Independence Avenue BRT

Charlotte, North Carolina

Do TODs Make a Difference?

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PROJECT TITLE

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

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1-INTRODUCTION

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

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

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

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

The final research question considers the relationship between workplace and residence 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 section.

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 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. 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 then 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 viable as transit corridors. This meant that corridors 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 Transit Oriented Development (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 is classified using the North American Industrial Classification System (NAICS), and data is available for each Census Block at the two-digit summary level. Data was 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/. The data was downloaded 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 Transit Oriented Development (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 build 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.

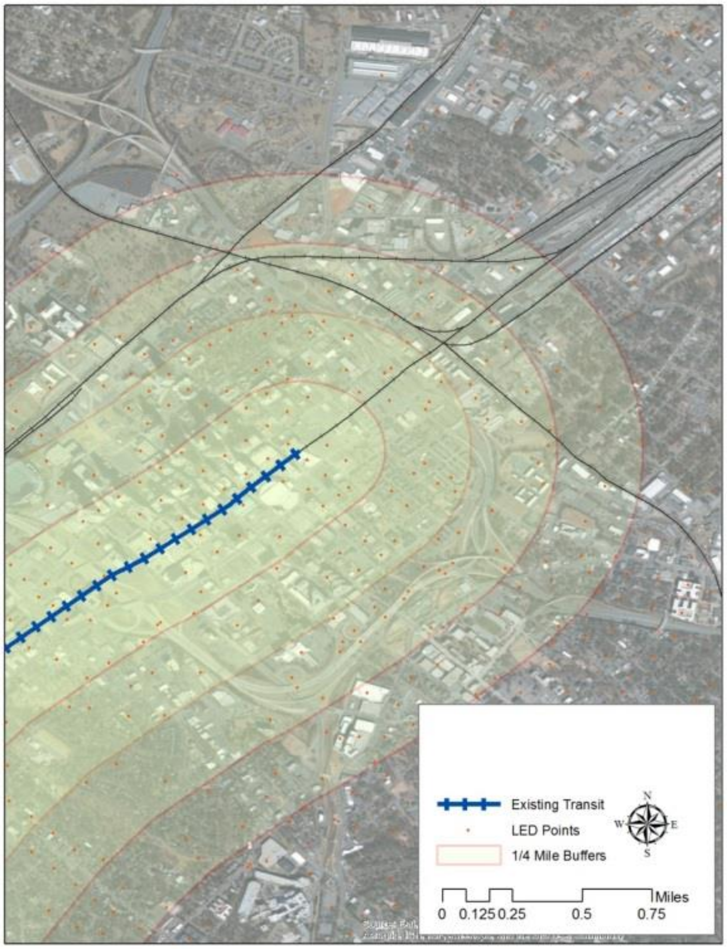
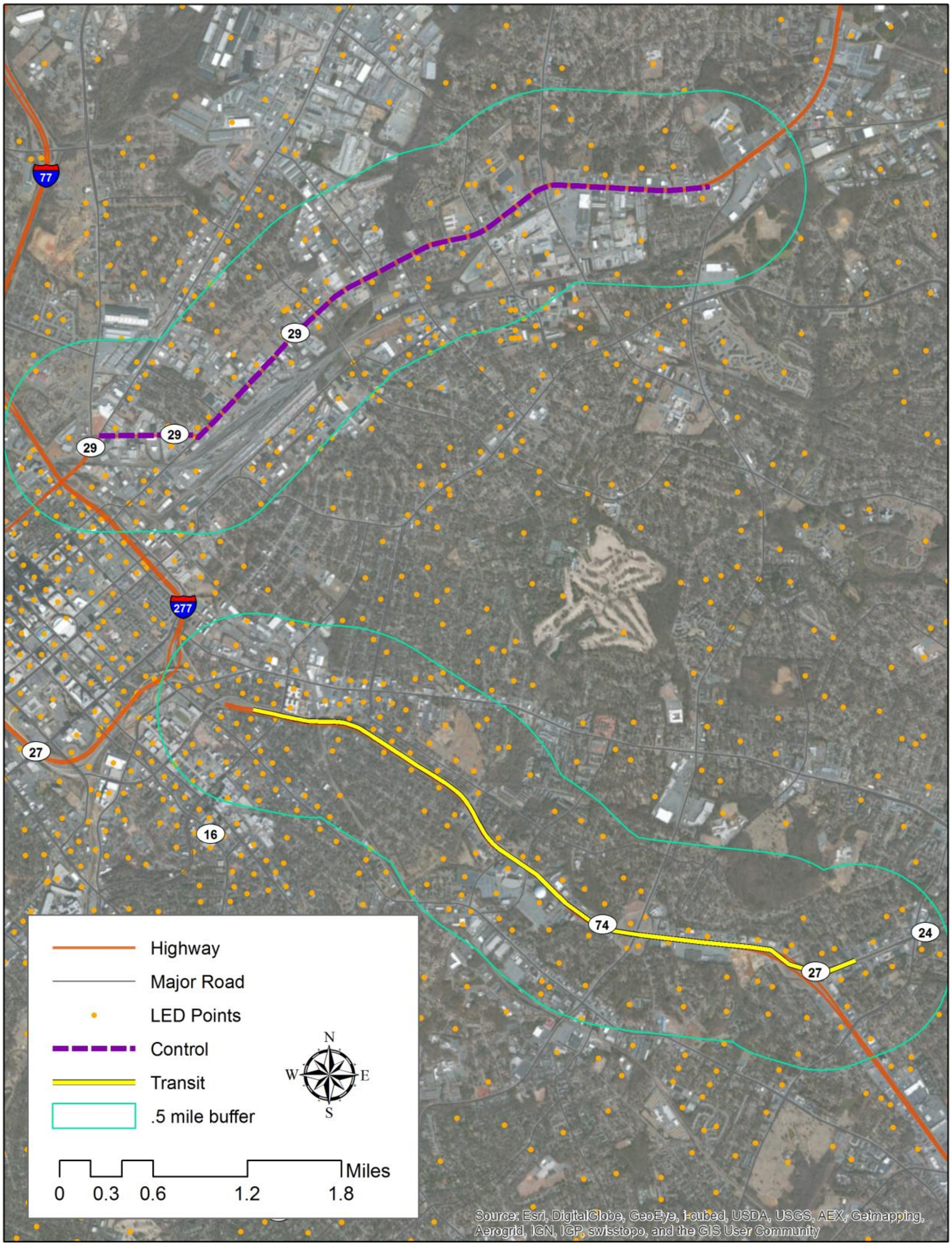


Figure 1: Example corridor, buffers, and LED census block points

Study Area

This study examines Charlotte's bus rapid transit line. More properly, the project is an 'open busway' without inline stations, served by a two-way exclusive bus-only lanes in the center of Independence Avenue. While Charlotte has a number of experiments with best bus and bus plus systems, such as Sprinter bus and the Gold Rush Trolleybus, both fail the critical test of a Bus Rapid Transit System: Dedicated guide-way. Charlotte’s bus rapid transit makes use of underused HOV lanes the center of Independence Boulevard. In addition, it enjoys the use of queue jumpers at certain intersections. The 2-way HOV lanes provide 2.6 miles of dedicated right of way. The right of way is typically used by express buses. Buses traveling the corridor originate in the southeast corner of the metropolis, and ends slightly inside the I-485 beltway. Figure 2 shows the transit and comparable corridors as well as the location of LED points.


77
29
29
29
277
27
16
74
24
27
Highway
Major Road
LED Points
Control
Transit
.5 mile buffer
N
W
E
S
0
0.3
0.6
1.2
1.8
Miles

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 2: Transit and comparable corridor locations

3-EMPLOYMENT CONCENTRATION

Introduction

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

Data & Methods

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

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.

