305	36,454	(4,851)	-12%	4,020	4,987	967	24%	-249	(472)	1,689
Professional	104,372	97,022	(7,350)	-7%	19,166	14,724	(4,442)	-23%	-1189	(1,350)	(1,903)
Management	23,422	21,885	(1,537)	-7%	2,973	2,523	(450)	-15%	-184	(195)	(70)
Administrative	181,797	160,550	(21,247)	-12%	17,810	16,337	(1,473)	-8%	-1105	(2,081)	1,713
Education	146,135	148,176	2,041	1%	16,375	17,772	1,397	9%	-1016	229	2,184
Health Care	179,399	215,800	36,401	20%	25,670	35,642	9,972	39%	-1593	5,209	6,356
Arts, Ent. Rec.	33,004	35,689	2,685	8%	5,874	4,928	(946)	-16%	-364	478	(1,059)
Lodging & Food	164,891	156,919	(7,972)	-5%	17,819	12,888	(4,931)	-28%	-1106	(861)	(2,964)
Other Services	53,625	51,111	(2,514)	-5%	8,357	7,769	(588)	-7%	-518	(392)	322
Public Admin	78,996	78,759	(237)	0%	27,843	27,077	(766)	-3%	-1727	(84)	1,045
Total	**1,808,321**	**1,697,247**	**(111,074)**	**-6%**	**223,847**	**213,504**	**(10,343)**	**-5%**	**(13,888)**	**(6,743)**	**10,288**

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

The entire metropolitan area suffers a serious decline in employment of 6 percent. The transit corridor suffers less, with a decline in employment of about 5 percent. However, this still represents a loss of over 10,000 jobs. In numeric terms, the only industry to enjoy the most significant numeric increases is Health Care, although the Manufacturing and Education sectors do well. In addition, Manufacturing enjoys a significant percentage increase in employment, as do Healthcare and Real Estate. For reasons discussed earlier, Manufacturing can be disregarded, as it represents transit adjacent development (TAD) rather than Transit Oriented Development (TOD). Disregarding the Manufacturing industry, Finance and Retail also enjoy significant percentage increases in employment. Severe declines occur in the Transportation, Information, and Lodging/Food industries.

After using Shift-Share analysis to disaggregate the cause of change in employment, different patterns emerge. About half of the change in employment can be attributed to metro-scale trends, and another quarter to the industry mix within the corridor, both of which have negative effects on employment. In contrast, the effect of the corridor on employment is strongly positive.

Health Care employment growth can be attributed both to being a growing industry, and to location within the corridor. Other industries that appear to benefit from the corridor effect are Education,

Retail, and Administrative. But not all industries benefit from the corridor effect. The industries to suffer the most severe decreases in employment, such as Information, Transportation, and Lodging/Food,

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.

Industry	Comparable			Transit			Transit Advantage	
	# Change	Corridor Effect	Corridor Benefit	# Change	Corridor Effect	Corridor Benefit	Employment Change	Corridor Effect
Utilities	68	162	2.4	-580	491	0.8	-648	330
Construction	-847	821	1.0	-3705	407	0.1	-2858	-414
Manufacturing	223	719	3.2	2619	3424	1.3	2396	2706
Wholesale	-101	290	2.9	-611	388	0.6	-510	98
Retail	-593	62	0.1	679	1822	2.7	1272	1759
Transportation	-75	15	0.2	-4956	-3684	-0.7	-4881	-3699
Information	-453	-229	0.5	-3385	-1714	-0.5	-2932	-1485
Finance	1272	1719	1.4	856	1841	2.2	-416	122
Real Estate	-367	16	0.0	967	1689	1.7	1334	1673
Professional	-320	433	1.4	-4442	-1903	-0.4	-4122	-2337
Management	-109	-61	0.6	-450	-70	-0.2	-341	-9
Administrative	-3477	-2226	0.6	-1473	1713	1.2	2004	3940
Education	46	188	4.1	1397	2184	1.6	1351	1996
Health Care	-725	-1934	2.7	9972	6356	0.6	10697	8290
Arts, Ent. Rec.	-683	-762	1.1	-946	-1059	-1.1	-263	-297
Lodging & Food	-367	505	1.4	-4931	-2964	-0.6	-4564	-3469
Other Services	-748	-481	0.6	-588	322	0.5	160	804
Public Admin	-2241	366	0.2	-766	1045	1.4	1475	679
Total	**-9535**	**-200**	**0.0**	**-10385**	**10490**	**1.0**	**-846**	**10690**

Table 3: Shifts by corridor and comparison between corridors

Proximity to the transit corridors benefits different industries. The 'Corridor Benefit' is largest for the Retail and Finance Industries, but is over 1 for many more, indicating that location in the corridor had a very strong positive effect. That the effect is specific to transit can be discerned by contrasts with the comparable corridor. The corridor effect is much larger for the transit corridor than for the comparable corridor for many industries. The transit corridor has a notable advantage for Healthcare, Administrative, Education and Retail. The comparison suggests that the Transportation, Information, and Lodging/Food industries were specifically disadvantaged by location in the transit corridor. The minimal differences between the in the corridor effects suggests that the Arts/Entertainment/Recreation sector is indifferent to the transit corridor.

