NITC NATIONAL INSTITUTE for TRANSPORTATION and COMMUNITIES

**Tri-Rail Commuter Rail**

**Miami-Dade, Florida**

# Do TOD's Make a Difference?


THE UNIVERSITY OF UTAH
Metropolitan Research Center

OTREC
OREGON TRANSPORTATION RESEARCH AND EDUCATION CONSORTIUM

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# Disclaimer

PROJECT TITLE

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| Project Title:<br>**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. The remainder of this section describes the selection of existing transit (treatment) corridors and the data used for analysis. It also provides an overview of the transit corridor being analyzed.

## Selection of Treatment corridor

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

While the database contained routes, it did not identify the corridor for each station. Most transit routes make use of multiple corridors. While routes change in response to operational needs, a corridor consists of a common length of right-of-way that is shared by a series of stations on the corridor. Typically, all stations along a corridor begin active service at the same time. Transit systems grow by adding corridors to build a 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. All stations for that corridor were then imported into a geodatabase in ArcGIS. The analysis was carried out using the stations locations as point.

## 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 were 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 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 that 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.

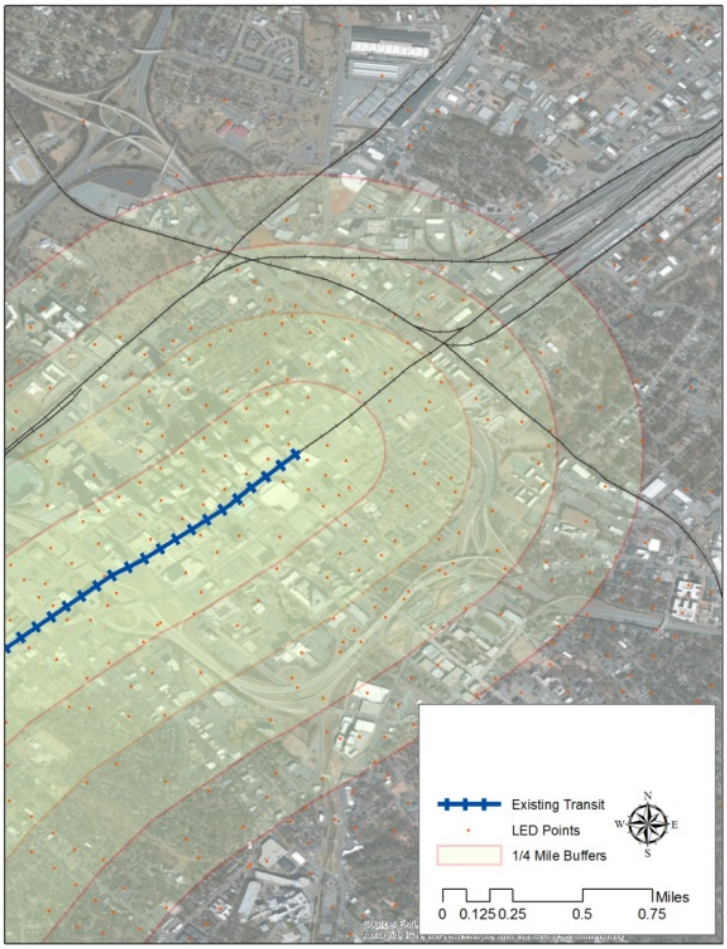


**Figure 1: Example corridor, buffers, and LED census block points**

## Study Area

This study examines the Tri-Rail commuter rail. It opened in opened in 1984, it has 70 miles of track along a freight rail corridor with 19 park and ride stations. The corridor was intended as congestion relief for the parallel I-95 corridor. It has gradually added several additional stations over the past few years. The Miami International Airport is the southern terminus, while the final stop to the north is in an outlying city. Figure 2 shows the station locations as well as the location of LED points.