Results

The location quotients for 0.5 mile buffers for both the transit and comparable corridors are shown in Table 1. For each corridor, the average location quotient for each analysis period is shown along with the change in those values. The differences between each corridor are shown, as are the differences in differences between the two corridors.

	Comparable Corridor			Transit Corridor			Differences		
Variable	Δ 2002-2002	Δ 2002-2011	Change	Δ 2002-2002	Δ 2002-2011	Change	Δ 2002-2002	Δ 2002-2011	Change
Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Utilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.01	0.01	0.00	-0.01	-0.01	0.00	-0.02	-0.02
Manufacturing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wholesale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Retail	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.01
Transportation	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.01	0.01
Information	0.00	-0.01	-0.01	0.00	0.01	0.01	0.00	0.01	0.01
Finance	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.01
Real Estate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Professional	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	0.00	0.00
Management	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Administrative	0.00	-0.01	-0.01	0.00	-0.04	-0.04	0.00	-0.03	-0.03
Education	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Health Care	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01
Arts, Ent. Rec.	0.00	0.01	0.01	0.00	-0.02	-0.02	0.00	-0.02	-0.02
Lodging & Food	0.00	0.00	0.00	0.00	-0.01	-0.01	0.00	-0.01	-0.01
Other Services	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01
Public Admin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 1: Location quotients comparison for Transit and comparable corridors

The change in location quotients before and after the beginning of transit operations indicates that the most significant increases in location occurr in the following industries: Information, Real Estate, Health care, and Other Services. Notable negative changes occurr in the Admininstrative and Arts, Entertainment, and Recreation industries. Several industry sectors do better in the transit corridor than the comparable corridor, notably Transportation, Information, Real Estate, Health Care, and Other Services.

For each corridor the differences in location quotient by industry are called out in Figure 3 by industry. This more clearly displays the differences between the corridors. The y-axis is numeric change in location quotient.

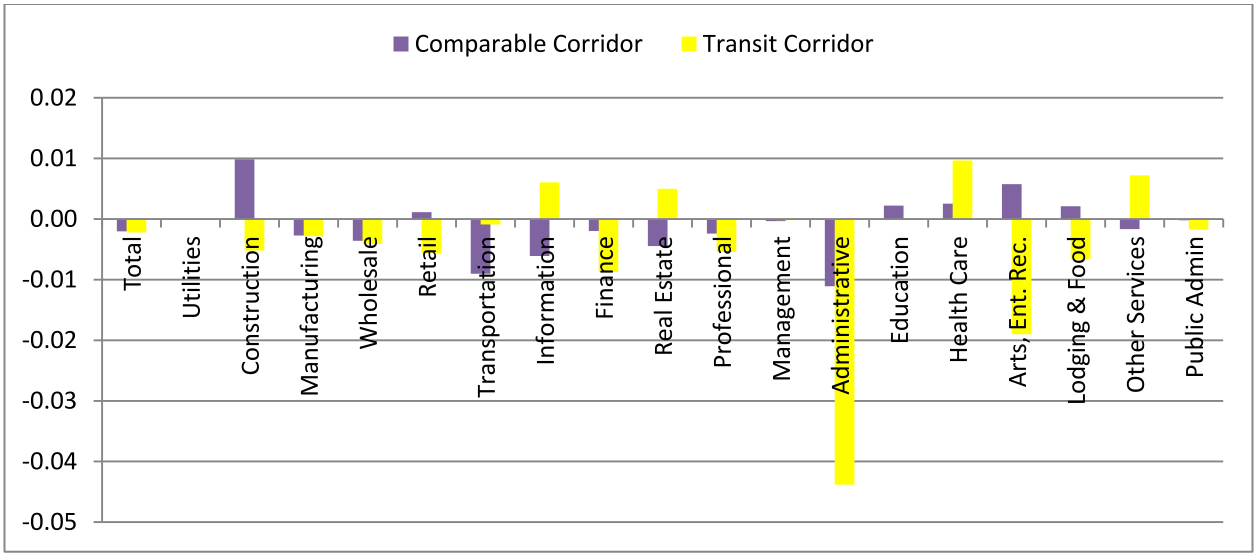


Figure 3: Changes in location quotient by corridor

The supremacy of the Health Care and Other Services industries in the transit corridor is more pronounced, as is the magnitude of decline in the Administration sector.

Discussion & Implications

The lack of strong increases in location quotient suggest two possible explanations: First, that the the accessibility provided by Bus Rapid Transit may not provide the level of premium associated with rail rapid transit. Bus Rapid Transit systems are less legally regulated than rail transit, and thu they are the mode most prone to suffer from corner cutting. Secondly, the Independence Avenue Busway is not a true busway, but rather makes use of freeway capacity to provide a limited access express section for commuter buses bound for downtown. As a result of the limited access along the freeway, there are no stations in that section, and so a major section of the route does not benefit from proximity to the BRT line.

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 changes is determined by other factors.

In theory, employment in different NAICS sectors should be variable depending on the NAICS code, as some NAICS 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, large institutions with large parking demands (universities, colleges, hospitals, and some government offices) could be expected to find proximity to transit valuable.

Data and Methods

A shift-share analysis attempts to identify the sources of regional economic changes, in attempt to identify 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. The second batch of columns shows the numeric and percentage changes in 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.

	Metro				0.5 mile buffer of Transit corridor				Sources of Employment Change		
NAICS Sector	**2002**	**2011**	**# Change**	**% Change**	**2002**	**2011**	**# Change**	**% Change**	**Share (of Metro)**	**Shift in Industry Mix**	**Effect of Corridor**
Utilities	6,114	4,929	(1,185)	-19%	-	-	-	0%	0	-	-
Construction	49,747	37,556	(12,191)	-25%	672	312	(360)	-54%	66	(165)	(261)
Manufacturing	109,472	71,781	(37,691)	-34%	1,292	644	(648)	-50%	126	(445)	(329)
Wholesale	51,267	53,105	1,838	4%	495	294	(201)	-41%	48	18	(267)
Retail	85,648	90,023	4,375	5%	1,217	776	(441)	-36%	119	62	(622)
Transportation	33,082	31,294	(1,788)	-5%	578	519	(59)	-10%	56	(31)	(84)
Information	25,097	21,594	(3,503)	-14%	212	313	101	48%	21	(30)	110
Finance	44,719	61,436	16,717	37%	677	394	(283)	-42%	66	253	(602)
Real Estate	11,503	12,946	1,443	13%	362	472	110	30%	35	45	29
Professional	38,873	55,051	16,178	42%	824	868	44	5%	80	343	(379)
Management	23,415	26,849	3,434	15%	42	43	1	2%	4	6	(9)
Administrative	53,572	69,022	15,450	29%	3,424	1,388	(2,036)	-59%	334	987	(3,358)
Education	49,886	64,388	14,502	29%	2,726	3,521	795	29%	266	792	(263)
Health Care	72,509	103,385	30,876	43%	5,180	8,384	3,204	62%	505	2,206	493
Arts, Ent. Rec.	12,227	18,214	5,987	49%	319	129	(190)	-60%	31	156	(377)
Lodging & Food	53,237	70,947	17,710	33%	1,178	1,096	(82)	-7%	115	392	(589)
Other Services	21,297	20,953	(344)	-2%	422	566	144	34%	41	(7)	110
Public Admin	22,187	24,673	2,486	11%	79	45	(34)	-43%	8	9	(51)
Total	**763,852**	**838,146**	**74,294**	**10%**	**19,699**	**19,764**	**65**	**0%**	**1922**	**4,593**	**(6,450)**

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

The entire metro area enjoys substantial growth of over 10% during the analysis period. That growth is not reflected in the transit corridor, which sees almost no change in total employment. There is substantial change in employment by industry within the corridor, with Construction, Manufacturing, and Administrative seeing substantial reductions in employment, in both numbers and as a percent of the total. Within the corridor, only Education and Healthcare see substantial increases. The shift-share analysis itself shows different trends. After controlling for metropolitan growth and shift in the industry mix, the effect of the transit corridor on employment is negative. The effect is most strongly negative for administration. The only industry to benefit from location in the corridor is Healthcare.