Discussion & Implications

Drawing any conclusion for the Metro Light Rail is difficult due to confounding factors. Metropolitan Phoenix is still suffering from the Great Recession, including a housing market had still not found its bottom in 2011.

The Shift Share Analysis suggests that proximity to the Valley Metro Light Rail is a significant positive good for most industries. Overall employment in the transit corridor declined less as a percent than the rest of the metropolitan area, a phenomenon that the shift-share analysis indicates is largely attributable to the corridor effect.

Without more rigorous controls, it is difficult to attribute all of the corridor effect to the METRO light rail. The corridor was not arbitrarily chosen, but rather a process of 'connecting the dots' between major regional employment centers. The METRO light rail reaches downtown Phoenix, Arizona State University, and the Sky Harbor airport (via the SkyTrain). These were places that already had significant employment, for which strong growth potential had already been predicted. It is questionable whether the light rail caused the corridor effect, or was located in the corridor due to the same factors that led to the strong corridor effect.

Of all the light rail system in America, the METRO light rail has the greatest theoretical claim to inducing growth. Unlike many other light rail systems, the majority of its running way is in the neutral ground in the middle of public streets, rather than along an old freight rail corridor. While it does contain a section in a freight rail corridor, that section has no stations, making it possible to travel rapidly through a low-value area. As a street-running system, it is slowed by intersections (even if provided with signal priority), given it a lower end-to-end speed than many systems. This lower mobility is balanced by the greater accessibility. While the Metropolitan Area is characterized by large blocks, the street network is comparatively more connected than a freight corridor, making the area near the transit line more accessible. This is especially important in Phoenix, where high desert temperatures can make walking more than a few blocks hazardous during the heat of the day. Almost all bus stops have shade shelters, and the METRO light rail stations are air conditioned.

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 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.