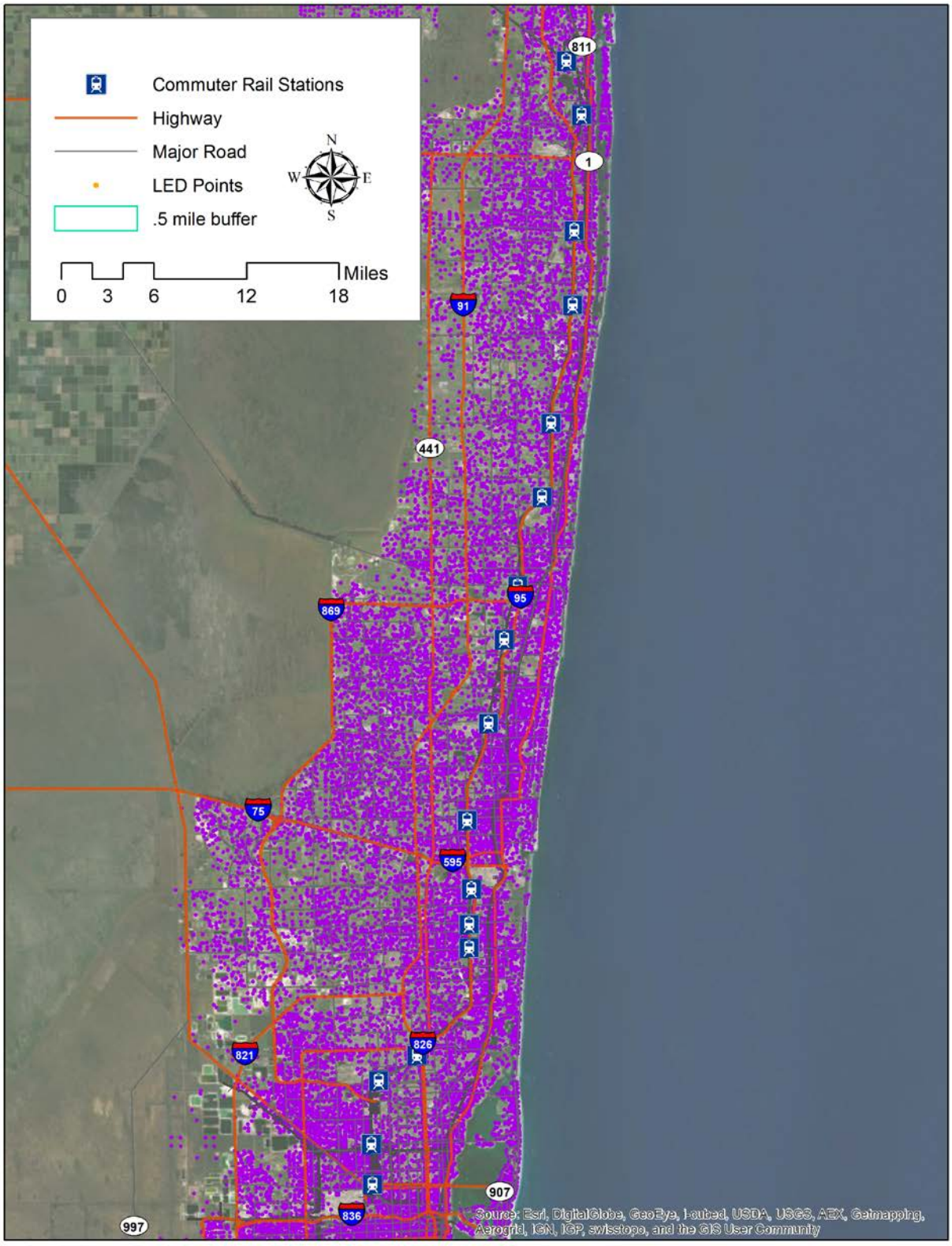


Figure 2: Transit corridor locations

# 3-EMPLOYMENT CONCENTRATION

## Introduction

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

## Data & Methods

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

## Results

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

Both corridors are located in a pre-existing, built-up urban area, so additional growth must occur through redevelopment of existing urban land, while the urban area that forms the denominator of the location quotient continues to grow through both development and redevelopment. With an expanding urban area, the location quotient for a fixed area would be expected to fall over time. Any increase in location quotient for a corridor should indicate locational advantage.

| Industry | Location Quotient | | | Changes |
|---|---|---|---|---|
| | 2002 | 2002-2011 | 2011 | Δ 2002-2011 |
| Utilities | 0.69 | | 2.26 | 1.56 |
| Construction | 1.20 | | 0.88 | -0.32 |
| Manufacturing | 2.15 | | 1.99 | -0.16 |
| Wholesale | 1.64 | | 1.29 | -0.35 |
| Retail | 0.81 | | 0.56 | -0.25 |
| Transportation | 1.18 | | 1.83 | 0.65 |
| Information | 1.65 | | 2.19 | 0.54 |
| Finance | 0.99 | | 0.95 | -0.04 |
| Real Estate | 0.84 | | 1.82 | 0.99 |
| Professional | 0.98 | | 1.16 | 0.18 |
| Management | 0.59 | | 1.64 | 1.05 |
| Administrative | 1.03 | | 1.32 | 0.28 |
| Education | 0.04 | | 0.12 | 0.08 |
| Health Care | 0.57 | | 0.71 | 0.14 |
| Arts, Ent. Rec. | 0.72 | | 0.82 | 0.10 |
| Lodging & Food | 0.50 | | 0.44 | -0.06 |
| Other Services | 0.71 | | 0.81 | 0.10 |
| Public Admin | 2.94 | | 2.50 | -0.45 |

Table 1: Location quotients comparison for transit corridor

Decreases in the location quotient may indicate that either the amount of employment within the corridor has shrunken, or that employment in that industry has grown outside the transit corridor.

Tri-Rail began operations began 2002, before the period that LEHD data was covers, so no before and after analysis was possible. In 2002, the Public Administration and Manufacturing industries had the highest location quotients in the corridor. The Education industry had the lowest, with virtually no presence. Over the next decade, almost all industries experienced substantial changes in location quotients. For most industries the location quotient rose over the next decade. Notable exceptions include the Construction, Manufacturing, Wholesale, and Retail industries. The Public Administration industry also experiences a dramatic drop in location quotient.

Sparklines shows trends over time for each industry. For many industries, the pattern in the location quotient is erratic, but industries that experience strong increases in location quotient tend to have more consistent patterns. Given that Tri-Rail operated for the duration of the study period, it seems

likely that industries responding positively toward it should see consistent increases over time. The Information, Real Estate, and Management industries meet this criterion.

## Discussion & Implications

Attributing causal effect to transit lines is always problematic, and more so for Commuter Rail systems. More so than light rail systems, they are typically built along existing freight rail corridors. As they represent the re-establishment of regional passenger rail in places that have lacked it for decades, the land uses associated with proximity to commuter rail are those indifferent to the noise and vibration of freight rail. For Tri-Rail, only a limited number of stations, have any kind of transit oriented development associated with them. For most other stations, the only development associated with the Tri-Rail are park and ride lots.

One industry that seems to be especially associated with commuter rail is Management. Commuter rail trains cover larger distances with longer traveling times. As a result, they tend to offer a higher level of amenity than short-hop light rail or metro trains, such as larger seats and electrical outlets. Consequently, such vehicles become places where it is possible to get work done while traveling to work. It is this latter function which may explain the strong growth in management and office uses along Tri-Rail. Commuter rail facilitates extreme commuting between widely seperated home and workplace locations.

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

# 4-EMPLOYMENT GROWTH BY SECTOR

## Introduction

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

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

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

## Data and Methods

A shift-share analysis attempts to identify the sources of regional economic changes to determine industries where a local economy has a competitive advantage over its regional context. Shift-share separates the regional economic changes within each industry into different categories and assigns a portion of that 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.

| NAICS Sector | Metro | | | | Transit Corridor | | | | Sources of Employment Change | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2002 | 2011 | # Change | % Change | 2002 | 2011 | # Change | % Change | Metro Share | Industry Mix Share | Corridor Effect |
| Utilities | 6,108 | 5,904 | (204) | -3% | 134 | 397 | 263 | 0% | 7 | (4) | 260 |
| Construction | 112,407 | 81,380 | (31,027) | -28% | 4,277 | 2,140 | (2,137) | -50% | 227 | (1,181) | (1,184) |
| Manufacturing | 116,900 | 77,390 | (39,510) | -34% | 7,948 | 4,599 | (3,349) | -42% | 422 | (2,686) | (1,085) |
| Wholesale | 132,217 | 131,971 | (246) | 0% | 6,860 | 5,070 | (1,790) | -26% | 364 | (13) | (2,142) |
| Retail | 251,854 | 309,081 | 57,227 | 23% | 6,443 | 5,174 | (1,269) | -20% | 342 | 1,464 | (3,075) |
| Transportation | 88,902 | 86,464 | (2,438) | -3% | 3,317 | 4,710 | 1,393 | 42% | 176 | (91) | 1,308 |
| Information | 63,996 | 46,674 | (17,322) | -27% | 3,332 | 3,047 | (285) | -9% | 177 | (902) | 440 |
| Finance | 92,095 | 102,222 | 10,127 | 11% | 2,886 | 2,881 | (5) | 0% | 153 | 317 | (476) |
| Real Estate | 59,323 | 53,740 | (5,583) | -9% | 1,570 | 2,922 | 1,352 | 86% | 83 | (148) | 1,416 |
| Professional | 141,684 | 157,051 | 15,367 | 11% | 4,394 | 5,429 | 1,035 | 24% | 233 | 477 | 325 |
| Management | 23,328 | 24,789 | 1,461 | 6% | 438 | 1,211 | 773 | 176% | 23 | 27 | 722 |
| Administrative | 170,536 | 171,065 | 529 | 0% | 5,570 | 6,715 | 1,145 | 21% | 296 | 17 | 832 |
| Education | 181,973 | 188,476 | 6,503 | 4% | 235 | 651 | 416 | 177% | 12 | 8 | 395 |
| Health Care | 253,427 | 317,431 | 64,004 | 25% | 4,589 | 6,723 | 2,134 | 47% | 244 | 1,159 | 731 |
| Arts, Ent. Rec. | 40,789 | 43,596 | 2,807 | 7% | 929 | 1,067 | 138 | 15% | 49 | 64 | 25 |
| Lodging & Food | 197,068 | 229,055 | 31,987 | 16% | 3,108 | 2,982 | (126) | -4% | 165 | 504 | (796) |
| Other Services | 84,026 | 87,458 | 3,432 | 4% | 1,892 | 2,118 | 226 | 12% | 100 | 77 | 48 |
| Public Admin | 106,781 | 127,970 | 21,189 | 20% | 9,944 | 9,525 | (419) | -4% | 528 | 1,973 | (2,920) |
| **Total** | **2,123,414** | **2,241,717** | **118,303** | **6%** | **67,866** | **67,361** | **(505)** | **-1%** | **3,604** | **1,064** | **(5,173)** |