Data 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.

	Comparable		Transit		Transit Advantage	
	# Change	Effects of Corridor	# Change	Effects of Corridor	Employment Change	Corridor Effect
Utilities	-	-	-	-	-	-
Construction	140	278	(360)	(261)	(500)	(539)
Manufacturing	(760)	(355)	(648)	(329)	112	26
Wholesale	(133)	(348)	(201)	(267)	(68)	81
Retail	151	10	(441)	(622)	(592)	(632)
Transportation	(350)	(404)	(59)	(84)	291	320
Information	(187)	(170)	101	110	288	280
Finance	(70)	(135)	(283)	(602)	(213)	(467)
Real Estate	(33)	(77)	110	29	143	106
Professional	(36)	(155)	44	(379)	80	(225)
Management	(3)	(13)	1	(9)	4	4
Administrative	(364)	(900)	(2,036)	(3,358)	(1,672)	(2,458)
Education	190	126	795	(263)	605	(390)
Health Care	462	218	3,204	493	2,742	275
Arts, Ent. Rec.	105	105	(190)	(377)	(295)	(482)
Lodging & Food	237	124	(82)	(589)	(319)	(713)
Other Services	(44)	(90)	144	110	188	200
Public Admin	(4)	(6)	(34)	(51)	(30)	(44)
Total	**(699)**	**(1,792)**	**65**	**(6,450)**	**764**	**(4,658)**

Table 3: Shifts by corridor and comparison between corridors

The corridor shift associated with the transit and comparable corridors are substantially different for most industries. The corridor effect for the transit corridor is better for Transportation, Information and Health Care, while the comparable corridor does substantially better in Administrative, Lodging and Food, and Retail.

Discussion & Implications

Based on the results of the shift-share analysis, there are industries that are both strongly attracted to and strongly repulsed from BRT transit corridors. The numeric change, percent change, shift-share, and contrast with the comparable corridor all indicate that proximity to the Independence Avenue BRT is attractive to Healthcare, and repulsive to Administration. Healthcare has been a rapidly growing sector of the economy, requiring large amounts of labor. In addition to transportation for its staffing needs, it generates a large number of trips as a destination for both patients and visitors, resulting in a strong demand for transportation. Consequently, they make attractive destinations for bus routes. In contrast, the administration industry largely represents ‘back office’ and processing functions. In the age of the internet, when data transfer is cheap and easy, relocating such functions to peripheral locations with lower rents has been an attractive preposition.

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; it provides alternate transportation options during conditions that impair other modes: weather, construction projects, or accident-induced delay; finally, it 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, reducing 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 and compares the differences. The time series datasets are separated by an ‘interruption’. 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 former represents the relationships between the change in variables, and the latter 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 2007. The vertical axis shows total employment in each industry sector along the corridor. Illustrative regression lines with R2 values have been added for some of the industries. The trend lines and associated R2 values for all industry sectors can be found in Table 4.

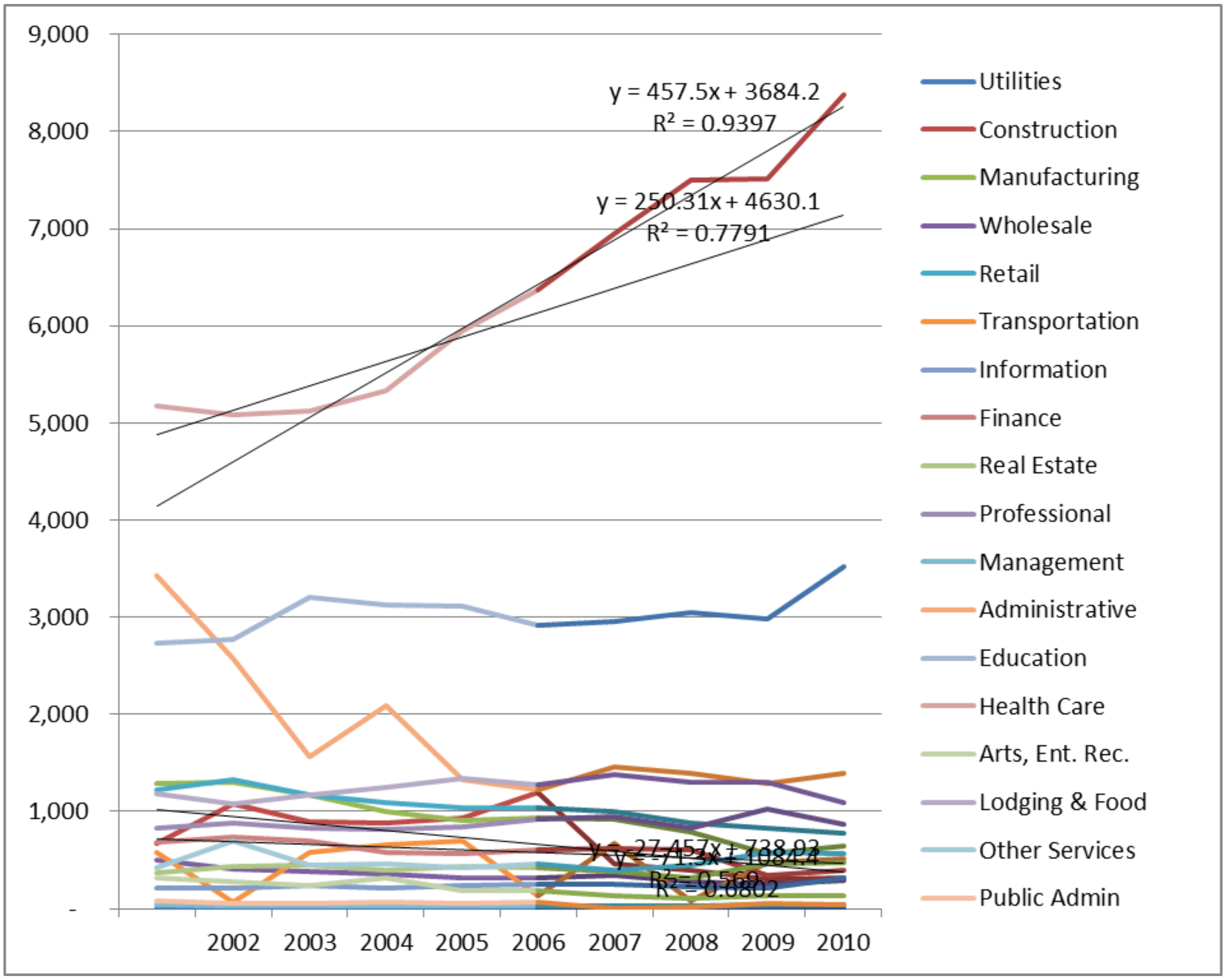


Figure 4: Regression trend lines and R-squared values for different industries

Figure 4 is intended to be illustrative of breaking a time-series into two portions, calculating the best-fit regression line of each, and R^2 value. The regression lines can be treated as trend lines representing the overall pattern of employment totals by industry during each time period, and including all information in the time series, not just that of the starting and ending pints. Times series that have more consistent patterns (trending upward or downward, rather than oscillating) will have higher R^2 values.

In Table 4 the regression coefficient for each time series is presented, as well as the R^2. Contrast between the 2002-2007 period and the 2007-2011 period highlights the resilience of different industries. More resilient industries should have comparable values during both periods.

