LYNX Light Rail

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

Report Structure

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

2-DATA AND METHODS

Data from before and after the opening of a transit line were analyzed to determine if the advent of transit causes a significant change in area conditions. To control for exogenous factors (such as things affecting the entire metro area), changes in transit corridors were then compared to changes in comparable corridors located in the same metropolitan region, matching length, location, mix of land uses, and suitability for transit. As corridors differ primarily in their lack of transit, the corridor matching represents a 'natural experiment', where one corridor receives the treatment (a fixed guide-way transit line) and the comparable corridor acts as a control. Because of the need to perform this matching, this study used the corridor as its unit of analysis rather than station points. For most transit systems, stations lie within a mile of one another, so the areas are quite similar. Without a network analysis of walking paths, exact distances to transit are difficult to determine.

The remainder of this section describes the selection of existing transit (treatment) corridors, the creation of comparable corridors, and the data used for analysis. It also provides an overview of the transit corridor being analyzed.

Selection of Treatment corridor

The process began with Center for Transit Oriented Development (CTOD)'s Transit Oriented Development (TOD) Database (July 2012 vintage). The database's unit of analysis is the station. For each station there is information about the station's location, providing both address and lat-long points. Station attributes include the transit agency for that station as well as the names of routes using that station. The database was enriched with the addition of transit modes for all stations since many transit stations serve more than one mode.

While the database contained routes, it did not identify the corridor for each station. Most transit routes make use of multiple corridors. While routes change in response to operational needs, a corridor consists of a common length of right-of-way that is shared by a series of stations on the corridor. Typically, all stations along a corridor begin active service at the same time. Transit systems grow by adding 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 0.5 mile buffer around a fixed guide-way transit station, while the former refers to land uses and built environment characteristics hospitable to transit. This analysis assumes that while the existing development during the year of initial operations (YOIO) may not be TOD, land uses respond to changes in transportation conditions over time, phasing out TAD and replacing it with TOD. On this basis, the TOD is conflated with TSA for the purpose of this analysis.

Data Processing

ArcGIS was used to create a series of buffers around each corridor in 0.25 mile increments. Those buffers were then used to select the centroid point of the LED block groups within those buffers, and summarize the totals. Because the location of census block points varies from year to year (for reasons of non-disclosure), it was necessary to make a spatial selection of points within the buffer for each year rather than using the same points each year. Figure 1 shows an example corridor, the buffers around the corridor, and the location of LED points in reference to both.

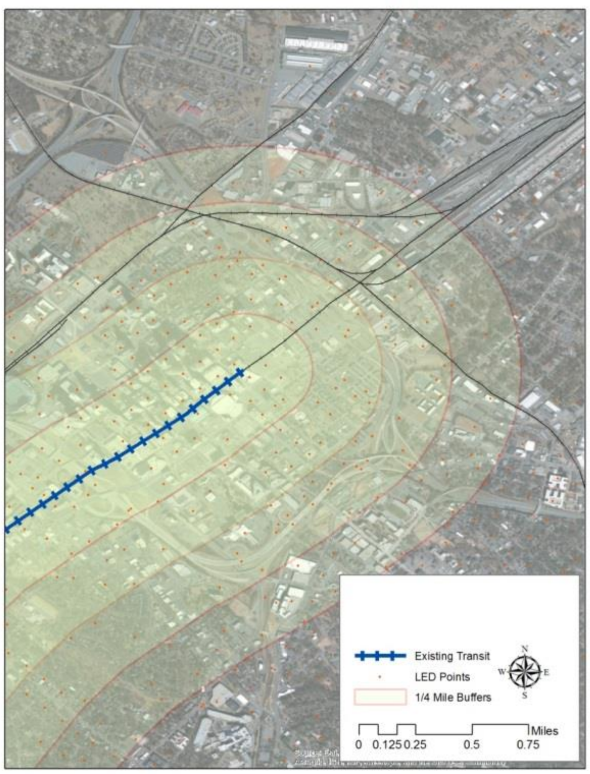

Figure 1: Example corridor, buffers, and LED census block points

Study Area

This study examines Charlotte's light rail line, the LYNX. It is a 9.6-mile light rail corridor that began service on

November 24, 2007. The corridor chosen for analysis was part of the South Rail Line. For a Comparable corridor, the planned Blue Line/North East extension along the existing railroad to UNC Charlotte was used. Both corridors are existing rail right-of-ways running through the central business district (CBD). Figure 2 shows the transit and comparable corridors as well as the location of LED points.