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

For the time period after the advent of transit in 2002, the metropolitan area enjoys a robust increase in employment of 6 percent. In sharp contrast, the employment around Tri-Rail stations shrinks, with a hefty 6 percent reduction, representing a loss of about 500 jobs. But this statistic hides a wealth of variety in the performance of different industries. In numeric terms, the industry to enjoy the most significant numeric increases is the Health Care industry, although Real Estate, Professional, and Administrative all post strong gains of over 1,000. The industries with the largest percentage changes are Management and Education. Serious declines occur in the Manufacturing, Construction, Wholesale, and Retail industries.

After using Shift-Share analysis to disaggregate the cause of changes in employment, different patterns emerge. Shift-share indicates that the effect of metropolitan growth was strongly positive, and that the industry mix contributed to growth only in the Public Administration and Retail industries. In total, the corridor effect is strongly negative, largely due to a strong negative corridor effect on the Manufacturing, Construction, Wholesale, and Retail industries. In addition, the corridor effect is also strongly negative for Public Administration.

Information about the corridor effect is presented for both the transit corridor in Table 3. The 'Corridor Benefit' relates the change employment in employment totals to the change due to the Corridor Effect. It is calculated as the corridor effect divided by the absolute value of employment change. A value of 1 indicates that almost all the change can be attributed to the corridor effect, while a value of 0 means that the corridor has almost no effect.

| Industry | Transit | | |
|---|---|---|---|
| | # Change | Corridor Effect | Corridor Benefit |
| Utilities | 263 | 260 | 1.0 |
| Construction | -2137 | -1184 | -0.6 |
| Manufacturing | -3349 | -1085 | -0.3 |
| Wholesale | -1790 | -2142 | -1.2 |
| Retail | -1269 | -3075 | -2.4 |
| Transportation | 1393 | 1308 | 0.9 |
| Information | -285 | 440 | 1.5 |
| Finance | -5 | -476 | -95.1 |
| Real Estate | 1352 | 1416 | 1.0 |
| Professional | 1035 | 325 | 0.3 |
| Management | 773 | 722 | 0.9 |
| Administrative | 1145 | 832 | 0.7 |
| Education | 416 | 395 | 0.9 |
| Health Care | 2134 | 731 | 0.3 |
| Arts, Ent. Rec. | 138 | 25 | 0.2 |
| Lodging & Food | -126 | -796 | -6.3 |
| Other Services | 226 | 48 | 0.2 |
| Public Admin | -419 | -2920 | -7.0 |
| **Total** | **-505** | **-5173** | **na** |

**Table 3: Corridor Effect and Corridor Benefit by Industry**

The Corridor Benefit aids in comparison by providing a metric that is independent of the magnitude of employment. The Corridor Effect from the last table is provided as a point of reference. The Corridor Benefit is largest for the Information industry, but most industries with positive employment growth attribute the majority of that growth to the corridor effect. Five industries (Utilities, Transportation, Real Estate, Management, and Education) attribute almost all of their employment growth to the Corridor Effect.

## Discussion & Implications

Changes in industries near Tri-Rail stations indicate the near-total evacuation of low-density development for increases in office style development. Construction, Manufacturing, and Wholesale are all low-density warehouse and industrial uses. Retail is not commonly thought of as low density, but

even in dense urban environments, multistory retail is rare. Even in great pedestrian environments, with every block face wrapped in retail, the density of retail fails to compare with that of a mid-rise office building. As the rents on land rise, the highest and best use shifts. Existing industries are displaced to cheaper locations, and previous land uses are converted to higher and better uses.

More rigorous analysis is required to draw firm conclusions. The Tri-Rail corridor runs adjacent to I-95 for most of its alignment. Most stations are located well back from interchanges, and thus pedestrian accessibility to the stations is limited. Few stations areas would be characterized as pedestrian oriented, so walking to most destinations within 0.5 miles of a Tri-Rail station would be difficult.

Tri-Rail commuter rail stations are not pedestrian-friendly transit oriented development, but rather vehicle-friendly park and ride centers. Changes in industries within the 0.5-mile buffer are likely unrelated to proximity to Tri-Rail. It seems likely that the 0.5-mile buffer around a corridor is an inappropriate analytical geography for transit analysis. It is a buffer established less by empirical evidence than by custom and data limitations. That some people walk distances greater than 0.5 miles to transit has been rigorously established, as has a negative binomial relationship between distance and number of people willing to walk to transit, so any buffer distance is somewhat arbitrary. A half-mile has been used as the maximum distance for the majority of people. The amount of acreage accessible within a 20-minute walk of a transit station, following roadways, is very different from the acreage within a 0.5-mile buffer of a location. Using a smaller buffer would reduce the number of confounders.

One notable exception is for the Miami International Airport. It has a dedicated people-mover connecting the Tri-Rail station to the airport proper. Most stations are not so fortunate, although Tri-Rail also connects with the Miami Metrorail system, an elevated heavy rail metro, at two locations.

# 5-EMPLOYMENT RESILIENCE

## Introduction

Resilience is defined as the ability to absorb and recover from shocks or disruptions. Resilient systems are characterized by diversity and redundancy. The resilience of employment is a critical factor in community economic health. For many communities, the loss of a single primary employer can be catastrophic, resulting in a state of sustained collapse. Employment resilience is the capacity to recover from such disruptions, due to locational characteristics.

Access to transit can help improve employment resilience because proximity to transit is a source of competitive advantage for some industries. Firms located near transit also benefit from reduced employee and visitor parking needs. This translates into an ability to economize on the size of parcels required, both reducing costs and increasing the number of viable sites for business locations.