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 size of the trend number indicates the rate of decrease or increase. The R2 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. These totals are presented for both time periods.

The change in the trend between the two time periods is given in the 'Δ Slope' column. A positive value 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 'Δ 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.

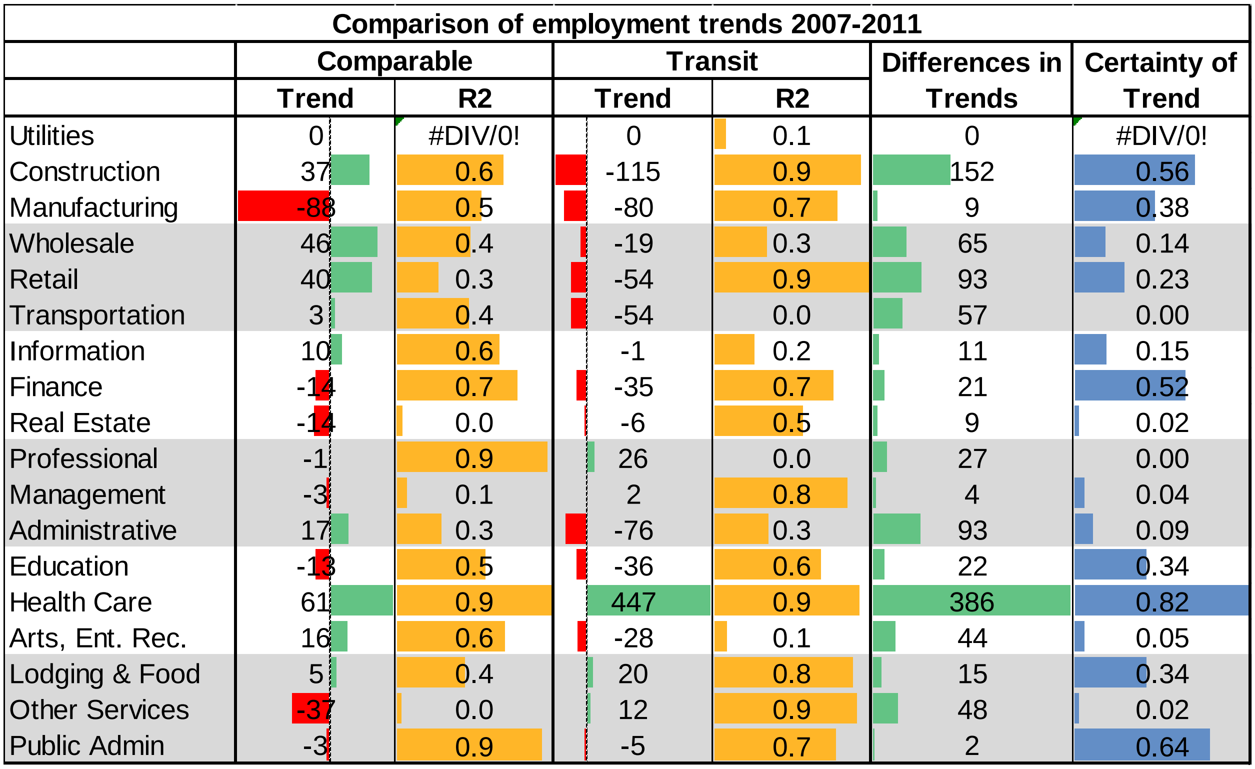
Changes in employment trends for 0.5 mile buffer of transit corridor

	2002-2007		2007-2011			
	Trend	**R2**	**Trend**	**R2**	**Δ Trend**	**Δ R2**
Utilities	0.1	0.04	0.1	0.1	0.0	0.0
Construction	-13.0	0.01	-115.3	0.9	-102.3	0.9
Manufacturing	-75.7	0.86	-79.8	0.7	-4.1	-0.1
Wholesale	-25.3	0.77	-19.4	0.3	6.0	-0.5
Retail	-48.3	0.80	-53.9	0.9	-5.6	0.1
Transportation	18.5	0.02	-53.9	0.0	-72.4	0.0
Information	6.3	0.75	-0.8	0.2	-7.1	-0.5
Finance	-19.3	0.44	-34.5	0.7	-15.3	0.3
Real Estate	1.7	0.02	-5.6	0.5	-7.3	0.5
Professional	16.6	0.47	26.4	0.0	9.7	-0.5
Management	-1.0	0.09	1.8	0.8	2.8	0.7
Administrative	-316.0	0.72	-75.9	0.3	240.0	-0.4
Education	31.0	0.13	-35.6	0.6	-66.6	0.5
Health Care	311.7	0.85	446.6	0.9	134.9	0.0
Arts, Ent. Rec.	-28.6	0.74	-27.9	0.1	0.7	-0.7
Lodging & Food	41.7	0.74	19.9	0.8	-21.8	0.1
Other Services	-20.2	0.18	11.5	0.9	31.7	0.7
Public Admin	-7.4	0.47	-5.3	0.7	2.1	0.3

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

Notable trends before the advent of transit include the decline in employment in the Administration sector and an increase in Healthcare Employment. Strong trends (represented by high R^2 values) before the advent of transit include Manufacturing (.86), and Healthcare (.85). After the advent of transit, there are strong differences in the trends for Construction, Administration, and Healthcare. A positive change indicates that the trend has improved. Either shifting from loss to a less sharp loss, from loss to gain, or from gaining to an increase rate of gain. Construction does worse with the advent of transit, while both Administrative and Healthcare do better. The difference in R^2 between the two periods shows changes in the consistency of the trend. Construction, Management, and Other Services all show strong increases in trend strength.

For comparison, the same trend information is presented for the comparable corridor in Table 5. Industries with comparable trends and trend strengths in both corridors can be considered to be caused by factors affecting both corridors, such as metropolitan scale trends.



Comparison of employment trends 2007-2011						
	Comparable		Transit		Differences in Trends	Certainty of Trend
	Trend	R2	Trend	R2		
Utilities	0	#DIV/0!	0	0.1	0	#DIV/0!
Construction	37	0.6	-115	0.9	152	0.56
Manufacturing	-88	0.5	-80	0.7	9	0.38
Wholesale	46	0.4	-19	0.3	65	0.14
Retail	40	0.3	-54	0.9	93	0.23
Transportation	3	0.4	-54	0.0	57	0.00
Information	10	0.6	-1	0.2	11	0.15
Finance	-14	0.7	-35	0.7	21	0.52
Real Estate	-14	0.0	-6	0.5	9	0.02
Professional	-1	0.9	26	0.0	27	0.00
Management	-3	0.1	2	0.8	4	0.04
Administrative	17	0.3	-76	0.3	93	0.09
Education	-13	0.5	-36	0.6	22	0.34
Health Care	61	0.9	447	0.9	386	0.82
Arts, Ent. Rec.	16	0.6	-28	0.1	44	0.05
Lodging & Food	5	0.4	20	0.8	15	0.34
Other Services	-37	0.0	12	0.9	48	0.02
Public Admin	-3	0.9	-5	0.7	2	0.64

Table 5: Comparison of changes in employment trends within a 0.5 mile buffer

Because the comparable corridor acts as a control, it does not receive the treatment of transit. Thus, trends before and after the advent of transit should be very similar. This is largely the case, with smaller changes in both trends (**Δ** Slope) and the strength of the trend. (**Δ** R^2). The largest change in slope is slightly over 100, and the change in strength of trend is never over 0.6.

Discussion & Implications

Employment in any industry sector is variable. Because the geographic unit of analysis is small, the amount of fluctuation is larger, where changes might average out over a larger unit of geographic aggregation. Thus, trend strength is very important in interpreting changes. 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.