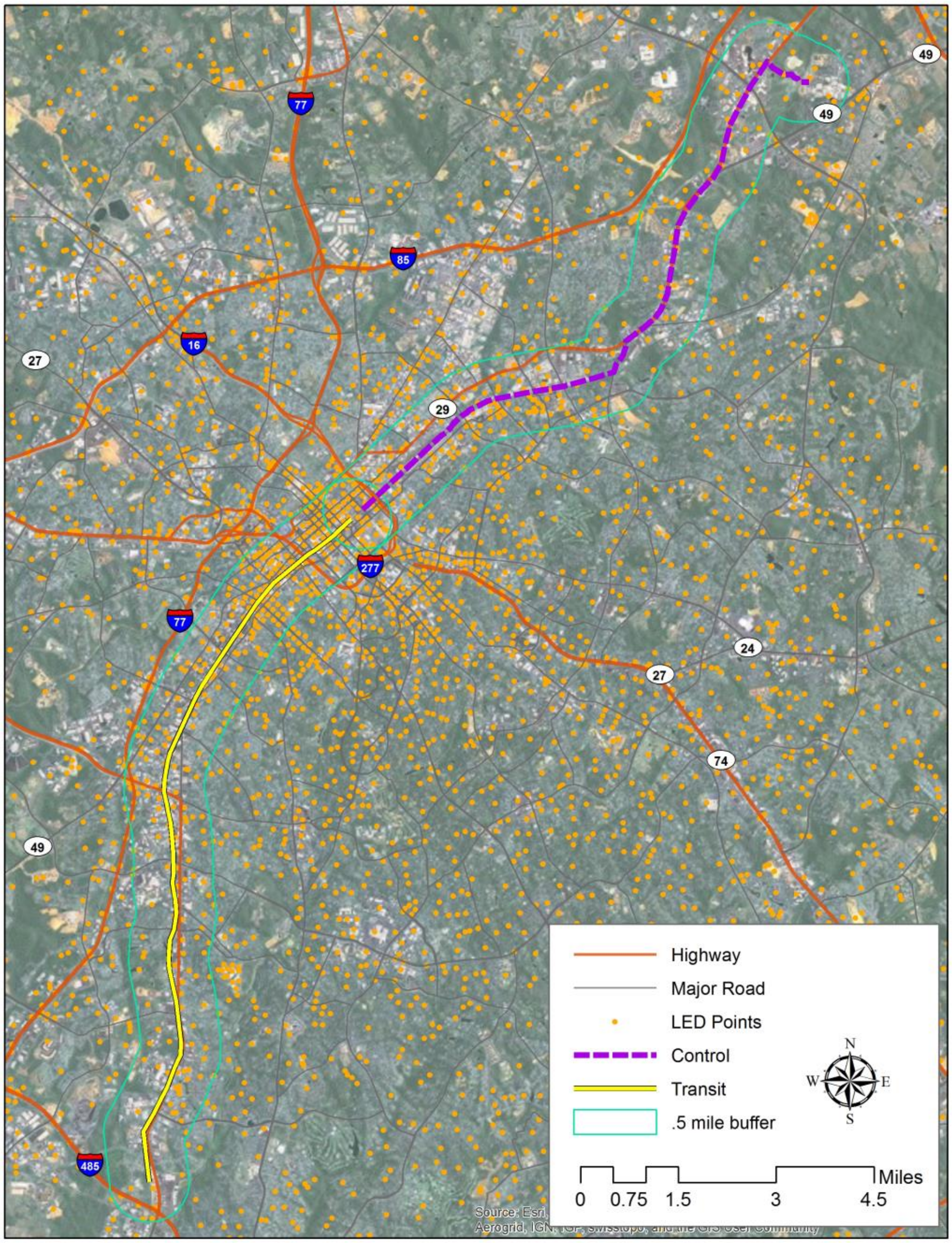

Figure 2: Transit and comparable corridor locations

3-EMPLOYMENT CONCENTRATION

Introduction

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

Data & Methods

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

Results

The location quotients for the 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.

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.

	Comparable Corridor			Transit Corridor			Differences		
Variable	Δ 2002-2007	Δ 2007-2011	Change	Δ 2002-2007	Δ 2007-2011	Change	Δ 2002-2007	Δ 2007-2011	Change
Total	0.00	0.00	0.01	-0.01	0.01	0.01	0.00	0.00	0.00
Utilities	0.00	0.00	0.00	0.03	-0.06	-0.09	0.03	-0.06	-0.10
Construction	-0.01	0.01	0.02	0.01	-0.03	-0.03	0.02	-0.03	-0.05
Manufacturing	0.00	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
Wholesale	0.00	0.01	0.01	0.01	0.00	-0.01	0.01	-0.01	-0.02
Retail	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01
Transportation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Information	-0.04	0.04	0.08	-0.09	0.00	0.09	-0.05	-0.03	0.01
Finance	-0.01	-0.02	-0.01	-0.02	-0.03	-0.01	-0.01	-0.01	0.00
Real Estate	0.00	-0.01	-0.01	0.02	0.02	0.00	0.02	0.03	0.01
Professional	0.00	-0.02	-0.03	-0.02	0.00	0.03	-0.03	0.02	0.05
Management	-0.01	0.04	0.05	-0.02	0.02	0.03	0.00	-0.02	-0.02
Administrative	0.00	-0.01	0.00	-0.02	0.03	0.05	-0.01	0.04	0.05
Education	-0.07	0.02	0.09	-0.11	0.05	0.16	-0.04	0.03	0.07
Health Care	0.00	0.01	0.01	0.00	0.00	0.00	0.00	-0.01	-0.01
Arts, Ent. Rec.	0.01	0.03	0.02	0.07	0.00	-0.07	0.07	-0.03	-0.09
Lodging & Food	-0.01	0.01	0.02	-0.02	0.00	0.02	-0.01	-0.01	0.00
Other Services	0.01	-0.01	-0.02	0.00	0.00	0.00	-0.01	0.02	0.02
Public Admin	0.01	0.00	0.00	-0.01	0.00	0.01	-0.02	0.00	0.02

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 quotient occur in the Education, Information, and Administrative sectors. The location quotient for the Utilities sector falls significantly. The differences between the transit and comparable corridors suggest that transit benefitted the Education, Professional, and Administrative sectors.

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

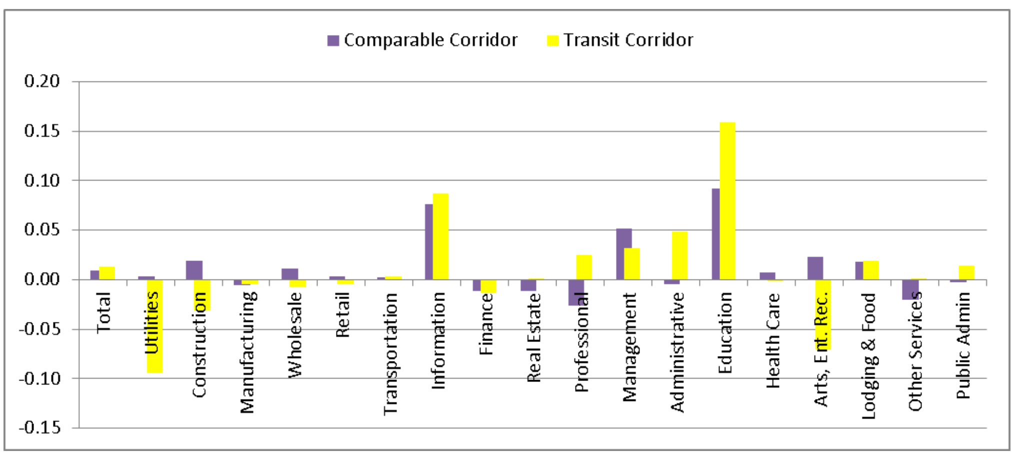

Figure 3: Changes in location quotient by corridor

This more clearly displays the differences between the corridors. Employment in Utilties, Construction and Arts/Entertainment/Recreation experiences a reduction in location quotient in the transit corridor and increasing employment in the comparable corridor. The reverse is true for the Professional sector. Finally, while the location quotient for Education increases in both corridors, it increases more for the transit corridor.

Discussion & Implications

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, so increases in the location quotient for Education could be expected. Likewise, the decline in the Utilities and Construction industries is expected, as such industries require large volumes of low-cost space, typically warehouses. The decline in Arts/Entertainment/Recreation is somewhat unexpected, as event venues typically do well in conjunction with transit. However, it is also an industry that makes use of light industrial and warehouse space, and rising land values associating with transit may result in redevelopment that displaces older, run-down or depreciated industrial structures. The increase in the Administrative sector is also puzzling, as modern telecommunications has made it possible to displace such uses to peripheral suburban locations.