Transit provides a mechanism to meet transportation needs and unusual or unexpected conditions, such as an automobile breakdown or lower income, and it provides alternate transportation options during conditions that impair other modes, such as weather, construction projects, or accident-induced delay. It also provides accessibility to a population unable to drive such as the young, the elderly, and the poor (VPTI 2014). These factors act to reduce tardiness and absenteeism, thus reducing employment turnover.

Transit also helps create 'thick' markets for employment, whereby employees can match themselves to numerous different employment opportunities. This reduces the time necessary to find matches, unemployment duration, and the unemployment rate.

## Data and Methods

An interrupted time series was used to compare the resilience of employment in both areas to determine if proximity to transit represents a locational advantage. An interrupted time series divides a time series dataset into two time series with the datasets separated by an 'interruption' and compares the differences. For the purpose of this analysis, the interruption is the Great Recession, considered to have begun in 2007.

If an interruption has a causal impact, the second half of the time series will display a significantly different regression coefficient than the first half. Failure to be adversely affected by a severe economic shock indicates employment resilience. A low R-squared ($R^2$) represents larger variability in total employment. Industry sectors with a high $R^2$ demonstrate robust trends, indicating that employment failed to change regardless of the effects on the larger economy. The regression coefficient represents the relationships between the change in variables, and the $R^2$ explains how much of the variance in the data is explained by the regression equation—a measure of the 'goodness' of the regression.

## Results

A line graph of the employment by industry time series is presented in Figure 4. The time series (2002-2011) for each is interrupted in 2008. The vertical axis shows total employment in each industry sector along the corridor. Illustrative regression lines with $R^2$ values have been added for some of the industries. The trend lines and associated $R^2$ values for all industry sectors can be found in Table 4.

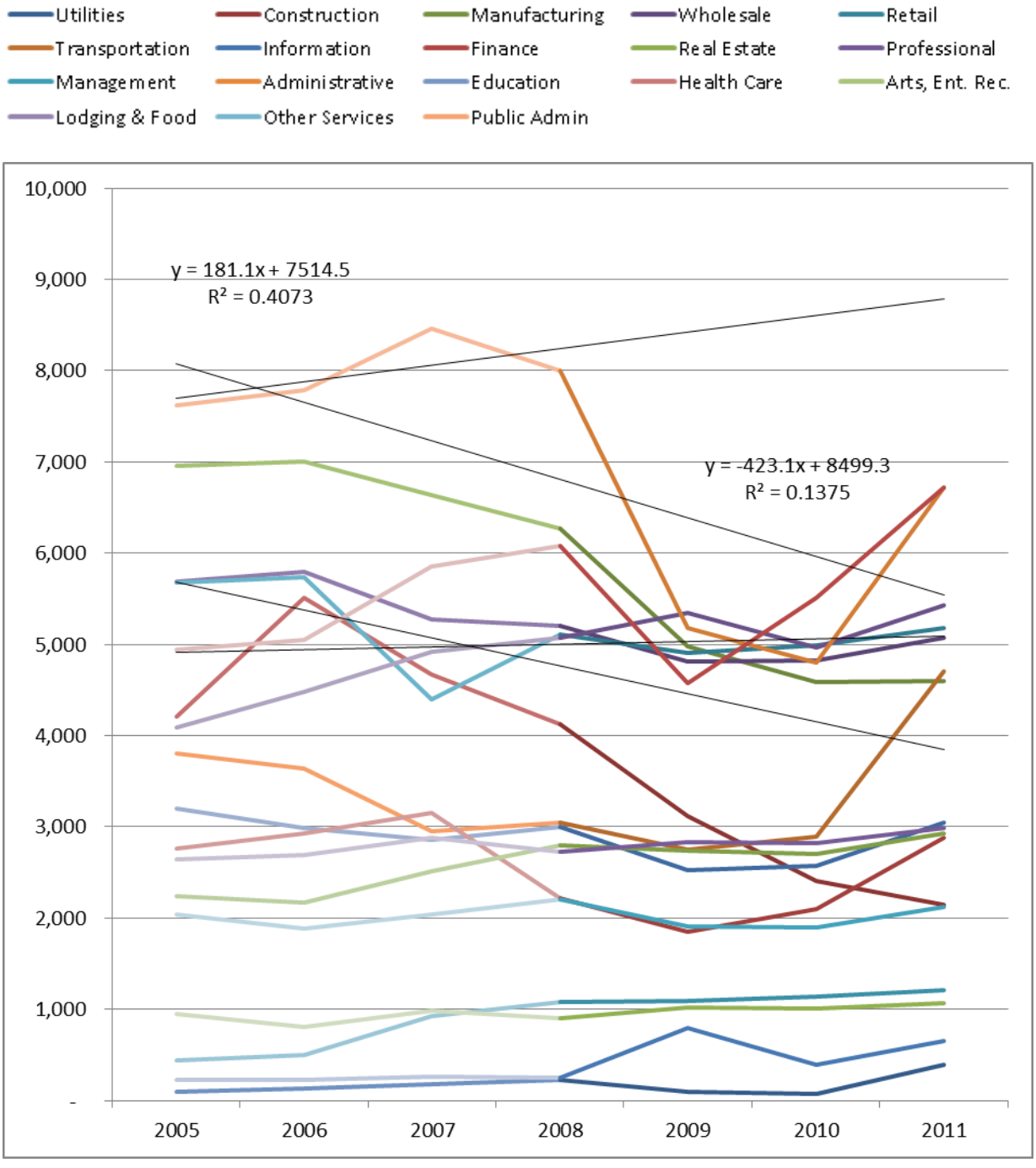


Figure 3: Regression trend lines and R-squared values for different industries

As the graph shows, industry employment varies by year, with many industries affected by substantial fluctuations in employment, both before and after the recession. While visual inspection is valuable, more rigorous interpretation is necessary.

Resilience by industry is presented in Table 4. It highlights the resilience of different industries between 2002-2008 and 2008-2011. The trend number is the linear regression line on industry employment over time. Trend indicates whether total employment increases or decreases during each time period. A negative trend indicates sustained loss of employment while a positive trend indicates a sustained gain. The trend number is the slope of the regression line. However, industries with larger total employment will have larger slopes. To normalize trend numbers for comparison between industries, the trend percent is presented. It is calculated by dividing the trend number for a time period by the average employment for that period. Finally, the $R^2$ column indicates how strong a trend is. Industry sectors with a high $R^2$ demonstrate robust trends—trends in employment change that are consistent over time with less tendency to fluctuate.