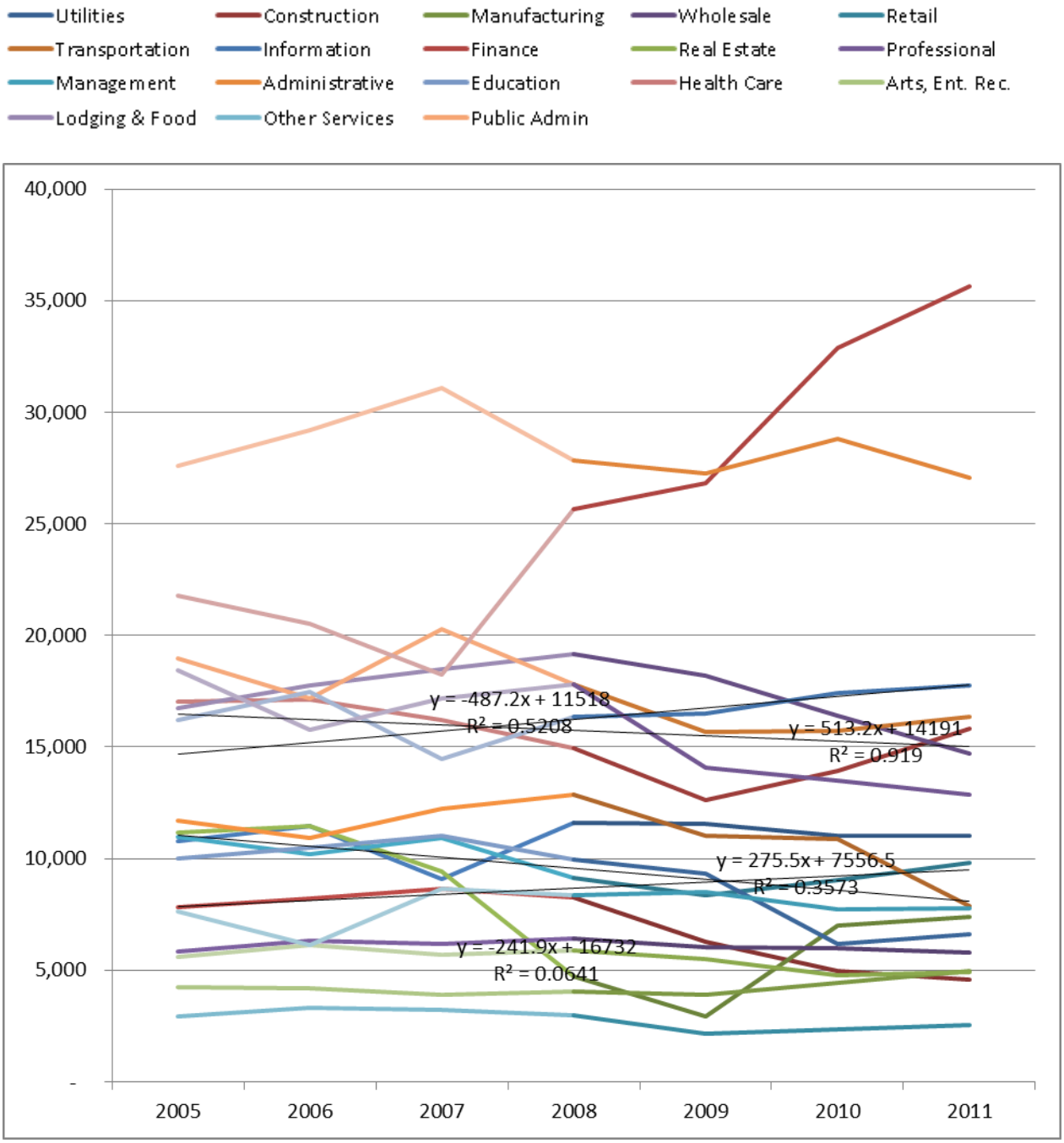

Figure 4: Regression trend lines and R-squared values for different industries

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. Trend indicates 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 R2 column gives the change in strength of trend. 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	24	0%	0.00	-227	-2%	0.83	-250	-2%	0.83
Construction	182	2%	0.49	-1244	-21%	0.92	-1426	-23%	0.44
Manufacturing	-2135	-23%	0.79	1191	22%	0.55	3326	45%	-0.24
Wholesale	161	3%	0.63	-188	-3%	0.90	-350	-6%	0.27
Retail	-487	-5%	0.52	276	3%	0.36	763	8%	-0.16
Transportation	466	4%	0.55	-1499	-14%	0.89	-1965	-18%	0.34
Information	36	0%	0.01	-1331	-17%	0.80	-1367	-17%	0.79
Finance	-719	-4%	0.85	388	3%	0.13	1107	7%	-0.72
Real Estate	-95	-2%	0.57	342	8%	0.81	437	10%	0.23
Professional	793	4%	0.99	-1512	-9%	0.99	-2305	-13%	0.00
Management	6	0%	0.00	-118	-5%	0.19	-124	-5%	0.19
Administrative	-39	0%	0.00	-435	-3%	0.32	-396	-2%	0.32
Education	-242	-1%	0.06	513	3%	0.92	755	5%	0.85
Health Care	940	4%	0.15	3595	12%	0.94	2656	8%	0.79
Arts, Ent. Rec.	36	1%	0.04	-355	-7%	0.81	-391	-7%	0.77
Lodging & Food	-44	0%	0.00	-1539	-11%	0.80	-1495	-10%	0.80
Other Services	474	6%	0.29	-255	-3%	0.68	-728	-9%	0.38
Public Admin	265	1%	0.05	-75	0%	0.02	-339	-1%	-0.03
Total	-196	0%	0.16	-2481	-1%	0.20	-2284	-106%	0.04

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

During the 2008 to 2011 period, many industries still had falling employment. The Health Care and Real Estate industries saw significant percentage increases; although only Health Care saw major numerical employment increases. The Retail, Finance and Education industries experience both numeric and percentage growth, although the R2 values indicates that it represented a strong trend only for the

Education industry. Manufacturing can be disregarded as a spurious correlate, for reasons explained in the first section.

Differences in trends (number and percent) and the strength of trends (R^2) indicate which industries in the corridor did better after the recession. The most substantial difference in trends is for Real Estate, followed by Health Care and Retail. The trend for the Health Care industry is much stronger after the recession, while the trend for the Retail industry, never strong to begin with, becomes more uncertain afterward. The strength of trend improves for the Real Estate industry after the recession, becoming more consistent. While Finance continues to add jobs, the fall in R2 indicates that it does so erratically, with substantial year on year fluctuations.

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	-250	-2%	0.83	-19	-2%	0.11	-232	0%	0.73
Construction	-1426	-23%	0.44	-319	-12%	0.67	-1107	-11%	-0.24
Manufacturing	3326	45%	-0.24	120	4%	-0.23	3206	41%	-0.01
Wholesale	-350	-6%	0.27	-120	-5%	0.06	-230	-1%	0.20
Retail	763	8%	-0.16	185	2%	0.03	577	6%	-0.20
Transportation	-1965	-18%	0.34	51	5%	0.08	-2016	-23%	0.26
Information	-1367	-17%	0.79	-241	-21%	0.07	-1126	4%	0.73
Finance	1107	7%	-0.72	1200	15%	-0.04	-93	-8%	-0.67
Real Estate	437	10%	0.23	-354	-21%	-0.43	791	32%	0.67
Professional	-2305	-13%	0.00	-167	-3%	-0.37	-2139	-10%	0.37
Management	-124	-5%	0.19	-73	-28%	-0.08	-51	23%	0.28
Administrative	-396	-2%	0.32	-1531	-30%	-0.03	1135	27%	0.35
Education	755	5%	0.85	89	3%	0.39	666	1%	0.46
Health Care	2656	8%	0.79	-392	-5%	-0.21	3047	12%	1.00
Arts, Ent. Rec.	-391	-7%	0.77	-74	-3%	0.35	-317	-4%	0.42
Lodging & Food	-1495	-10%	0.80	-123	-2%	-0.65	-1372	-9%	1.44
Other Services	-728	-9%	0.38	-268	-13%	0.94	-460	4%	-0.55
Public Admin	-339	-1%	-0.03	-930	-2%	0.80	591	1%	-0.83

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. Discounting Manufacturing, the industries with an advantage over the comparable corridor are the Real Estate, Administrative and Management industries. Of these, only the Real Estate industry displays a positive trend in the transit corridor. Employment in the Retail Industry has better trends in the transit corridor, but is more consistent in the comparable corridor. Education shows the same ultra-resilience as Retail. It not only maintains its prior trend, but also exceeds it. Rather than just surviving, employment in Education is thriving in the transit corridor. Health Care shows the same pattern, but does an even greater degree.