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 radius around the transit corridor.

	Metro				0.5 mile buffer of Transit corridor				Sources of Employment Change		
NAICS Sector	2007	2011	# Change	% Change	2007	2011	# Change	% Change	Share (of Metro)	Shift in Industry Mix	Effect of Corridor
Utilities	4,162	4,929	767	18%	580	367	(213)	0%	7	107	(327)
Construction	59,223	37,556	(21,667)	-37%	5,713	2,671	(3,042)	-53%	67	(2,090)	(1,019)
Manufacturing	90,229	71,781	(18,448)	-20%	4,583	3,391	(1,192)	-26%	54	(937)	(309)
Wholesale	56,275	53,105	(3,170)	-6%	3,189	2,941	(248)	-8%	38	(180)	(106)
Retail	97,337	90,023	(7,314)	-8%	6,134	5,473	(661)	-11%	72	(461)	(272)
Transportation	30,220	31,294	1,074	4%	697	824	127	18%	8	25	94
Information	22,095	21,594	(501)	-2%	5,000	4,905	(95)	-2%	59	(113)	(40)
Finance	60,563	61,436	873	1%	17,714	15,946	(1,768)	-10%	209	255	(2,232)
Real Estate	13,657	12,946	(711)	-5%	1,967	2,110	143	7%	23	(102)	222
Professional	48,198	55,051	6,853	14%	12,034	13,902	1,868	16%	142	1,711	15
Management	20,982	26,849	5,867	28%	7,784	10,376	2,592	33%	92	2,177	324
Administrative	63,117	69,022	5,905	9%	9,812	13,046	3,234	33%	116	918	2,201
Education	40,580	64,388	23,808	59%	422	3,900	3,478	824%	5	248	3,225
Health Care	91,003	103,385	12,382	14%	2,787	3,264	477	17%	33	379	65
Arts, Ent. Rec.	13,974	18,214	4,240	30%	2,764	3,661	897	32%	33	839	26
Lodging & Food	69,311	70,947	1,636	2%	6,720	6,856	136	2%	79	159	(102)
Other Services	23,138	20,953	(2,185)	-9%	2,930	2,697	(233)	-8%	34	(277)	9
Public Admin	24,057	24,673	616	3%	10,532	10,877	345	3%	124	270	(49)
Total	**828,121**	**838,146**	**10,025**	**1%**	**101,362**	**107,207**	**5,845**	**6%**	**1193**	**2,926**	**1,725**

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

The entire metropolitan area enjoys a slight increase in employment of 1 percent. In contrast, the transit corridor enjoys robust growth in employment of about 6 percent, representing almost 6,000 new jobs. In numeric terms, the industries that enjoy the most significant increases are Education, Administrative, and Management. These same industries also do the best in terms of percentage increases, with all increasing over 30 percent. While not as numerically significant, Arts/Entertainment/Recreation also increases by over 30 percent. The industry sectors with the most notable numeric decline within the corridor are Construction, Finance, and Manufacturing. The percentage decline for the Construction industry is especially severe, at over 50 percent.

After using a shift-share analysis to disaggregate the cause of change in employment, different patterns emerge. It confirms that a significant portion of the change in Administrative and Education can be attributed to the corridor, but suggests that the increase in employment in the Management and Professional sectors can be attributed to a general growth in that industry. The analysis also suggests that the reduction of employment in the Finance industry is exacerbated by the effect of the corridor. However, the reduction in Construction employment can be attributed to general industry trends, rather than the corridor.

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.

	Comparable		Transit		Transit Advantage	
	# Change	Effects of Corridor	# Change	Effects of Corridor	Employment Change	Corridor Effect
Utilities	-	-	(213)	(327)	(213)	(327)
Construction	(450)	246	(3,042)	(1,019)	(2,592)	(1,265)
Manufacturing	(817)	(471)	(1,192)	(309)	(375)	162
Wholesale	253	324	(248)	(106)	(501)	(430)
Retail	-	189	(661)	(272)	(661)	(461)
Transportation	14	(16)	127	94	113	110
Information	708	739	(95)	(40)	(803)	(780)
Finance	(1,036)	(1,256)	(1,768)	(2,232)	(732)	(976)
Real Estate	(178)	(146)	143	222	321	368
Professional	(471)	(1,220)	1,868	15	2,339	1,235
Management	1,470	1,008	2,592	324	1,122	(684)
Administrative	(63)	(455)	3,234	2,201	3,297	2,655
Education	1,628	1,549	3,478	3,225	1,850	1,676
Health Care	1,554	1,155	477	65	(1,077)	(1,090)
Arts, Ent. Rec.	891	563	897	26	6	(537)
Lodging & Food	986	820	136	(102)	(850)	(921)
Other Services	(426)	(315)	(233)	9	193	324
Public Admin	275	50	345	(49)	70	(98)
Total	**4,319**	**2,749**	**5,802**	**1,698**	**1,507**	**(1,051)**

Table 3: Shifts by corridor and comparison between corridors

The corridor shift associated with the comparable and treatment corridors are substantially different for most industries. Differences in the corridor effect show that the transit corridor enjoys a substantial advantage over the comparable corridor in the Administrative, Education, and Professional sectors. For almost all other industries, the comparable corridor is favored, most notably in the case of Construction, Healthcare, and Finance. The most significant difference between the two corridors is for the Administrative sector, where the transit effect is positive for the transit sector and negative for the comparable corridor.

Discussion & Implications

While the growth in employment for the Education sector is expected, the growth in the Administrative sector presents a puzzle. Both are office uses, but the rapid growth in employment implies substantial increases in the amount of physical space. The development seems to be occurring inside the CBD at relatively high densities, and it is also associated with a large number of parking garages. Together this suggests that transit is making it possible to further concentrate office employment within a limited area.

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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 2007. 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.

Comment [a1]: Is an R2 value missing for one of the equations on this graph?