6-HOUSING AFFORDABILITY

Introduction

It is not always possible to maintain a supply of affordable housing for a growing population by adding additional 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. 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 Transit Oriented Development (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 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 frequented by non-walk modes, including bicycle, bus, and automobile. The characteristics of the built environment within a mile buffer of 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 magnitude of effect for proximity to transit. The area within the smallest buffers should show the strongest reaction.

Data Source and Geography

This study uses 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 metros. 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 weighted by geographic ratio. The geographic ratio 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% of the area in the buffer, H+T characteristics for that block group received a weight of 3%. 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. (stacked graph)
2. Change in H+T costs for transit corridors (stacked graph)
3. Change in H+T costs for transit and comparable corridors. (Line Graph)

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

The 2009 combined housing, transportation, and H+T dollar costs for the transit corridor are shown in Figure 5. It is a cross-sectional analysis intended to determine if there is any relationship between housing costs, transportation costs, and distance to transit. 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.

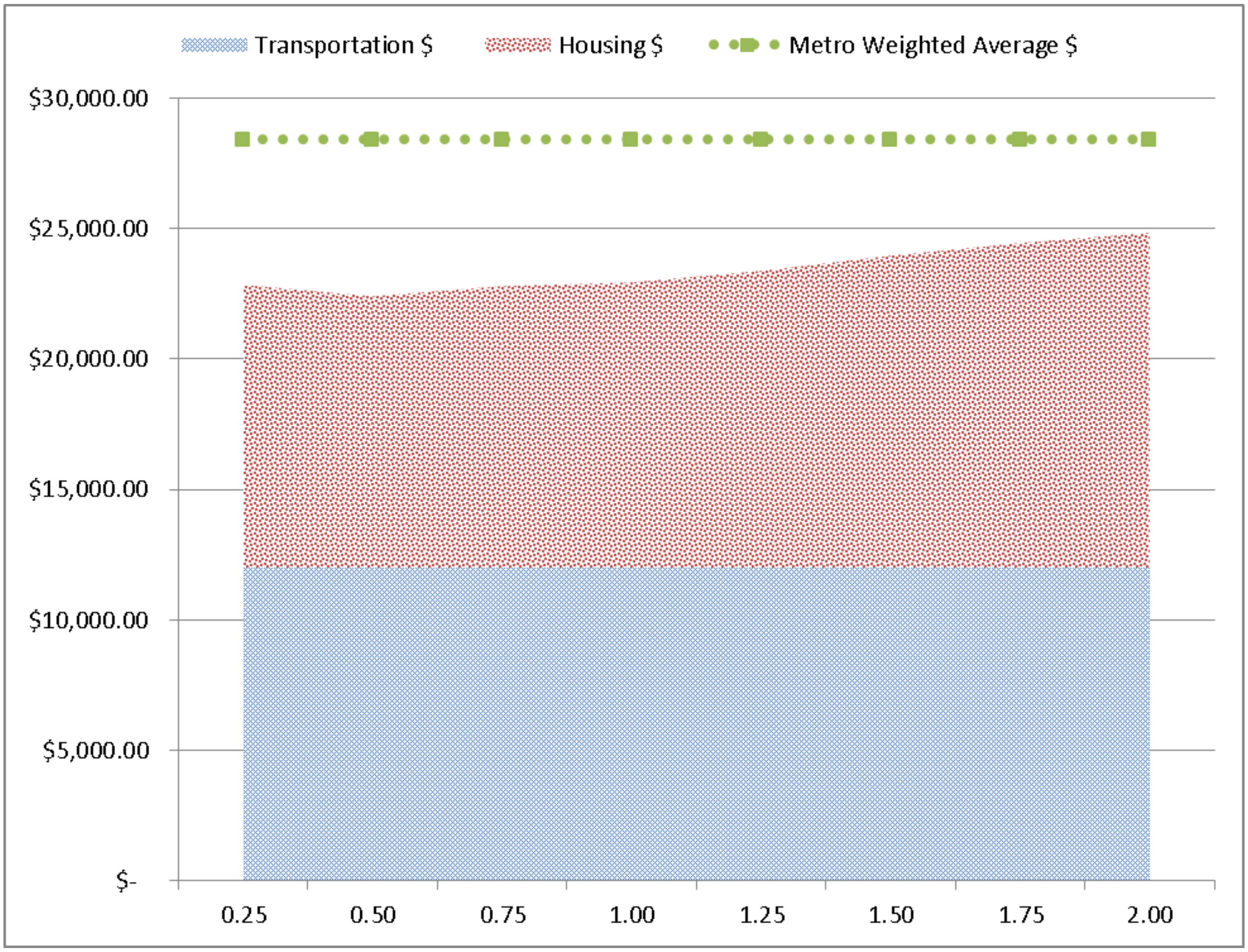


Figure 5: Housing, transportation, and H+T costs for the transit corridor, 2009, by buffer distance

As the above graph shows, H+T costs near the transit line are lower than the metropolitan average. Housing costs generally decline within proximity to the transit line, with a slight upward trend within a quart mile of the transit line. Transportation costs are constant at all distances to the transit line.

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.

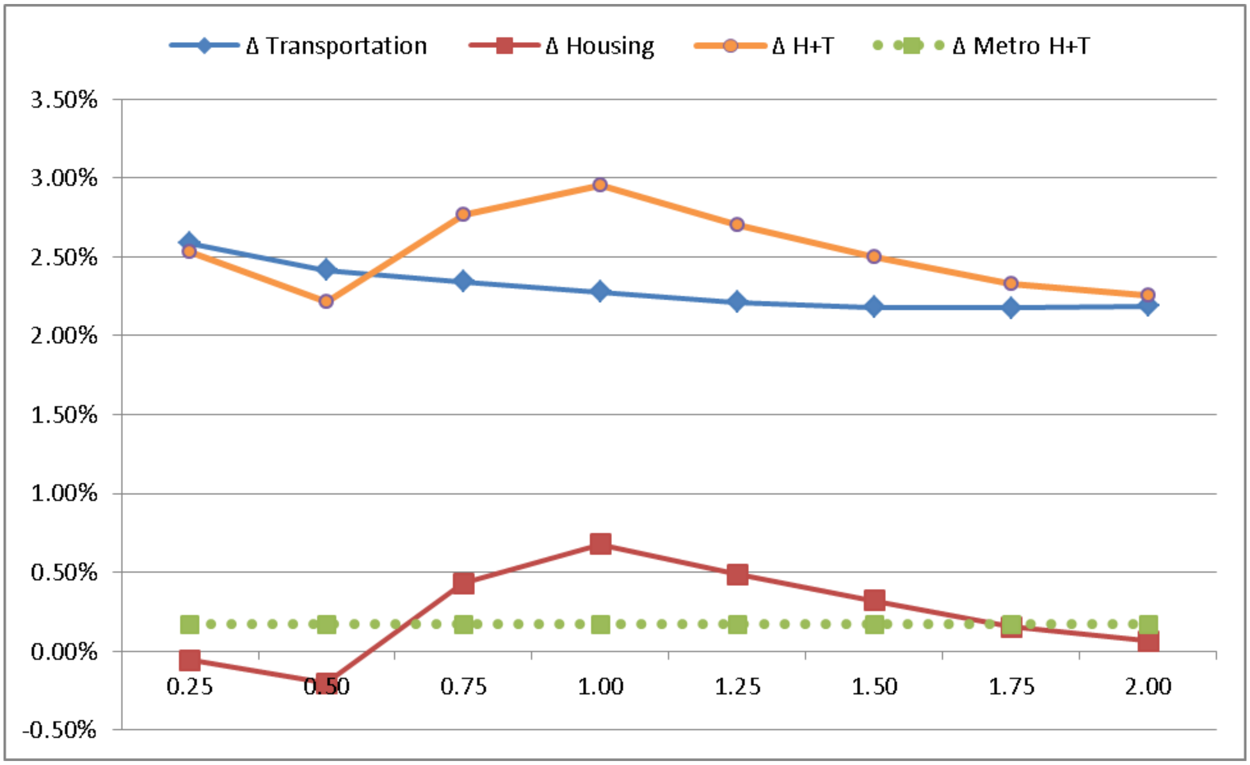


Figure 6: Change in housing and transportation costs, 2000-2009, for transit corridor, by buffer distance

Changes in H+T costs vary with distance to the transit corridor, but inconsistently. The increase is greatest a mile from the transit corridor, and declines with further distance. The increase is most minimal in the half mile buffer around the transit corridor. Change in transportation costs is inverse to distance to the transit corridor, with the greatest increase occurring near the corridor. Housing costs rise the most a mile from the transit corridor, and actually decline within the .25 and .50 mile buffers.