Additionally, differences between the two corridors indicate that the transit corridor may have numerous industries that, while not resilient, are robust. The strength of the trend is less (with lower R^2 values), but their trend is better than that of the comparable corridor. While they do not maintain previous trends, they are more capable of resisting downward trends. The Retail industry matches this pattern.

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 Real Estate, Retail and Health Care industries did better than their prior trend. The growth in Real Estate employment seems to be a function of proximity to office tower development in downtown Phoenix. Retail development is puzzling, and the increase seems to be driven almost entirely by a development in the bend between the 202 and the Phoenix zoo. Health care is much more transparent. There was an existing cluster of Health Care related employment in downtown Phoenix prior to the METRO light rail, which grew in in both size and extent afterward.

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 0.5 miles, the effects of proximity to transit can be detected out to 1.5 miles away (Nelson 2011). Access to fixed guide-way transit systems is frequently by non-walk modes such as bicycle, bus, and automobile. The characteristics of the built environment within a mile buffer of a station can still affect transit ridership (Guerra, Cervero, & Tischler 2011).

Data and Methods

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

Data Source and Geography

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

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

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

Data Processing

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

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

Results

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

1. Housing, Transportation, and H+T dollar costs for the transit corridor

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

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

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

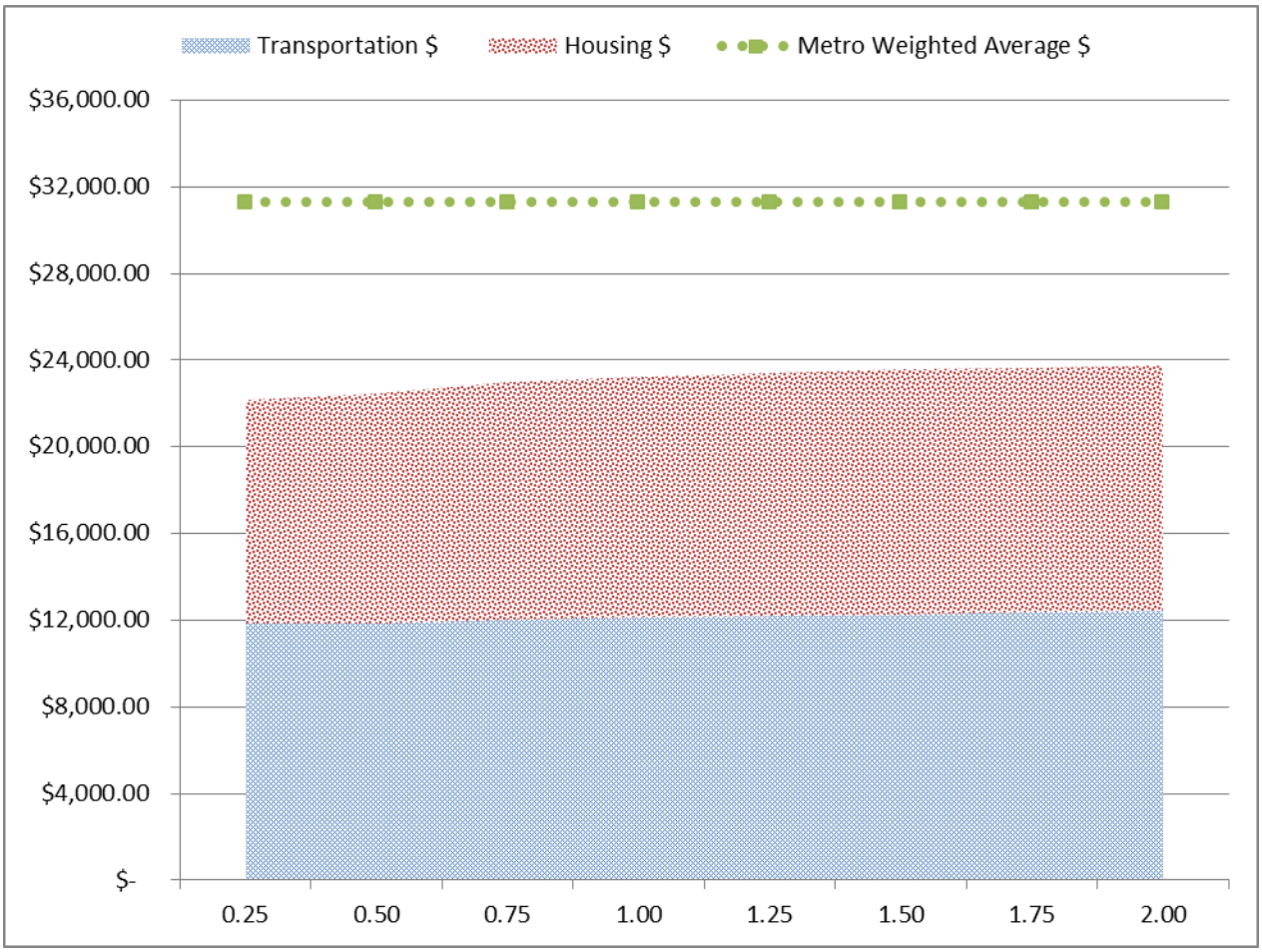

Figure 5: Housing, transportation, and H+T costs for the transit corridor, 2009, by buffer distance

As the above graph shows, H+T costs near the transit line are lower than the metropolitan average. Housing costs are lower nearer to the transit line, with a perceptible drop for distances under .75 miles. While differences in transit costs are not as significant as differences in housing cost, they are perceptibly lower nearer the transit corridor.