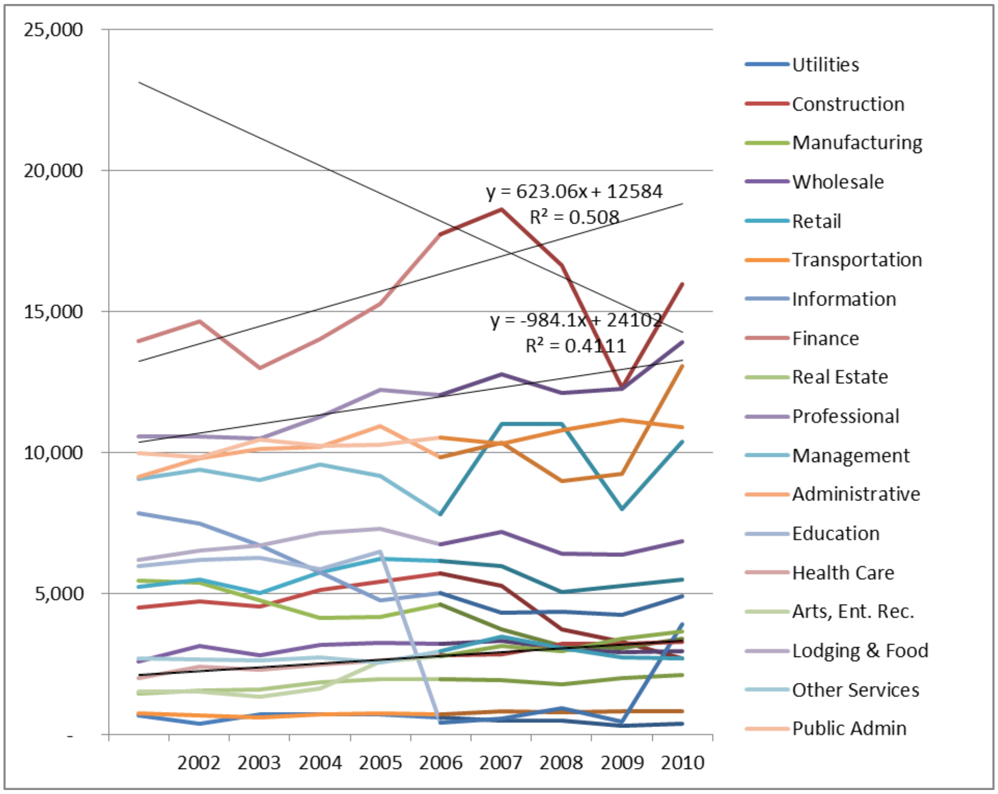

Figure 4: Regression trend lines and R-squared values for different industries

As the graph shows, industry employment varies by year, with many industries affected by substantial fluctuations in employment.

Resilience by industry is presented in Table 4. It highlights the resilience of different industries between 2002-2007 and 2007-2011. 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. The trend percent is presented for comparison. It is calculated as the trend number divided by the average value during the trend time period. The R^2 column indicates how strong a trend is. Industry sectors with a high R^2 demonstrate robust trends—trends in employment change that are consistent over time with less tendency to fluctuate.

The change in the trend between the two time periods is given in the differences column. A positive value for the trend number represents a change from employment loss to employment gain, or a reduction in the rate of decline in employment for that industry. The change in strength of trend is given by the '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.

Comment [a2]: Do you mean the R2 column or should this column header have the delta symbol included?

	2002-2007			2007-2011			Differences		
	Trend #	Trend %	R2	Trend #	Trend %	R2	Trend #	Trend %	R2
Utilities	-7	-1%	0.01	-55	-13%	0.55	-48	(12.32)	0.54
Construction	186	4%	0.74	-822	-22%	0.92	-1008	(25.73)	0.18
Manufacturing	-265	-6%	0.76	-107	-3%	0.22	158	2.55	0.54
Wholesale	99	3%	0.65	-119	-4%	0.73	-218	(7.13)	0.08
Retail	167	3%	0.62	-122	-2%	0.16	-289	(5.18)	0.45
Transportation	17	2%	0.23	1	0%	0.01	-16	(2.33)	0.22
Information	-625	-10%	0.95	170	4%	0.48	795	14.30	0.46
Finance	799	5%	0.69	-1226	-8%	0.36	-2025	(12.95)	0.33
Real Estate	92	5%	0.85	78	4%	0.55	-14	(1.28)	0.31
Professional	402	4%	0.87	353	3%	0.31	-49	(0.75)	0.57
Management	98	1%	0.05	-485	-5%	0.19	-583	(5.86)	0.14
Administrative	156	2%	0.38	845	8%	0.34	689	6.57	0.04
Education	-980	-22%	0.59	954	65%	0.56	1934	86.98	0.02
Health Care	127	5%	0.89	131	4%	0.71	4	(0.91)	0.18
Arts, Ent. Rec.	305	15%	0.82	204	6%	0.74	-101	(8.57)	0.08
Lodging & Food	138	2%	0.58	-99	-1%	0.11	-237	(3.51)	0.47
Other Services	98	3%	0.46	-259	-9%	0.90	-356	(12.16)	0.43
Public Admin	81	1%	0.49	211	2%	0.59	130	1.16	0.10

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

During the 2007 to 2011 period, about half the industries saw increases in employment. The most notable trend numbers are for Administrative and Education, and the most notable trend percent is also for Education. However, the R^2 values indicate that many of these trends are weak. Arts/Entertainment/Recreation has the highest at .74, and Education has only a .56.

Differences in trends (number and percent) and the strength of trends (R^2) indicate which industries in the corridor did better after the recession, such as the Education and Information industries, although Information experiences a substantial drop in the R^2, indicating the trend improvement is not consistent.

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 are likely due to factors affecting both corridors, such as metropolitan scale trends.

Industry	Comparable			Transit			Differences		
	Trend #	Trend %	R2	Trend #	Trend %	R2	Trend #	Trend %	R2
Utilities	0	-120%	0.60	-55	-13%	0.55	-55	106.57	-0.05
Construction	-213	-12%	0.86	-822	-22%	0.92	-609	-9.92	0.06
Manufacturing	-95	-9%	0.51	-107	-3%	0.22	-12	6.08	-0.28
Wholesale	69	4%	0.33	-119	-4%	0.73	-188	-7.62	0.39
Retail	181	7%	0.59	-122	-2%	0.16	-303	-9.24	-0.43
Transportation	83	13%	0.26	1	0%	0.01	-82	-12.43	-0.25
Information	225	8%	0.52	170	4%	0.48	-55	-3.68	-0.04
Finance	-489	-6%	0.87	-1226	-8%	0.36	-737	-1.54	-0.51
Real Estate	-189	-23%	0.91	78	4%	0.55	267	26.75	-0.36
Professional	-205	-5%	0.47	353	3%	0.31	558	7.33	-0.16
Management	-560	-13%	0.60	-485	-5%	0.19	74	7.99	-0.41
Administrative	-186	-5%	0.31	845	8%	0.34	1031	13.25	0.03
Education	467	78%	0.60	954	65%	0.56	488	-12.49	-0.04
Health Care	399	11%	0.83	131	4%	0.71	-268	-7.21	-0.12
Arts, Ent. Rec.	41	2%	0.24	204	6%	0.74	163	3.96	0.50
Lodging & Food	218	4%	0.67	-99	-1%	0.11	-317	-5.69	-0.56
Other Services	-314	-25%	0.78	-259	-9%	0.90	56	16.68	0.12
Public Admin	132	2%	0.83	211	2%	0.59	79	-0.18	-0.24

Table 5: Comparison of employment trends 2007-2011

The Arts/Entertainment/Recreation sector is notably more resilient in the transit corridor. 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. Industries such as Real Estate, Other Services, and Administrative embody such patterns.