The change in metro H+T costs has been provided as a reference. As the above graph shows, the contributions of housing and transportation to changes in the H+T affordability are not constant. Further, the change in each differs by buffer distance.

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.

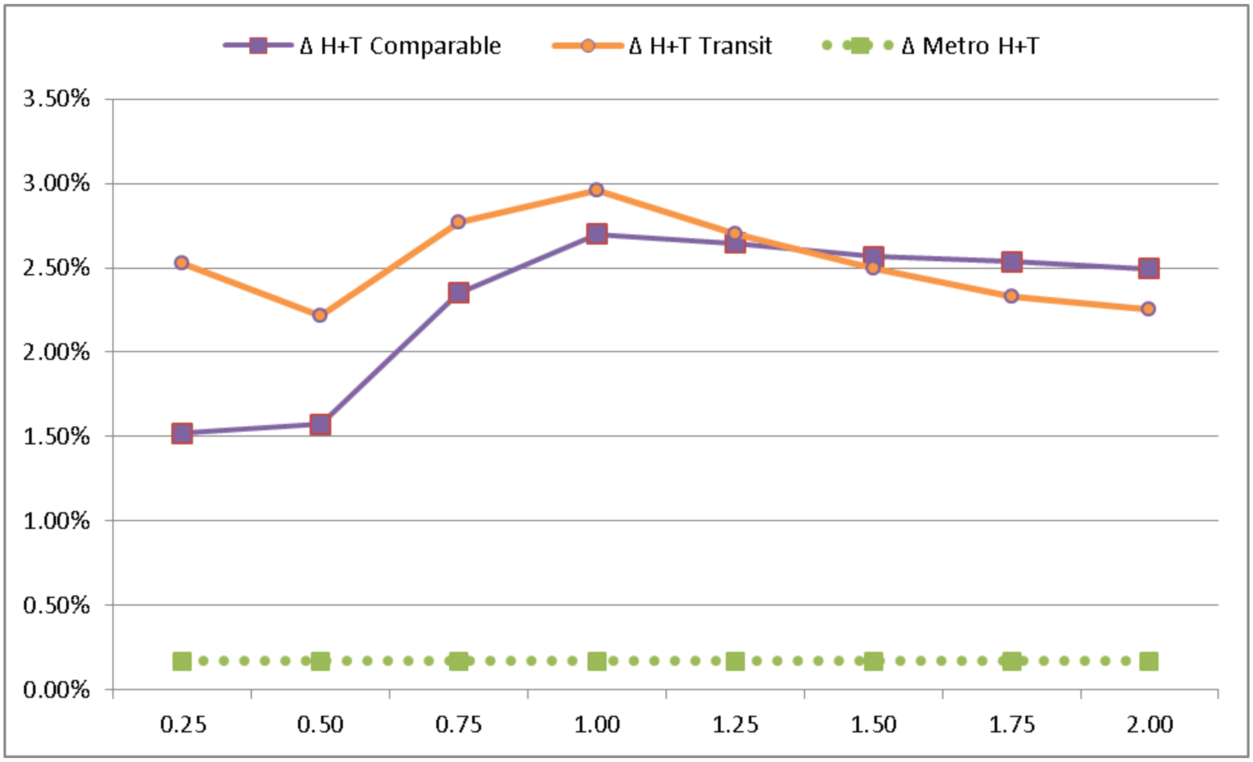


Figure 7: Changes in H+T, 2000-2009, for transit and comparable corridors, by buffer distance

Both corridors display a similar pattern of changes in H+T costs. The degree of change is different, and varies with the size of the buffer. The change in H+T costs is greater for the transit corridor than for the comparable corridor within all buffers 1.25 miles or less. The difference between the change in H+T costs is greatest nearest to the corridors.

Discussion & Implications

Contrary to expectations, the H+T costs in 2009 shows minimal relationship to transit. Proximity to transit should reduce transportation costs, and the effect should be strongest nearest the transit line. Changes in H+T costs are also contrary to expectations, with the largest increase near transit.

The accessibility premium associated with transit should also be capitalized into housing values, yet housing costs decrease with proximity to the transit corridor. Housing costs are only higher within the .25 mile buffer, suggesting walk-access only.

Many of these confounding effect are explained by the BRT's location within Independence Boulevard. For most of the running way of the BRT, Independence Boulevard is primary arterial with 3 lanes of traffic in each direction. It is state highway, and includes a grade separated section. Such roadway geometry is consistent with high volumes of traffic and the associated noise and pollution, and is a notoriously unfriendly pedestrian environment. Whatever the benefits of transit accessibility, they are likely being masked by negative effects of Independence Boulevard. This is consistent with the negative change in housing costs near the transit corridor.

This helps explain differences between the transit and comparable corridors. While H+T costs rise in proportion to proximity to the transportation corridor, housing costs are falling, indicating that the majority of the increase in H+T costs is due to increases in transportation. Facing rising transportation costs, people are locating in undesirable locations to maintain an acceptable overall H+T level. The large number of apartment buildings on marginal behind the aging strip development adjacent to Independence Boulevard supports this hypothesis.

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. Transit Oriented Development (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 work 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 or 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 is 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 is 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 resident 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. The jobs-housing balance at the metro scale represents a normal ratio. 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 improve the jobs-housing balance over time so that it more closely approaches that of the metro.

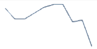
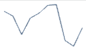
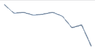
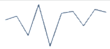
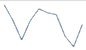
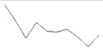
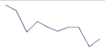
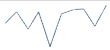
	Metro			Comparable				Transit			
Year	Work, 000's	Home, 000's	Jobs-Housing Ratio	Work, 000's	Home, 000's	Jobs-Housing Ratio	Year on Year Change in	Work, 000's	Home, 000's	Jobs-Housing Ratio	Year on Year Change in
2002	766	678	1.13	10.24	4.47	2.29	0.00	19.7	7.7	2.56	0.00
2003	750	669	1.12	9.42	4.15	2.27	-0.02	19.0	7.1	2.69	0.13
2004	735	667	1.10	8.83	4.16	2.12	-0.15	18.2	6.6	2.76	0.07
2005	780	702	1.11	9.78	4.32	2.26	0.14	18.7	6.8	2.76	0.00
2006	811	767	1.06	9.55	4.50	2.12	-0.14	18.4	7.6	2.43	-0.33
2007	831	771	1.08	10.20	4.59	2.22	0.10	18.3	7.1	2.57	0.13
2008	838	775	1.08	10.11	4.60	2.20	-0.02	18.9	6.8	2.78	0.22
2009	777	709	1.09	9.56	4.07	2.35	0.15	18.2	6.6	2.78	0.00
2010	771	708	1.09	9.36	4.13	2.26	-0.09	18.3	5.9	3.14	0.35
2011	841	774	1.09	9.54	3.36	2.84	0.58	20	5.5	3.61	0.47
Trend											

Table 6: Jobs-housing balance for all income categories

The overall jobs-housing ratio for both the comparable and transit corridors is relatively job-rich. For the comparable corridor, the ratio remains fairly constant over time, although it rises substantially in 2011, largely as a result of a drop in the number of residents in the corridor. In contrast, the jobs-housing ratio for the transit corridor rises in all years but one, and also includes a substantial increase in 2011. As with the comparable corridor, the rise can largely be attributed to a fall in the number of residents, from 7.7 thousand (7,700) to 5.5 thousand (5500).