Percentage point changes in housing, transportation, and H+T costs are shown below in **Figure 6**. The changes represent the difference in the percentage of income calculated to be necessary for housing and transportation expenditures. A stacked graph has been used to display the disaggregated effects of

housing and transportation on H+T affordability. The vertical axis shows the change in percentage points needed to meet housing and transportation costs. The horizontal axis shows how the total varies by buffer distance from the transit corridor. The time series analysis is intended to show if changes in H+T cost respond to proximity to transit.

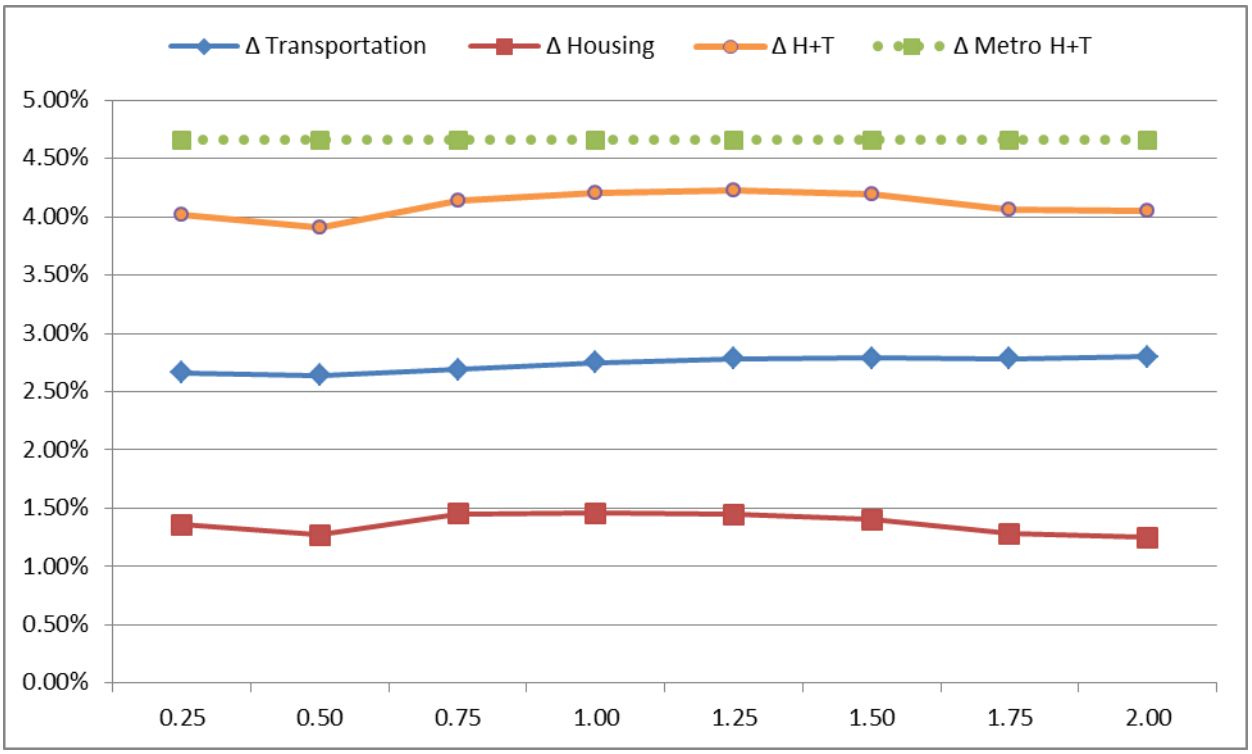

Figure 6: Change in housing and transportation costs, 2000-2009, for transit corridor, by buffer distance

The changes in H+T costs for the transit corridor are similar to the metro as a whole. Changes in H+T costs vary with distance to the transit corridor. Changes in the transportation costs in the transit corridor are much larger than the changes in housing costs. The changes in transportation costs are lower nearer to the transit corridor, although only be a fraction of a percent. Housing costs display an erratic pattern in relation to proximity to the transit corridor. They are lowest within .50 miles of the transit corridor, yet higher within .25 miles of the corridor.

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.