The change in the trend between the two time periods is given in the differences column. A positive value for the trend number represents a change from employment loss to employment gain, or a reduction in the rate of decline in employment for that industry. The change in the strength of the trend is given by the R2 column. A positive value indicates that a previously erratic trend has become more consistent. A negative value means a previously consistent trend has become more erratic.

| Industry | 2005-2008 | | | 2008-2011 | | | Differences | | |
|---|---|---|---|---|---|---|---|---|---|
| | Trend # | Trend % | R2 | Trend # | Trend % | R2 | Trend # | Trend % | R2 |
| Utilities | 42 | 27% | 1.00 | 50 | 25% | 0.19 | 8 | -2% | -0.80 |
| Construction | -111 | -2% | 0.05 | -666 | -23% | 0.94 | -555 | -20% | 0.89 |
| Manufacturing | -244 | -4% | 0.86 | -540 | -11% | 0.77 | -296 | -7% | -0.09 |
| Wholesale | -199 | -4% | 0.75 | -37 | -1% | 0.06 | 162 | 3% | -0.69 |
| Retail | -306 | -6% | 0.40 | 29 | 1% | 0.10 | 335 | 6% | -0.30 |
| Transportation | -295 | -9% | 0.81 | 513 | 15% | 0.52 | 809 | 24% | -0.28 |
| Information | -72 | -2% | 0.45 | 20 | 1% | 0.01 | 92 | 3% | -0.44 |
| Finance | -140 | -5% | 0.20 | 224 | 10% | 0.43 | 364 | 15% | 0.23 |
| Real Estate | 201 | 8% | 0.81 | 32 | 1% | 0.18 | -169 | -7% | -0.63 |
| Professional | 340 | 7% | 0.97 | 68 | 1% | 0.16 | -272 | -6% | -0.81 |
| Management | 237 | 32% | 0.93 | 44 | 4% | 0.89 | -193 | -28% | -0.03 |
| Administrative | 181 | 2% | 0.41 | -423 | -7% | 0.14 | -604 | -9% | -0.27 |
| Education | 11 | 5% | 0.63 | 78 | 15% | 0.17 | 67 | 10% | -0.46 |
| Health Care | 422 | 8% | 0.91 | 287 | 5% | 0.16 | -136 | -3% | -0.75 |
| Arts, Ent. Rec. | 2 | 0% | 0.00 | 48 | 5% | 0.80 | 46 | 5% | 0.80 |
| Lodging & Food | 43 | 2% | 0.28 | 78 | 3% | 0.88 | 35 | 1% | 0.60 |
| Other Services | 64 | 3% | 0.39 | -26 | -1% | 0.05 | -90 | -4% | -0.34 |
| Public Admin | 2500 | 19% | 0.87 | -2427 | -21% | 0.64 | -4927 | -39% | -0.23 |
| Total | 2684 | 4% | 0.96 | -2656 | -4% | 0.20 | -5340 | -8% | -0.76 |

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

Prior to the Great Recession, most industries had positive employment trends. The Public Administration industry had a trend that was both very large and very consistent.

Other notably large positive outliers included the Management and Utilities industries, and notable negative outliers were the Transportation and Retail industries. The overall trend for employment was strongly positive. During the 2008 to 2011 period in the transit corridor, the overall employment trend was strongly negative, although the majority of industries had increasing employment trends. The industries with the largest numeric trends were Transportation, Health Care and Finance. The Trend % calls attention to the magnitude of large magnitude of increases in the Utilities, Transportation and Education industries. Notably, Public Administration reverses itself, with a large negative trend. The Construction and Manufacturing industries also had significant negative trends.

Differences in trends (number and percent) and the strength of trends ($R^2$) indicate which industries in the corridor did better after 2008, as the recession reached its trough and the recovery began. For the industries with positive trends, the most substantial difference in trends is for the Public Administration industry. Few other industries see the increasing $R^2$ that indicates a more consistent trend after the Great Recession.

In terms of trend consistency, as measured by the $R^2$ value, the Arts/Entertainment/Recreation industry proved the most resilient. In addition to an improved $R^2$ value, indicating greater consistency in trends, it had positive trends before and after the Great Recession. Lodging/Food also appears to be resilient. Education has strong positive trends before and after the Great Recession, but experiences a large decline in $R^2$, indicating reduced consistency in the post-recessionary trend. However, it can still be considered to be resilient.

In addition to resilient industries, there are industries that are emergent. They represent a phase shift or transition away from pre-recession industrial ecology and toward a new and different one. Emergent industries are characterized by flat or falling trends prior to the recession, but large positive trends following the recession. Industries that characterize this pattern are the Transportation and Finance industries.

## Discussion & Implications

Trend comparisons aside, the time series data of resilient industries should have a characteristic profile after the recession: U-shaped, with a decline followed by a recovery. Examining the chart of regression trend lines is very helpful, but regardless of overall trends, resilient industries are immediately visible.

The Great Recession hit different places at different times, and the effects have lasted longer in some places than in others. Contrary to expectations, 2008 is rarely the nadir in employment. For some industries, the nadir occurs in 2009 even 2010. Industries that declined 2007-2008 were doomed to decline from 2008-2009. They might be deemed 'Fragile' industries. Against the slightest headwind, they collapse. A 2008-2009 positive trend was often a conflicted indicator. Most industries with one did badly from 2009 to 2010, indicating an industry specific recovery phasing broader economic headwinds. Curiously, a 2007 inflection point is actually a good sign. It may be that for such industries, the deadwood has been pruned before being battered by the Great Recession. Industries with uniform positive trends for post-recessionary periods are rare, and often have static employment.

There are, of course, regional and industry specific patterns. Typically, industries dependent on public funding lag the rest of the economy by a year. Funded by tax receipts, cutbacks occur only in the year after, as data about the previous year's economic performance affect budgeting.

Savaged by the Great Recession, employment in most industries declines between 2008 and 2011. But not all industries recovered equally, and overall economic performance for the metro provides no guidance for the success of any particular industry. Nor do pre-recessionary trends.

Some caveats are necessary. Employment in any industry sector is variable over time, and the amount of variability increases with smaller geographic units of analysis. Because the geographic unit of analysis is small, the amount of fluctuation is larger. Changes might 'average out' over a larger unit of geographic aggregation and may have significant effects. In a given year, the relocation of a single firm, or the addition of a new building, would be sufficient to dramatically change employment trends in any industry. Finally, the area within a 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.

Resilience is a poorly understood and poorly operationalized concept. Measurement attempts remain ad-hoc. 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. Employment level is likely the stronger standard. For national recessions, the number of months it takes a nation to return to a pre-recessionary level of GDP is a gauge of the resilience of the economy. Applying a similar measure to most industries is difficult, as employment in many had not recovered to pre-recessionary levels in 2011. Extrapolating post-recessionary trends would make it possible to estimate the date of return, but with some uncertainty. An evaluation of resilience, however, requires employment loss for this approach, and some industries fail to decline. These industries are robust, and an effective metric for resilience would need to be able to detect both as positive outcomes.