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 resident to high income workplaces will not increase job accessibility. Comparing the jobs-housing ratio by income category makes it possible to gauge not just the overall improvement in jobs-housing balance, but which earnings categories benefit the most from proximity to transit. To determine the degree to which an earnings-specific match is accomplished, **Table 7** compares the jobs-housing balance to the earnings category.

Low Income											
	Metro			Comparable				Transit			
Year	Work, 000's	Home, 000's	Jobs-Housing Ratio	Work, 000's	Home, 000's	Jobs-Housing Ratio	Year on Year Change in	Work, 000's	Home, 000's	Jobs-Housing Ratio	Year on Year Change in
2002	205	183	1.12	2.78	1.63	1.71	0.00	6.35	2.28	2.79	0.00
2003	202	181	1.12	2.31	1.50	1.54	-0.17	6.00	2.08	2.88	0.10
2004	191	175	1.09	2.00	1.51	1.32	-0.22	4.77	1.89	2.53	-0.36
2005	201	181	1.11	2.27	1.47	1.54	0.22	5.46	1.89	2.89	0.36
2006	204	194	1.05	2.12	1.48	1.43	-0.12	4.70	2.07	2.28	-0.62
2007	208	194	1.07	2.42	1.50	1.61	0.19	4.65	1.91	2.44	0.16
2008	209	193	1.08	2.27	1.46	1.56	-0.06	4.49	1.70	2.65	0.21
2009	188	171	1.10	2.10	1.28	1.64	0.08	4.07	1.62	2.51	-0.14
2010	184	171	1.08	1.99	1.32	1.51	-0.13	4.11	1.49	2.76	0.25
2011	195	182	1.07	2.12	1.02	2.08	0.57	3.80	1.30	2.94	0.18
Trend											

Medium Income											
	Metro			Comparable				Transit			
Year	Work, 000's	Home, 000's	Jobs-Housing Ratio	Work, 000's	Home, 000's	Jobs-Housing Ratio	Year on Year Change in	Work, 000's	Home, 000's	Jobs-Housing Ratio	Year on Year Change in
2002	333	294	1.13	0.49	2.19	0.22	0.00	8.35	3.63	2.30	0.00
2003	316	281	1.12	0.45	1.97	0.23	0.00	8.02	3.22	2.49	0.19
2004	296	267	1.11	0.41	1.86	0.22	-0.01	6.80	2.84	2.40	-0.09
2005	316	284	1.11	0.44	2.00	0.22	0.00	7.42	2.87	2.59	0.19
2006	328	310	1.06	0.42	2.03	0.21	-0.01	7.08	3.22	2.20	-0.39
2007	324	300	1.08	0.42	1.94	0.22	0.01	6.83	2.90	2.36	0.16
2008	323	297	1.09	0.43	1.96	0.22	0.00	7.07	2.73	2.58	0.22
2009	301	274	1.10	0.41	1.83	0.22	0.00	7.05	2.50	2.83	0.24
2010	289	264	1.10	0.38	1.76	0.22	0.00	5.98	2.15	2.78	-0.04
2011	313	286	1.09	0.41	1.53	0.27	0.05	6.41	2.07	3.10	0.32
Trend											

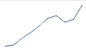
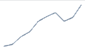
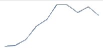
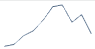
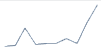
High Income											
	Metro			Comparable				Transit			
Year	Work, 000's	Home, 000's	Jobs-Housing Ratio	Work, 000's	Home, 000's	Jobs-Housing Ratio	Year on Year Change in	Work, 000's	Home, 000's	Jobs-Housing Ratio	Year on Year Change in
2002	229	202	1.13	2.61	0.66	3.97	0.00	5.00	1.79	2.80	0.00
2003	232	207	1.12	2.64	0.68	3.89	-0.09	4.98	1.76	2.83	0.03
2004	248	225	1.10	2.78	0.79	3.54	-0.35	6.66	1.88	3.55	0.72
2005	263	238	1.11	3.08	0.85	3.65	0.11	5.78	2.01	2.88	-0.67
2006	279	263	1.06	3.23	0.99	3.28	-0.37	6.63	2.29	2.90	0.02
2007	299	276	1.08	3.59	1.15	3.12	-0.15	6.85	2.34	2.93	0.03
2008	306	285	1.08	3.58	1.18	3.03	-0.09	7.34	2.36	3.11	0.18
2009	288	265	1.09	3.41	0.96	3.57	0.54	7.10	2.44	2.92	-0.19
2010	297	274	1.08	3.53	1.06	3.35	-0.22	8.26	2.22	3.73	0.81
2011	334	305	1.09	3.32	0.81	4.08	0.73	9.55	2.12	4.51	0.78
Trend											

Table 7: Jobs-housing balance by income category

For low-income workers, the jobs-housing ratio is erratic. Over time, both the number of low income residents and low-income workers fall. The same pattern is evident for the comparable corridor, but the drop is more severe for the transit corridor. The jobs-housing ratio for high income workers increases, despite steady increase in the number of high income workers in the corridor, because the number of high income workers increases even faster.

Industry balance provides a yet more refined understanding of the match between worker 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.

	Comparable					Transit				
Industry	2002	2002 to 2007	2007	2007 to 2011	2011	2002	2002 to 2007	2007	2007 to 2011	2011
Utilities	0.51		0.00		0.00	12.94		13.49		15.29
Construction	4.63		4.16		5.63	5.93		7.05		5.28
Manufacturing	2.79		3.17		2.25	4.15		4.68		4.31
Wholesale	2.91		3.00		4.55	2.73		3.90		4.20
Retail	2.75		2.53		4.04	3.13		3.44		3.86
Transportation	1.74		1.84		2.11	1.13		1.43		1.67
Information	11.21		8.82		13.63	11.50		9.92		9.64
Finance	9.62		9.02		10.20	10.62		11.11		11.14
Real Estate	4.18		4.32		4.09	5.00		7.08		8.47
Professional	6.83		5.90		6.35	10.46		9.55		9.32
Management	6.13		4.68		8.54	12.93		13.88		14.91
Administrative	3.84		4.31		4.07	6.87		7.17		8.17
Education	5.42		0.35		2.80	6.57		0.77		4.00
Health Care	1.86		2.48		3.95	1.34		1.65		1.87
Arts, Ent. Rec.	5.40		5.91		12.23	5.85		9.12		11.55
Lodging & Food	5.08		4.95		6.60	4.90		4.52		4.50
Other Services	3.57		4.63		4.18	5.96		6.26		7.41
Public Admin	17.09		20.17		32.67	21.22		27.94		34.86

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

If any population is making extensive use of transit, the jobs-housing balance should improve over time to a level more similar to the metro ratio. As the earlier tables show, the metro ratio varies between 1.05 and 1.13. For the transit corridor, this is the case for a limited number of industries. These include: Wholesale, Finance, Administrative, and Arts, Entertainment in Recreation. The change, for Wholesale is within the range of variation at the metro scale. Finance worsens for the comparable corridor, becoming more biased toward a job-poor ratio, suggesting an increase in housing for both. Given that Finance is typically a high-income industry, this suggests an increase in employees in Finance both living and working within .50 miles of the corridor. Earlier analysis suggests that the improvement in the jobs-housing ratio for the Administration industry is the result of employment losses, rather that growth in housing. The extreme drop in the jobs-housing ratio for the Arts, Entertainment, and Recreation Industry (from 2.48 to .88) suggests a similar explanation.