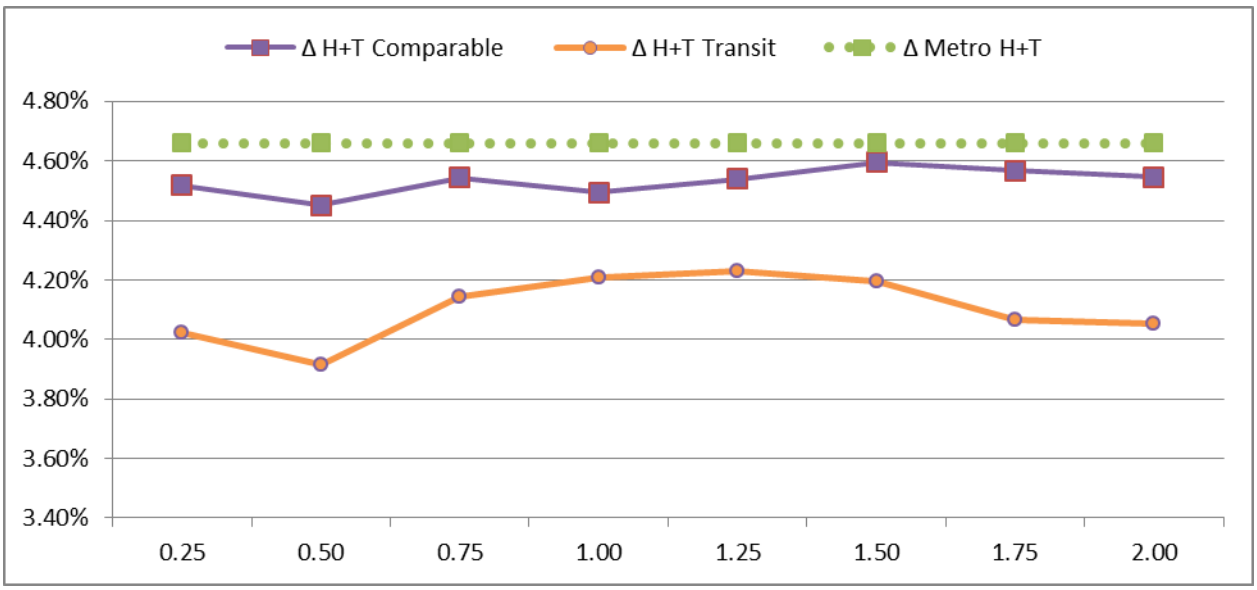

Figure 7: Changes in H+T, 2000-2009, for transit and comparable corridors, by buffer distance

The transit and comparable corridors display significantly different patterns in changes in H+T costs. The transit corridor experiences much lower increases in H+T costs than the comparable corridor for all buffer distances. The change in H+T costs is at its maximum about 1.25 miles from the transit station. For both corridors, the change in H+T is greater with 0.25 miles than for 0.50 miles, yet both are less than 0.75 mile distance.

Discussion & Implications

The METRO light rail doesn't run in a single direction. Rather, it has sections that run East-West, and a central portion that runs North-South. It also threads its way through the network of highways that joins together the polycentric Phoenix-Mesa metropolitan region. Corresponding, rather than a single 'rent' curve that declines with distance from more central places, housing costs along the METRO light rail displays erratic patterns in the changes in H+T costs, including a 'rent ridge' about 1.25 miles away from the corridor.

The region consists of many independent communities that have sprawled outward until they agglomerated into a single urban area. But the core of each of the independent cities is the original settlement, the seed from which each city grew, and the center from which they expanded outward. The first development to take place is thus the oldest, and typically run down and depreciated. Correspondingly, housing values are lower near these cores. The METRO light rail links many of these areas, as part of a general effort at raising property values and spurring redevelopment. The strong uptick in H+T costs within .25 miles for the transit line suggests this has been a successful strategy.

Transit Oriented Development 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 two miles, the majority walks far less. The relationship has 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 matches this relationship. The increases in H+T costs are greatest near the transit line. The increase does not occur in transportation costs, but in the housing costs, suggesting that the value of the accessibility provided by the METRO light rail is being capitalized into housing values.

This suggests that rather than improving housing affordability, transit actually impair its. This both confirms and contradicts theory. Theoretically, the value of the additional accessibility generated by proximity to transit should be capitalized into property value, resulting in rising housing costs. However, transit was expected to increase affordability overall, presuming that higher housing costs could be offset by lower transportation costs, with a lower overall H+T costs. Evidence for the METRO light rail generally confirms both. Housing costs are higher within a walkable distance of the transit corridor, and transportation costs are lower.

The pattern of changes in transportation cost shows a consistent relationship with the transit corridor, but does so for distances far beyond a normal walk radius. It is unlikely that the local population is willing to walk significantly further than normal, especially given environmental conditions. It is possible that other active transportation modes such as biking are being used to access the transit stations. The local transit agency, Valley Metro, has integrated bus service with the light rail. But the light rail does not run with sufficient frequency (enough vehicles per hour) to serve as the spine of a transfer-based transit network, so it seems unlikely the passenger shed for the transit line is being extended that way. More likely, transportation costs along the METRO light rail corridor are lower because the corridor is central to the metropolitan area. The average distance between a peripheral location and all other locations is large than that for a central location. Shorter distances mean fewer miles driven, and reduced costs for gas and mileage, and hence lower transportation 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 et al. 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	1,629	1,595	1.02	105.4	41.6	2.53	0.00	220.0	36.1	6.10	0.00	2002
2003	1,730	1,693	1.02	105.4	41.6	2.53	0.00	220.0	36.1	6.10	0.00	2003
2004	1,629	1,595	1.02	105.4	41.6	2.53	0.00	220.0	36.1	6.10	0.00	2004
2005	1,730	1,693	1.02	107.4	45.0	2.39	-0.15	226.3	36.8	6.15	0.05	2005
2006	1,818	1,778	1.02	110.0	46.0	2.39	0.00	224.9	39.1	5.75	-0.40	2006
2007	1,842	1,805	1.02	112.3	43.0	2.61	0.22	226.0	39.2	5.76	0.01	2007
2008	1,821	1,787	1.02	106.7	41.5	2.57	-0.04	225.2	36.8	6.12	0.37	2008
2009	1,676	1,626	1.03	99.4	36.2	2.75	0.17	207.8	35.5	5.86	-0.26	2009
2010	1,661	1,622	1.02	96.9	35.6	2.72	-0.02	214.1	31.6	6.77	0.91	2010
2011	1,708	1,653	1.03	97.1	35.9	2.71	-0.02	215	32.4	6.63	-0.14	2011
Trend												Trend