While transit may not increase the resilience of some industries, it may increase their robustness. For example, industries like Real Estate, Professional, and Management show reduced trend strength, but all managed to increase employment more than the comparable corridor.

Discussion & Implications

Some caveats are necessary as 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. 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.

The area within a 0.5-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.

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 Education, Administrative and Information industries did better than their prior trend.

Education can be explained by the fact that an unprecedented number of people opted to ride out the Great Recession by going back to school. Education employment is concentrated within the I-277 beltway, most of which is within a 0.5 mile from the LYNX light rail. Employment in Administrative may be responding to proximity to I-77, and highways 49 and 521, which parallel the transit corridor. Along with the Information industry employment, Administrative employment is also highly clustered within the I-277 beltway. Some industries did not recover their previous trend, but did maintain employment levels.

6-HOUSING AFFORDABILITY

Introduction

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

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

While the effects of heavy rail transit on housing affordability has been extensively researched, the effects of non-heavy rail TOD on housing affordability is mixed. Matching low-income employment to high-income housing fails to improve housing affordability, and matching high-income employment to low-income housing may actually decrease affordability through gentrification-induced displacement. Maintaining affordable housing through TODs may require the allocation of affordable housing resources (NAHB 2010). A review of the hedonic literature reporting the price effects of transit stations on housing suggests that TODs may be an anathema to the provision of affordable housing, given their propensity to increase housing values (Bartholomew and Ewing 2011).

Calthorpe (1993) initially proposed a ten-minute walk, or about a 0.5-mile radius, as the ideal size for a TOD. Empirical studies confirm that while the majority of walk trips occur for distances of or equal to a 0.5 mile, the effects of proximity to transit can be detected out to 1.5 miles away (Nelson 2011). Fixed guide-way transit systems frequently accessed by non-walk modes, including 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).

Comment [AS3]: Incomplete sentence

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. 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 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 metropolitan 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 two 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.

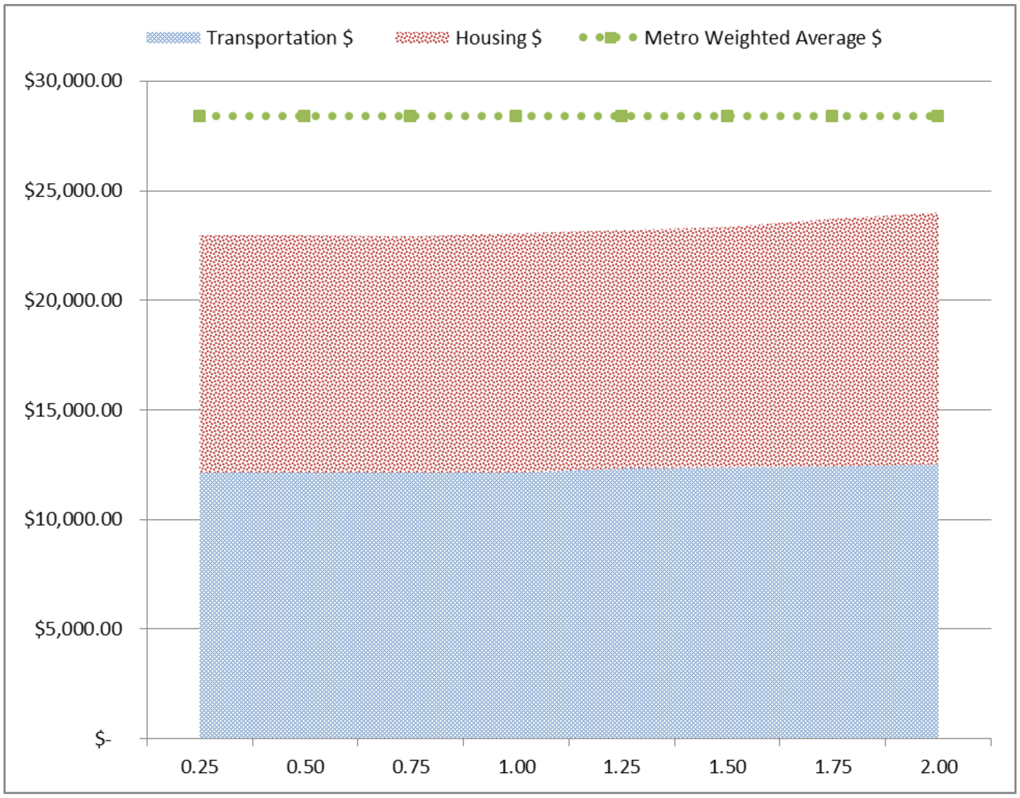

Figure 5: Housing, transportation, and H+T costs for the transit corridor, 2009, by buffer distance

As the above graph shows, H+T costs near the transit line are lower than the metropolitan average. Housing costs generally decline within proximity to the transit line, with a slight upward trend within a 0.25 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.

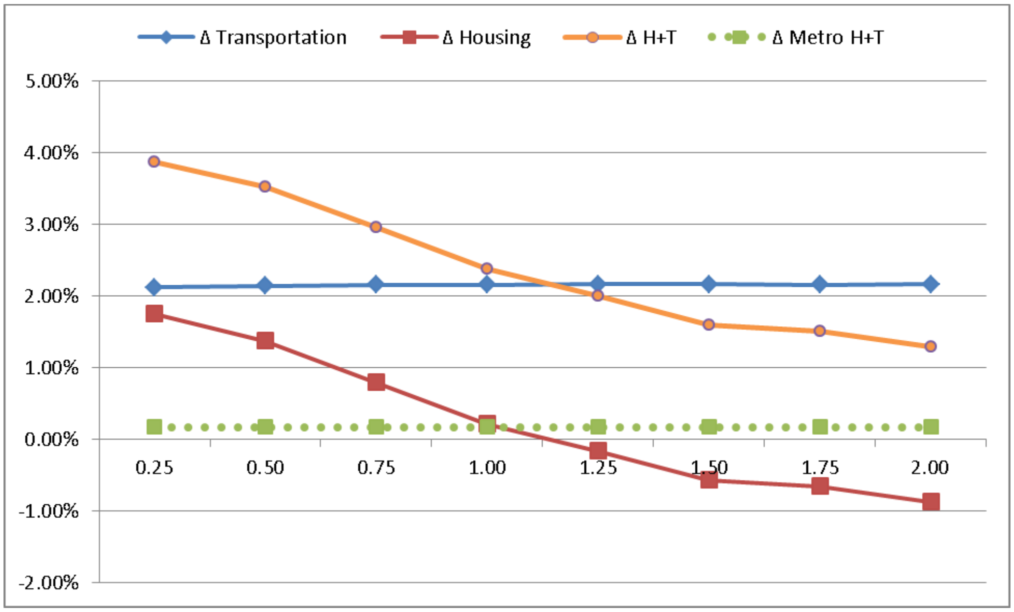

Figure 6: Change in housing and transportation costs, 2000-2009, for transit corridor, by buffer distance