Discussion & Implications

There is no evidence that the Independence Boulevard BRT improves jobs-housing balance, and substantial evidence to the contrary. Between 2001 and 2011, the overall trend is for the jobs-housing ratio to increase, and for the ratio to do so at a greater rate in the transit corridor than for the comparable corridor.

Breaking out jobs-housing balance by income category does nothing to contradict these conclusions. For low, medium, and high income workers, the jobs-housing ratio increases from 2002 to 2011. For low and medium income workers, the trend clearly shows a decline in the number of residents and number of workers in the corridor, with the number of residents declining faster than the number of workers. For high income workers, the jobs-housing ratio increases despite an increasing number of high income workers in the corridor.

By industry category, a limited number of industries have a jobs-housing-ratio that changes to become more balanced. For most of those industries, the positive changes can be assumed to be caused by reductions in employment, rather than increases in housing.

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. IT seems likely whether the magnitude of the effect of transit is insufficient to improve jobs-housing balance. Whether this lack of effect is generalizable to all BRT, specific to Charlotte, or specific to the Independence Boulevard BRT is unknown. However, the latter seems likely. As an open busway, it lacks substantial stations or branded buses, two characteristics associated with successful BRT systems. It’s main differentiator from a standard bus is its ability to make use of dedicated guideway by using HOV lanes. While superior to mixed traffic operations, they are inferior to the exclusive guideway typically associated with rapid transit.

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.

7-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: Information, Real Estate, Health care, and Other Services.
- Substantial Reductions: Administrative, and Arts/Entertainment/Recreation.

Advantage over Comparable corridor
- Transportation, Information, Real Estate, Health Care, 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 does not significantly change during study period.
- Substantial percent increases: Information, Real Estate, Education, Health Care and Other Services.
- Substantial numeric increases: Education and Healthcare.
- Substantial percent reductions: Arts/Entertainment/Recreation, Administrative, Construction, & others.
- Substantial numeric reductions: Administrative.

Effect of corridor, as per shift-share
- Only positive effect is Healthcare.
- Changes in Education attributable to a growing industry.
- Negative corridor effect on Administration sector is severe; outside of corridor Administration a growing industry.

Advantage over Comparable corridor
- The effect of corridor location in transit corridor superior to comparable corridor for many industries.
- The difference in corridor effect favors transit for Transportation, Information, and Other Services.

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

Resilience represents the ability to recover from a substantial shock. Resilience is defined as the capacity to maintain a positive trend despite the economic shock of the 'Great Recession'. The R2 values measure the amount of variation in trend before and after the recession. More resilient industries will have more comparable R2 values.

Transit corridor
- Strong positive trend before transit: Health Care.
- Strong positive trend after transit: Health Care.
- Weak positive trend before transit: Transportation, Professional, Education, and Lodging/Food.
- Weak positive trend after transit: Professional, Lodging/Food and Other Services.
- Industries with positive trends proving resilient through the Great Recession: Healthcare, Lodging/Food, and Other Services.

Advantage over Comparable corridor
- Healthcare is equally as resilient in the comparable corridor.
- Lodging/Food is more resilient in the transit corridor.
- Other Services is substantially more resilient than the comparable corridor.

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 .50 mile buffers. The magnitude of the effect of transit should be proportional to proximity to transit.

Transit corridor in 2009
- H+T costs for the transit corridor are less than the metropolitan average.
- Housing costs are actually lower near transit.
- Transportation costs are constant, regardless of distance to transit.

Transit corridor changes in H+T costs 2000-2009
- H+T costs for the transit corridor change more than the metro average.
- Transportation costs change more than housing costs.
- Changes in transportation are actually higher near transit, contrary to expectations.
- Changes in housing costs are actually negative near transit, contrary to expectations.

Advantage over Comparable Corridor
- None; within 1.25 miles, the increase in H+T cost is greater for the transit corridor.
- Beyond 1.25 miles, the change in H+T cost is less 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 resident 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.

Transit corridor

- There is no evidence that transit improves job accessibility.
- Job rich at start of study period, with jobs-housing ratio greater than that of the metro.
- Jobs-housing ratio increased steadily over the course of the study period.
- Increase in jobs housing ratio can largely be attributes to a fall in the number of residents.
- The jobs-housing ratio for low income workers showed no clear trend
- The jobs-housing ratio for medium income workers increased, as a result of a falling number of residents.
- The jobs-housing ratio for high income workers increased, despite a rising number of high income residents.
- For almost all industries, the jobs-housing ratio rose.
- For industries for which the jobs-housing ratio did not rise, the cause is losses in employment.

Comparable corridor

- For most industries, the jobs-housing ratio rose, diverging more from the metropolitan total.
- The jobs-housing ratio for the Information and Administrative industry sectors converged with the metropolitan ratio.

8-REFERENCES

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

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

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

US Census Bureau. Table 643, Annual Total Compensation and Wages and Salary Accruals Per Full-Time Equivalent Employee, by Industry: 2000 to 2009. < http://www.census.gov/compendia/statab/cats/labor_force_employment_earnings/compensation_wages_and_earnings.html>

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

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

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

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

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

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

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

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

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

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

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

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

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

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

9-APPENDIX A

LEHD

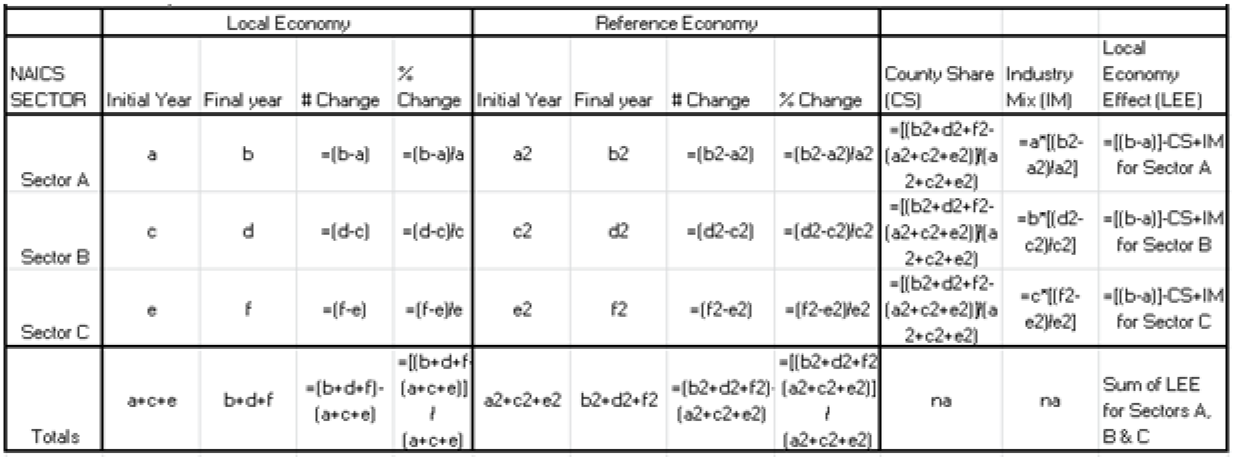
The Longitudinal Employer-Household Dynamics (LEHD) program is part of the Center for Economic Studies at the U.S. Census Bureau. The LEHD program produces new, cost effective, public-use information combining federal, state and Census Bureau data on employers and employees under the Local Employment 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