Equal or better trends after the recession are also a bit of a red herring. Many industries do 'less badly' after the Great Recession, without doing well in any meaningful way. A positive post-recessionary trend is an unmitigated good, and highlights yet another outcome of the economic shock delivered by the Great Recession: Industries doing very badly suddenly doing much better. As conditions shift, creative destruction in some industries clears the way for growth in different industries.

Contrary to expectations, a high $R^2$ value for the post recessionary period is actually a conflicted indicator—consistently declining industries have high $R^2$ values, while the ideal U-shaped pattern in total employment associated with resilience is characterized by a very low $R^2$ value.

# 6-HOUSING AFFORDABILITY

## Introduction

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

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

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

Calthorpe (1993) initially proposed a ten-minute walk, or about 0.5-mile radius, as the ideal size for a TOD. Empirical studies confirm that while the majority of walk trips occur for distances of or equal to 0.5 miles, the effects of proximity to transit can be detected out to 1.5 miles away (Nelson 2011). Access to fixed guide-way transit systems is frequently by non-walk modes such as bicycle, bus, and automobile. The characteristics of the built environment within a mile buffer of a station can still affect transit ridership (Guerra, Cervero, & Tischler 2011).

## Data and Methods

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

## Data Source and Geography

This study uses the Location Affordability Index (LAI). The Location Affordability Index was developed under the aegis of the Sustainable Communities, an inter-agency partnership between the Housing and Urban Development, US Department of Transportation, and the Environmental Protection Agency. The LAI is an effort to use statistical modeling to determine the factors that underlie the causes of housing and transportation costs. It controls for a number of factors known to influence transportation and housing costs, such as income and number of workers. The full methodology for the LAI can be found at: http://lai.locationaffordability.info/methodology.pdf.

The LAI provides an estimate of the total cost of housing plus transportation for different locations. The LAI offers eight different household profiles of different family types. For this analysis, type 1 household (hh_type1) was used. It represents the Regional Typical household, with average household size, median income, and an average number of commuters per household for the region. A full data dictionary can be found at: http://lai.locationaffordability.info/lai_data_dictionary.pdf

The unit of analysis for the dataset is the 2010 Decennial Census Block Group. The data extent is the Census 2010 Core-Based Statistical Area (CBSA). When transit lines crossed the boundary into adjacent statistical areas, both statistical areas were included.

## Data Processing

The data were downloaded from http://www.locationaffordability.info/lai.aspx?url=download.php as CSV (Comma Separated Values) files. They were then joined to a shapefile of the 2010 Decennial Census Block Groups from https://www.census.gov/geo/maps-data/data/tiger.html

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 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 index was devised. Because the metropolitan area contains all census blocks, not just urban blocks, weighting the blocks by area was deemed inappropriate. 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 value for the metro area was calculated by weighting the block group characteristics by Census 2012 block group population. This weighted average is intended to provide a referent for what normal values are for the metropolitan area.

This analysis makes use of seven characteristics from the location affordability index: Housing Costs as a Percent of Income and Transportation Costs as a Percent of Income, for owners, renters, and all

households in the region. Additionally, it makes use of the median income to translate percentages into dollar amounts.

## 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. Housing costs by tenure, by percent of income
3. Change in LAI H+T costs for transit corridor

For interpreting the Location Affordability Index, housing is considered affordable if total housing and transportation costs do not exceed 46 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. A stacked graph has been used to display the disaggregated effects of housing and transportation on H+T affordability.

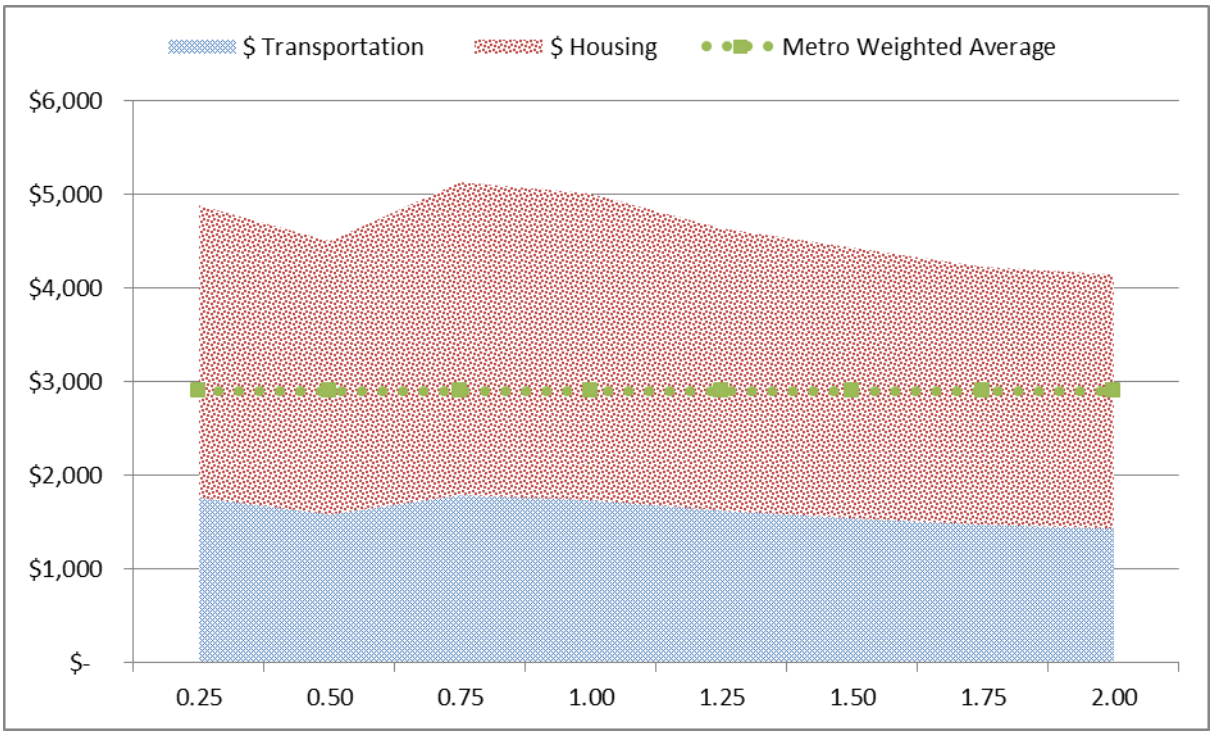


**Figure 4: Housing, transportation, and H+T costs for the transit corridor, 2009, by buffer distance**

As the above graph shows, H+T costs near the transit line are significantly higher than the metropolitan average. Housing costs vary erratically with distance to Tri-Rail stations, indicating that the cause is likely a metropolitan scale effect. Transportation costs also vary erratically with proximity to Tri-Rail stations, although the degree of variance is less.