Changes in H+T costs vary with distance to the transit corridor. Transportation costs are constant, while housing costs increase with proximity to the transit corridor. The increase in H+T costs for the transit corridor is greater than the increase for the metro area for buffer distances less than 1.0 mile, and less than the metro area for distances greater than 1.0 mile. The magnitude of change in the H+T value is directly and inversely proportional to the distance from transit.

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.

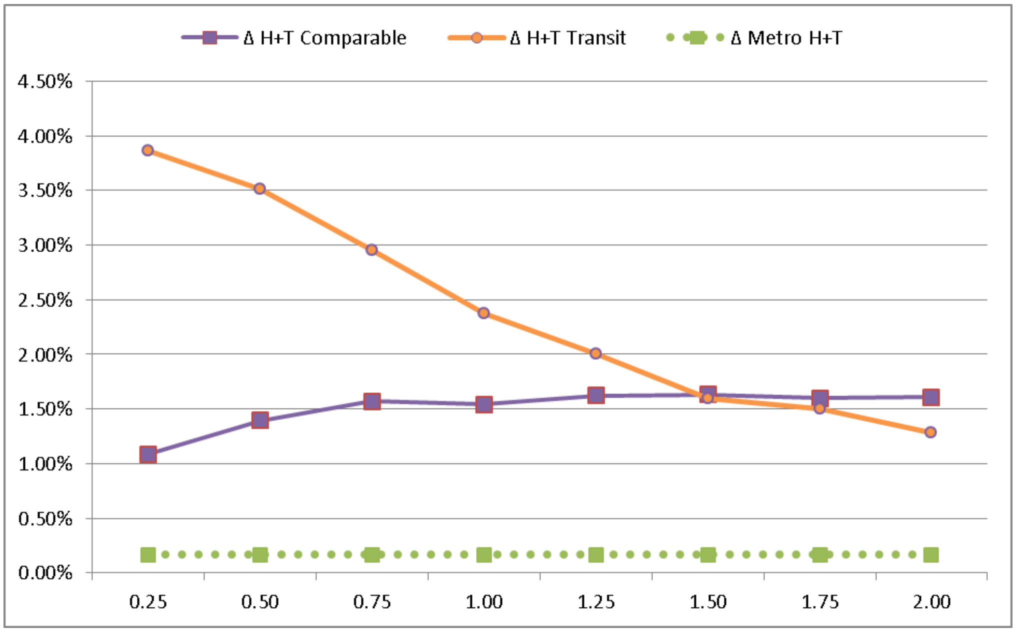

Figure 7: Changes in H+T, 2000-2009, for transit and comparable corridors, by buffer distance

The corridors display significantly different patterns in changes in H+T costs. The transit corridor experiences much higher increases in H+T costs than the comparable corridor for all buffer distances less than a 0.5-mile. In addition, the comparable corridor experiences a lower increase in H+T cost near the corridor, suggesting that proximity to the comparable corridor is noxious or contains nuisance effects. Theoretically, differences between the affordability for the two corridors can be attributed to proximity to transit.

Discussion & Implications

Rather than improving housing affordability, transit actually seems to impair it. 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. This is consistent with the changes in H+T costs, which show increasing H+T costs, and increases in H+T cost proportional to proximity to transit. However, transit was expected to increase affordability overall, presuming that higher housing costs could be offset by lower transportation costs. No evidence to support this theory has been found.

The effect of increasing H+T costs is compounded by tenure type. Housing affordability issues are most severe in locations where renting is the primary form of tenure. Renters, unlike owners, are not insulated against increases in housing costs. Rental tenure in America is characterized by short leases, so increases in property value can rapidly be capitalized into higher rents. Rising rents increase housing costs, resulting in the displacement of previous tenants, who are no longer able to afford the higher rents. In contrast, mortgage payments are fixed upon purchase, so that current homeowners are largely insulated from the effects of increases in housing costs. The primary cause of declining affordability for existing homeowners is increasing property taxes, of which homeowners pay only a fraction of the increase in value.

The percent of homeowners also acts to confound actual housing affordability conditions. In the past decade, the appreciation in home value has outstripped appreciation in wages so that many current homeowners could no longer afford to buy their own homes. While they are affordable for the current owners, their appreciated value makes them less affordable to prospective owners. Over time, this compounds housing affordability issues. Lower housing affordability means that fewer households are able to become home owners, and must remain renters. They thus remain vulnerable to further increases in housing costs. As rents rise, so does the premium associated with home ownership, so that households are willing to pay more for property. Cities with high monthly rents also have high property prices for a reason.

Policy intervention is necessary to ensure that housing locations near transit stations remain affordable. Without measures to maintain housing affordability, areas around transit stations will see the displacement of low-income renters in favor of medium income owners. There is a strong negative relationship between income and transit ridership, as low income households are more likely to be transit dependent, so this process acts to reduce transit ridership. Changes in the distribution of tenure will also reduce the benefits of self-selection. Household locating near transit self-select for proximity to transit, and are thus the types of households most likely to make use of transit.

Over time, as household characteristics, such as place of work and size of household change, the utility of proximity to transit changes. A single person household is extremely likely to be able to make use of transit, while a two-worker family household is less likely to be able to do so. Unable to make use of transit, such households would then require multiple vehicles, resulting in transportation costs in line with the metropolitan norm. In a worst case scenario, housing units around transit stations are owned by non-transit using households and yet suffer from higher average housing costs. In contrast, households in rental tenure are more likely to relocate in response to changing conditions, so that even if housing costs rise, transit ridership suffers less.

Long term, ensuring a supply of affordable transit oriented housing near stations will require policy intervention. The amount of affordable housing that is constructed is minimal. Most affordable housing results from the depreciation of former medium income housing. Constructing new housing as infill development requires higher density housing than the surrounding urban fabric, because the land value has increased in the interval since the initial development of the area. Constructing new affordable housing requires higher densities, due to the lower return per unit. In combination with parking requirements, new affordable housing is required to ‘go vertical’ to achieve sufficient density.