Table 6: Jobs-housing balance for all income categories

A special caveat is required when interpreting data for the Phoenix –Mesa metropolitan area. Arizona declined to participate in the first two years of the Local Employment-Housing Dynamics (LEHD)

program, so the first year of actual data is for 2004. For completeness, the 2002 and 2003 have been backfilled using 2004 data.

The overall jobs-housing ratio for both the comparable and transit corridors is relatively job-rich. The transit corridor has 5-6 times as many jobs per worker than the metropolitan area. The ratio does not significantly change with the advent of transit in 2008. There are big changes in 2008, which can be attributed to a drop in the number of workers living in the corridor, and bigger changes in 2010 for the same reason. The comparable corridor is less job-rich, with a jobs-housing ratio between 2 and 3. It has much smaller 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

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	467	452.17	1.03	21.4	13.3	1.60	0.00	53.5	12.4	4.31	0.00	2002
2003	467	452.17	1.03	21.4	13.3	1.60	0.00	53.5	12.4	4.31	0.00	2003
2004	467	452.17	1.03	21.4	13.3	1.60	0.00	53.5	12.4	4.31	0.00	2004
2005	480	463.91	1.03	20.9	13.7	1.52	-0.09	53.5	12.0	4.46	0.15	2005
2006	479	464.63	1.03	20.4	13.2	1.54	0.02	47.7	12.1	3.93	-0.52	2006
2007	464	450.41	1.03	19.9	11.8	1.68	0.14	48.2	11.8	4.09	0.16	2007
2008	450	438.09	1.03	17.6	10.8	1.62	-0.06	44.0	10.6	4.16	0.07	2008
2009	406	387.76	1.05	14.8	9.1	1.63	0.00	37.4	9.4	3.96	-0.19	2009
2010	387	373.34	1.04	14.1	8.9	1.59	-0.04	34.8	8.5	4.10	0.14	2010
2011	399	384.31	1.04	13.7	9.2	1.49	-0.10	35.7	8.5	4.18	0.08	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	673	658	1.02	4.5	19.0	0.24	0.00	81.1	16.5	4.92	0.00	2002
2003	673	658	1.02	4.5	19.0	0.24	0.00	81.1	16.5	4.92	0.00	2003
2004	673	658	1.02	4.5	19.0	0.24	0.00	81.1	16.5	4.92	0.00	2004
2005	705	689	1.02	4.4	20.7	0.21	-0.02	82.4	17.1	4.82	-0.10	2005
2006	734	714	1.03	4.7	21.3	0.22	0.01	83.1	17.9	4.64	-0.18	2006
2007	732	714	1.03	4.5	19.3	0.23	0.01	80.6	17.9	4.49	-0.15	2007
2008	710	694	1.02	4.3	18.6	0.23	0.00	78.7	16.3	4.83	0.34	2008
2009	661	638	1.04	4.1	16.1	0.25	0.02	73.2	16.1	4.56	-0.27	2009
2010	639	620	1.03	3.7	15.8	0.24	-0.02	71.4	13.9	5.14	0.58	2010
2011	647	620	1.04	3.72	15.84	0.23	0.00	70.6	13.9	5.09	-0.05	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	489	485	1.01	38.7	9.2	4.19	0.00	85.4	7.1	11.99	0.00	2002
2003	489	485	1.01	38.7	9.2	4.19	0.00	85.4	7.1	11.99	0.00	2003
2004	489	485	1.01	38.7	9.2	4.19	0.00	85.4	7.1	11.99	0.00	2004
2005	545	541	1.01	42.1	10.5	3.99	-0.20	90.4	7.7	11.73	-0.26	2005
2006	605	599	1.01	42.3	11.5	3.68	-0.30	94.1	9.1	10.36	-1.37	2006
2007	646	641	1.01	47.3	11.9	3.99	0.30	97.2	9.5	10.23	-0.14	2007
2008	661	655	1.01	45.9	12.0	3.82	-0.17	102.5	9.9	10.37	0.15	2008
2009	610	601	1.02	43.9	11.1	3.96	0.14	97.1	10.0	9.75	-0.62	2009
2010	635	628	1.01	45.5	11.0	4.16	0.20	107.8	9.2	11.68	1.93	2010
2011	662	648	1.02	46.2	10.8	4.27	0.11	108.5	10.0	10.87	-0.81	2011
Trend												Trend

Table 7: Jobs-housing balance by income category

The transit corridor is job-rich for all three income categories, but particularly for high income, where it has 9-12 times as many workers as working residents. The ratio is lower for medium-income workers, and lower still for low-income workers. Over time, the jobs-housing ratio for low-income workers is fairly constant, with small year on year changes. For low income, the year-on-year change in the jobs-housing ratio demonstrates no pattern of changes before or after transit. For low income, the year on year changes in the transit corridor are not significantly different than the comparable corridor.