Transportation costs, and housing costs by tenure are shown in Figure 6. The vertical axis shows the percent of income needed to meet housing costs. The horizontal axis shows how the total varies by buffer distance from the transit corridor. The response to transit should be more significant nearer to the transit line.

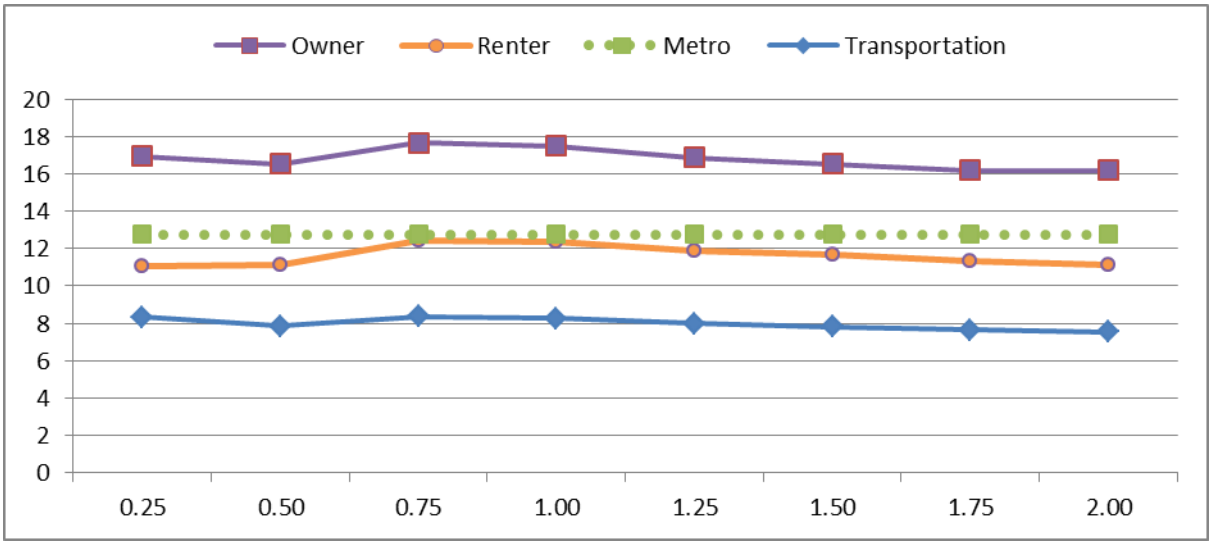


**Figure 5: Transportation costs & Housing costs by tenure, by buffer distance.**

Contrary to theory, transportation costs are perceptible higher near to Tri-Rail stations within 0.25 miles, where walk access should be greatest. They are at their highest about 0.75 miles from stations. Housing costs for owners shows a 'rent ridge' where the rents are highest about 0.75 miles away from the corridor. Housing costs for renters shows very similar pattern. However, while housing costs for rents are similar to the metropolitan average, housing costs for owners are substantially higher.

## Discussion & Implications

The strongest response to transit should be in the areas closest to the transit station, and the housing and rental costs nearly the station should strongly reflect this. The value of the additional accessibility generated by proximity to transit should be capitalized into property value, resulting in rising housing costs, while proximity to transit should reduce transportation costs. Neither pattern can be observed with relation to proximity to Tri-Rail stations. No consistent pattern at all can be observed, which strongly suggests a confounding factor, such as proximity to I-75 or I-95. I-95 parallels Tri-Rail for much of the route, and proximity to limited access highways has a much stronger effect on home values (and thus housing cost) than proximity to commuter rail.

# 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.

## 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 NAICS at the two-digit summary level.

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

## Results

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

### Overall Balance

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

| Year | Metro | | | Transit | | | | Year |
|---|---|---|---|---|---|---|---|---|
| | Work, 000's | Home, 000's | Jobs-Housing Ratio | Work, 000's | Home, 000's | Jobs-Housing Ratio | Year on Year Change | |
| 2002 | 2,147 | 2,146 | 1.00 | 67.9 | 20.2 | 3.36 | 0.00 | 2002 |
| 2003 | 2,118 | 2,112 | 1.00 | 61.3 | 20.0 | 3.06 | -0.29 | 2003 |
| 2004 | 2,060 | 2,070 | 1.00 | 60.5 | 19.0 | 3.19 | 0.13 | 2004 |
| 2005 | 2,219 | 2,239 | 0.99 | 68.4 | 20.5 | 3.33 | 0.14 | 2005 |
| 2006 | 2,243 | 2,236 | 1.00 | 69.7 | 20.9 | 3.34 | 0.01 | 2006 |
| 2007 | 2,301 | 2,301 | 1.00 | 73.9 | 21.6 | 3.42 | 0.07 | 2007 |
| 2008 | 2,192 | 2,175 | 1.01 | 76.0 | 19.8 | 3.84 | 0.43 | 2008 |
| 2009 | 2,118 | 2,098 | 1.01 | 60.5 | 20.1 | 3.00 | -0.84 | 2009 |
| 2010 | 2,119 | 2,088 | 1.01 | 59.6 | 18.7 | 3.19 | 0.19 | 2010 |
| 2011 | 2,261 | 2,195 | 1.03 | 67 | 18.9 | 3.57 | 0.38 | 2011 |
| Trend | | | | | | | | Trend |

Table 5: Jobs-housing balance for all income categories

The overall jobs-housing ratio for the area near Tri-Rail stations is job-rich, with a jobs-housing ratio about 3 times that for the metropolitan area. With the advent of transit operations, the jobs-housing balance generally moves further from parity with the metropolitan area, through a combination of

changes in both the number of employees living and residing in the corridor. There are major deviations from the trend in 2003 and again in 2009.

## 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 | | | Transit | | | | Year |
| | Work, 000's | Home, 000's | Jobs-Housing Ratio | Work, 000's | Home, 000's | Jobs-Housing Ratio | Year on Year Change | |
| 2002 | 663 | 668 | 0.99 | 15.5 | 7.3 | 2.14 | 0.00 | 2002 |
| 2003 | 654 | 656 | 1.00 | 14.6 | 6.9 | 2.11 | -0.02 | 2003 |
| 2004 | 620 | 628 | 0.99 | 15.5 | 6.6 | 2.36 | 0.25 | 2004 |
| 2005 | 626 | 641 | 0.98 | 14.8 | 6.5 | 2.27 | -0.09 | 2005 |
| 2006 | 608 | 615 | 0.99 | 14.5 | 6.5 | 2.24 | -0.03 | 2006 |
| 2007 | 609 | 614 | 0.99 | 14.6 | 6.6 | 2.22 | -0.02 | 2007 |
| 2008 | 550 | 548 | 1.00 | 13.8 | 5.5 | 2.50 | 0.28 | 2008 |
| 2009 | 522 | 519 | 1.01 | 11.6 | 5.6 | 2.09 | -0.41 | 2009 |
| 2010 | 516 | 509 | 1.01 | 10.4 | 5.0 | 2.07 | -0.02 | 2010 |
| 2011 | 563 | 538 | 1.05 | 12.0 | 5.2 | 2.31 | 0.24 | 2011 |
| Trend | | | | | | | | Trend |