Reducing or eliminating parking minimums near transit stations would be an effective policy. Reduced parking would lower per-unit cost of new affordable housing, and reduce the tendency to convert affordable transit oriented rental units to unaffordable transit indifferent owner-occupied units.

7-JOB ACCESSIBILITY

Introduction

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

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

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

Data & Methods

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

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

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

- Greater than $3333/month

The categories have been treated as low-medium-high income classifications. The actual monthly values are less significant than changes over time in the distribution of each of the categories in proximity to the transit corridor. LED employment data are also classified by industry using the North American Industrial Classification System (NAICS) at the two-digit summary level.

ArcGIS was used to create a series of buffers around each corridor in 0.25 mile increments. Those buffers were then used to select the centroid point of the LED block groups within those buffers, and summarize the totals. Because the location of census block points varies from year to year (for reasons of non-disclosure), it was necessary to make a spatial selection of points within the buffer for each year, rather than using the same points each year. For this analysis, on the 0.5 mile buffer was used.

Results

Overall jobs-housing balance for the existing transit and comparable corridor are presented below in Table 6 for each year. The ratio column indicates the ratio of workers who are employed within the corridor to the number of workers residing in the corridor. The year-on-year change for ratios is also presented. Sparklines at the bottom show the trend for each column. Years for which the transit system is in operation are shaded.

Overall Balance

The jobs-housing ratio at the metropolitan level represents a balanced level of jobs to workers. Comparing that value to the jobs-housing ratio for each corridor demonstrates how far out of balance both corridors are. Ideally, the addition of transit (years of operation highlighted in pink) should make the jobs-housing ratio more similar to the metropolitan level ratio.

	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	Year
2002	766	678	1.13	46.8	9.5	4.94	0.00	99.6	15.6	6.39	0.00	2002
2003	750	669	1.12	46.6	9.0	5.16	0.23	102.3	14.9	6.86	0.48	2003
2004	735	667	1.10	47.1	8.8	5.36	0.20	99.0	14.8	6.67	-0.19	2004
2005	780	702	1.11	49.8	9.2	5.43	0.07	102.3	15.2	6.73	0.06	2005
2006	811	767	1.06	49.6	9.8	5.04	-0.39	106.5	16.8	6.35	-0.38	2006
2007	831	771	1.08	47.2	9.8	4.83	-0.22	101.5	15.4	6.59	0.24	2007
2008	838	775	1.08	52.0	10.1	5.15	0.33	106.0	16.4	6.46	-0.13	2008
2009	777	709	1.09	50.9	9.1	5.58	0.43	98.4	15.0	6.57	0.11	2009
2010	771	708	1.09	48.0	9.2	5.22	-0.36	90.9	16.0	5.67	-0.90	2010
2011	841	774	1.09	51.5	8.4	6.12	0.90	107	15.2	7.07	1.40	2011
Trend												Trend

Table 6: Jobs-housing balance for all income categories

The overall jobs-housing ratio for both the comparable and transit corridors is relatively job-rich. The transit corridor has 6-7 times as many jobs per worker than the metropolitan area. The ratio does not significantly change with the advent of transit in 2007. There are big changes in 2010, which can be attributed to a drop in employment, and big changes in 2011, which can be attributed to a combination of rebounding employment, and a decrease in the number of workers residing in the 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	205	182.64	1.12	9.6	3.1	3.14	0.00	21.1	4.4	4.76	0.00	2002
2003	202	180.53	1.12	9.5	2.8	3.41	0.27	21.0	4.2	5.05	0.29	2003
2004	191	174.77	1.09	9.2	2.7	3.39	-0.02	19.4	4.1	4.78	-0.28	2004
2005	201	180.93	1.11	10.0	2.6	3.79	0.40	20.0	4.0	5.04	0.26	2005
2006	204	194.06	1.05	9.6	2.8	3.42	-0.37	21.0	4.5	4.65	-0.39	2006
2007	208	194.46	1.07	9.5	2.7	3.46	0.04	18.8	4.0	4.67	0.02	2007
2008	209	192.98	1.08	9.9	2.8	3.48	0.02	19.0	4.1	4.64	-0.03	2008
2009	188	170.76	1.10	9.6	2.4	3.97	0.49	17.3	3.6	4.84	0.19	2009
2010	184	170.57	1.08	8.8	2.5	3.47	-0.50	16.5	3.8	4.30	-0.54	2010
2011	195	182.44	1.07	10.1	2.1	4.79	1.32	18.6	3.6	5.20	0.90	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	333	294	1.13	1.8	4.4	0.41	0.00	38.6	6.8	5.67	0.00	2002
2003	316	281	1.12	1.7	4.2	0.41	0.00	38.7	6.4	6.09	0.42	2003
2004	296	267	1.11	1.6	3.7	0.43	0.02	33.7	5.9	5.77	-0.33	2004
2005	316	284	1.11	1.7	4.0	0.43	0.00	35.6	6.2	5.74	-0.03	2005
2006	328	310	1.06	1.5	4.1	0.37	-0.05	37.4	6.7	5.59	-0.15	2006
2007	324	300	1.08	1.5	3.9	0.39	0.01	32.5	5.7	5.71	0.12	2007
2008	323	297	1.09	1.6	3.8	0.42	0.03	32.5	5.9	5.47	-0.24	2008
2009	301	274	1.10	1.5	3.6	0.42	0.00	29.5	5.4	5.45	-0.03	2009
2010	289	264	1.10	1.4	3.4	0.40	-0.01	26.0	5.7	4.54	-0.90	2010
2011	313	286	1.09	1.55	3.31	0.47	0.07	31.1	5.7	5.47	0.93	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	229	202	1.13	18.9	2.0	9.47	0.00	39.8	4.4	9.15	0.00	2002
2003	232	207	1.12	19.9	2.1	9.62	0.15	42.6	4.4	9.69	0.54	2003
2004	248	225	1.10	22.0	2.4	9.33	-0.29	45.9	4.9	9.31	-0.37	2004
2005	263	238	1.11	22.6	2.5	9.02	-0.31	46.6	5.0	9.30	-0.01	2005
2006	279	263	1.06	24.6	2.9	8.48	-0.54	48.1	5.5	8.66	-0.64	2006
2007	299	276	1.08	22.6	3.1	7.22	-1.26	50.2	5.7	8.83	0.17	2007
2008	306	285	1.08	26.2	3.5	7.57	0.35	54.5	6.4	8.54	-0.29	2008
2009	288	265	1.09	26.3	3.1	8.45	0.88	51.6	6.0	8.62	0.08	2009
2010	297	274	1.08	25.4	3.2	7.87	-0.58	48.5	6.5	7.48	-1.14	2010
2011	334	305	1.09	25.9	3.0	8.63	0.76	57.6	5.9	9.75	2.27	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 8-9 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. The year-on-year change in the jobs-housing ratio demonstrates no pattern of changes before or after transit. They are not significantly different than the comparable corridor. Likewise, the year-on-year changes for medium income workers shows neither response to transit. For high income workers, the ratio steadily declines as a result of an increasing number of residents, only to rebound to its highest level in 2011. The improvement in the job-worker balance was a result of a rising number of residents. The increase in number of high income residents plateaus in 2007, dips in 2010 and then rebounds to its highest level in 2011.