After the advent of transit, the jobs-housing ratio seesaws erratically for medium income workers in the transit corridor, but shows a general upward trend. In 2010, there is a major drop in the number or workers with homes in the corridor. The employment decline predates the Great Recession, and continues steadily through it.

High-income workers are the sole category to see increases. It has a very high jobs-housing ratio for the entire study period, although it is characterized by very large year on year changes. These changes continue with the advent of transit, and are due to large shifts in both workers and workers resident in the corridor. Barring 2009, the number of high income workers in the corridor increases steadily. The number of workers resident in the corridor shows a similar pattern, but appears to reach a 'cap' about 2008, plateauing at about 10,000 resident workers. The jobs-housing ratio shows no consistent pattern, before or after transit.

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 were 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 2008	2008	2008 to 2011	2011	2002	2002 to 2008	2008	2008 to 2011	2011
Utilities	3.47		2.75		4.71	60.76		42.43		67.76
Construction	0.92		1.09		1.53	2.69		3.43		3.61
Manufacturing	0.92		0.96		1.25	5.07		2.37		4.52
Wholesale	1.21		1.28		1.55	4.06		4.32		4.62
Retail	1.27		1.10		1.14	2.75		2.26		2.93
Transportation	0.44		0.59		0.63	10.67		11.00		7.44
Information	1.42		1.74		1.46	10.32		12.41		10.16
Finance	2.52		3.00		3.63	6.57		6.94		7.75
Real Estate	1.53		2.50		2.23	5.48		4.53		6.52
Professional	2.70		2.47		2.88	8.23		8.78		7.55
Management	0.57		0.67		0.59	7.60		6.37		5.58
Administrative	1.34		1.54		0.89	4.31		4.05		4.42
Education	0.84		0.82		0.89	4.77		5.46		5.89
Health Care	2.16		2.27		1.91	7.05		6.97		8.92
Arts, Ent. Rec.	5.60		5.73		4.47	7.69		8.53		7.05
Lodging & Food	2.02		2.05		2.14	5.01		4.53		3.49
Other Services	1.91		1.85		1.47	6.96		6.71		6.79
Public Admin	23.45		22.18		25.36	14.44		16.14		18.73

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

The transit corridor is jobs-rich for all industries, so falling values for the jobs-housing ratio indicate an improvement in the jobs-worker balance, and increasing job accessibility. From the first year of transit operations (2008), the jobs-housing ratio rises for almost all industry sectors. Notable exceptions are the Professional, Management, Arts/Entertainment/Recreation, and Lodging/Food industries. The Management and Lodging/Food can be discounted, as the jobs-housing ratio was already improving prior to the beginning of transit operations. Contrast with the comparable corridors shows no significant changes in the Professional, and Arts/Entertainment/Recreation industries.

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 Phoenix, 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 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 jobs-housing ratio improves to become more balanced for only a small number of industries, notably Professional and Arts/Entertainment/Recreation. The improvement may be a result of falling number of workers, or a rising number of workers resident. In either case, this suggests that proximity to the transit line is valuable, with the METRO light rail providing access that is either faster, more reliable or cheaper than alternative modes, inducing employees working in those employees to also reside in the corridor.

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: Real Estate, Health Care
- Substantial Reductions: Transportation, Information
- Transit induced reductions: Professional, Transportation

Transit advantage over comparable corridor

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

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

Numeric Change in Transit corridor

- Employment in transit corridor shrank less than metropolitan area.
- Substantial numeric increases: Health Care, Education
- Substantial percent increases: Health Care and Real Estate
- Substantial reductions: Transportation, Information, and Lodging/Food

Effect of corridor, as per shift-share

- Health Care benefits the most.
- Education, Retail and Administrative benefit
- Strong negative corridor effect on Information, Transportation and Lodging/Food.

Transit advantage over comparable corridor

- Corridor Benefit is strongest for Retail, Real Estate and Education.
- The Corridor Effect is especially beneficial for Health Care and Administrative for the transit corridor.

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

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

Transit corridor after 2008

- Major positive trends: Health Care and Real Estate.
- Minor positive trends: Education.
- Weak trend strength but positive trend: Finance, Retail.

Transit Corridor Differences before and after Great Recession

- Improved: Real Estate, Health Care, & Finance.
- Declined: Other Services, Professional, & Transportation

Advantage over Comparable corridor:

- Better trends: Real Estate, Administrative, and Management.
- 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 .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 fall with proximity, barring the area within .25 miles.
- Transportation costs are lower 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.
- Changes in transportation costs are lower nearer the transit corridor.
- Changes in housing costs show an uptick within .25 miles of transit
- The change in H+T costs are less for the transit corridor than for the comparable corridor.

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

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

- Job rich at start of study period, with jobs-housing ratio greater than that of the metropolitan area.
- Erratic trends, big year on year changes.
- Changes in jobs-housing ratio caused by both declining number of workers, and declining number of workers resident in the corridor.
- There is no clear trend in the jobs-housing ratio for any income category.
- Job balance improves for two industries: Professional, and Arts/Entertainment/Recreation industries.

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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