Industry Balance

Industry balance provides a more refined understanding of the match between place of residence and place of work. Comparing the jobs-housing ratio by industry category makes it possible to determine which industries benefit the most from proximity to transit. The industry balance for the transit corridor is presented in Table 8. The jobs-housing ratio has been broken into two data series by the year of the advent of transit.

If any population is making extensive use of transit, they would be expected to be both working and living in the transit corridor. If so, the number of people in any given industry both working and living in the corridor should increase over time, bringing the jobs-housing ratio for the corridor closer to the ratio for the metropolitan area.

Industry	Comparable					Transit				
	2002	2002 to 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

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 (2007), the jobs-housing balance worsens for almost all industry sectors. The Information and Professional sectors experience minor improvements. However, there was already an improvement in the jobs-housing ratio in these sectors prior to the advent of transit. The increase in the jobs-worker imbalance for the comparable corridor was greater than for the transit corridor.

Discussion & Implications

The overall jobs-housing ratio indicates that transit has no significant effect on the jobs-housing balance. If anything, it suggests that the tendency of transit is to aggravate the job-housing imbalance. There is no consistent trend in year-on-year changes. Breaking out changes in jobs-housing balance by income does nothing to contradict this, thus demonstrating how brutal a year 2010 was for employment for any income level.

Comparing changes in jobs-housing ratios by industry suggests that increases in jobs-housing imbalance are normal, and that transit corridors are more prone to balance than others. However, it seems possible that transit may act to mitigate the degree of increase in imbalance.

If the LYNX shows no demonstrable pattern in improving job accessibility, it is not by accident. 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.

The purpose of transit is to provide transportation, typically by linking residential locations to employment locations, but doing so requires both the location of work and location of residence to be located near the transit corridor. Ideally, both are located within walking distance, but outside of historically dense urban environments, this is unlikely. Instead, other modes are used to bring riders to the transit stations, such as buses and park and ride lots. Like most light rail systems, the LYNX makes extensive use of both.

As a result, the most accessible (and thus most valuable) land in proximity to transit stations is used as parking, rather than developed for other higher and better uses. Parking lots are the lowest tier of transit oriented development and have their own issues. They are public spaces, yet need to provide secure storage for automobiles and secure access for their drivers. Consequently, there is a tendency to control access through fencing. The acres nominally accessible to a station, as the crow flies, may have little relationship to the acres actually accessible from the station.

Lack of accessibility is compounded by the fact that the LYNX light rail corridor is located in a former freight right of way for much of its length. Such corridors have limited accessibility. To increase safety, strong efforts have been made to reduce the number of potential conflicts between other modes of transportation and the trains by reducing accessibility. Railroad corridors have a limited number of crossings for the same reason. Unless built adjacent to an existing crossing, a train station may be accessible from only one side of the track (barring a purpose-built pedestrian overpass).

Thus, the actual area impacted by the proximity to the transit corridor is not constrained within a 0.5 mile buffer for walk access, but by the area from which bus and car access are feasible, which is a much larger shed, indicating that a larger buffer, such as 1.5 miles, would be more appropriate for residential access.

In contrast, walking access to transit stations in employment rich locations is much more feasible. Such corridors are typically directly adjacent to employment areas. To reach those areas, they tend to be street running, and street networks are more highly connected than railroad corridors.

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: Education, Information, Administrative.
- Substantial Reductions: Utilities.

Comparable corridor

- Does better than the transit corridor in Utilities, Construction, and Arts/Employment/Recreation.
- Did worse than the transit corridor for Professional.

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

Numeric Change in Transit corridor

- Employment in transit corridor increases more rapidly than the metropolitan area.
- Substantial numeric increases: Education, Administrative and Management.
- Substantial percent increases: Education, Administrative, and Management.
- Substantial numeric reductions: Construction, Finance, and Manufacturing
- Substantial percent reductions: Construction, Manufacturing, Transportation.

Effect of corridor, as per shift-share

- Education and Administrative sectors positively affected by corridor.
- Increases in Professional and Management employees largely attributed to general industry growth.
- Negative corridor effect on Finance sector is severe.
- The effect of corridor location in transit corridor inferior to comparable corridor for many industries.
- The difference in corridor effect favors the transit corridor for Administrative, and Education.

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

- Positive trends after 2007: Education and Administrative.
- Strong trends positive trends after 2007: Arts/Entertainment/Recreation best at 0.74, Healthcare at 0.71.
- Weak positive trend after transit: Administrative, Arts/Entertainment/Recreation, Healthcare, Real Estate, & Information.
- Resilient Industries with positive trends: Education, Administrative

Advantage over Comparable corridor:

- Arts/Entertainment/Recreation is more resilient in transit corridor.
- Other Services is slightly more resilient in 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 0.5-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 metropolitan average.
- Transportation costs change more than housing costs.
- Changes in transportation costs are constant with distance to transit, contrary to expectations.
- Changes in housing costs are proportional with distance to transit.

Advantage over Comparable Corridor

- Within 1.5 miles, the increase in H+T cost is greater for the transit corridor.
- Beyond 1.5 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 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.

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 metropolitan area.
- Jobs-housing ratio increased steadily over the course of the study period.
- Increase in jobs housing ratio can largely be attributed to a decrease in the number of residents.
- The jobs-housing ratio for low income workers showed no clear trend.
- The jobs-housing ratio was for medium- and high-income workers was becoming more balanced until 2011.
- The jobs-housing ratio for high-income workers increased, despite a rising number of high-income residents.
- The advent of transit does not appear to have improved job accessibility for any industry.
- The jobs-housing ratio improved for Construction and Manufacturing, both of which can be attributed to job losses.

Comparable corridor

- Unlike the transit corridor, between 2007 and 2011, the jobs-housing ratio became more balanced for the Manufacturing, Real Estate, Administrative, and Other Services Categories.

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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