| Medium Income | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Metro | | | Transit | | | | Year |
| | Work, 000's | Home, 000's | Jobs-Housing Ratio | Work, 000's | Home, 000's | Jobs-Housing Ratio | Year on Year Change | |
| 2002 | 926 | 924 | 1.00 | 30.7 | 9.5 | 3.23 | 0.00 | 2002 |
| 2003 | 909 | 906 | 1.00 | 28.2 | 9.6 | 2.95 | -0.29 | 2003 |
| 2004 | 878 | 884 | 0.99 | 26.4 | 9.1 | 2.91 | -0.04 | 2004 |
| 2005 | 928 | 939 | 0.99 | 28.4 | 9.6 | 2.95 | 0.04 | 2005 |
| 2006 | 939 | 940 | 1.00 | 27.7 | 10.0 | 2.78 | -0.16 | 2006 |
| 2007 | 960 | 962 | 1.00 | 29.0 | 10.1 | 2.88 | 0.09 | 2007 |
| 2008 | 911 | 905 | 1.01 | 28.2 | 9.4 | 3.00 | 0.12 | 2008 |
| 2009 | 873 | 868 | 1.01 | 23.1 | 9.6 | 2.40 | -0.60 | 2009 |
| 2010 | 872 | 860 | 1.01 | 23.1 | 9.1 | 2.55 | 0.15 | 2010 |
| 2011 | 903 | 883 | 1.02 | 26.0 | 8.8 | 2.98 | 0.42 | 2011 |
| Trend | | | | | | | | Trend |

| High Income | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Metro | | | Transit | | | | Year |
| | Work, 000's | Home, 000's | Jobs-Housing Ratio | Work, 000's | Home, 000's | Jobs-Housing Ratio | Year on Year Change | |
| 2002 | 559 | 554 | 1.01 | 21.8 | 3.5 | 6.25 | 0.00 | 2002 |
| 2003 | 556 | 550 | 1.01 | 18.5 | 3.5 | 5.28 | -0.98 | 2003 |
| 2004 | 562 | 558 | 1.01 | 18.6 | 3.3 | 5.59 | 0.31 | 2004 |
| 2005 | 664 | 659 | 1.01 | 25.1 | 4.3 | 5.78 | 0.19 | 2005 |
| 2006 | 696 | 681 | 1.02 | 27.5 | 4.4 | 6.22 | 0.44 | 2006 |
| 2007 | 733 | 725 | 1.01 | 30.3 | 5.0 | 6.07 | -0.15 | 2007 |
| 2008 | 731 | 721 | 1.01 | 34.0 | 4.9 | 6.98 | 0.92 | 2008 |
| 2009 | 722 | 711 | 1.02 | 25.7 | 4.9 | 5.22 | -1.76 | 2009 |
| 2010 | 731 | 720 | 1.02 | 26.0 | 4.6 | 5.69 | 0.47 | 2010 |
| 2011 | 796 | 774 | 1.03 | 29.4 | 5.0 | 5.93 | 0.24 | 2011 |
| Trend | | | | | | | | Trend |

Table 6: 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 5 to 6 times as many workers as working residents. The jobs-housing ratio is nearest to parity with

the metropolitan area for low-income workers. Over the study period, the jobs-housing ratio shows no consistent trend toward jobs-housing balance for any income category. However, barring a major deviation in 2009, the jobs-housing ratio is fairly steady.

The Sparklines of the jobs-housing ratio shows that low-income employment declines steadily throughout the study period. The pattern for medium-income workers in the corridor is more erratic, showing a general improvement toward parity. The jobs-housing ratio for high-income workers is the most erratic, with larger variations. While it moves steadily further from parity until 2008, it becomes dramatically before more balanced before regaining its prior trend.

## Industry Balance

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

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

| Industry | Transit | | |
|---|---|---|---|
| | 2002 | 2002 to 2011 | 2011 |
| Utilities | 3.44 |  | 10.73 |
| Construction | 3.45 |  | 2.88 |
| Manufacturing | 5.72 |  | 5.92 |
| Wholesale | 6.79 |  | 5.20 |
| Retail | 2.84 |  | 1.94 |
| Transportation | 4.57 |  | 6.53 |
| Information | 6.94 |  | 8.91 |
| Finance | 3.69 |  | 4.24 |
| Real Estate | 2.91 |  | 6.89 |
| Professional | 3.77 |  | 4.75 |
| Management | 1.90 |  | 5.94 |
| Administrative | 2.98 |  | 4.20 |
| Education | 0.17 |  | 0.50 |
| Health Care | 1.84 |  | 2.47 |
| Arts, Ent. Rec. | 2.10 |  | 2.62 |
| Lodging & Food | 1.54 |  | 1.37 |
| Other Services | 2.30 |  | 2.77 |
| Public Admin | 9.24 |  | 9.07 |

**Table 7: Job accessibility trends over time by industry sector and corridor**

Tri-Rail began operations began 2002, before the period that LEHD data covered, so no before and after analysis was possible. Data from 2002 shows that the areas near Tri-Rail stations were job rich for all industries, with the notable exception of Education. Over time, most industries moved further from parity with the metropolitan jobs-housing ratio becoming yet more job-rich. Notable exceptions include Public Administration, Lodging/Food, Retail, Wholesale, and Construction. Of these, the largest changes were in the Wholesale and Retail Industries. The sparklines display consistent patterns for the Lodging/Food, Retail and Wholesale industries.

## Discussion & Implications

The larger the metropolitan area, the more places it is 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 that the magnitude of the effect of transit is insufficient to improve jobs-housing balance.

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

While often considered a Sunbelt State, Florida was actually settled in a much earlier era of transportation. While its population exploded with the highway network, it already possessed an extensive array of freight and passenger railroad lines. Towns along these regional rail lines became the seeds from which the metropolitan area grew. Constrained on one edge by the Atlantic Ocean and on the other by the geographic limitation of the Everglades, this generated a long and very narrow metropolitan area. Tri-Rail links together not only the historic railroad centers, but also ‘Edge Cities’ like Dadeland that emerged in response to the access generated by limited access highways.

Tri-Rail stations act as intermodal hubs, between park and ride lots, local buses, regional Amtrak trains, and the Miami Metrorail system. Alone, it does very little to match workplaces to homes, and has little capacity to match jobs to housing along the corridor. The need to act as a hub and support multiple modes of transit also undermines the capacity for commuter rail systems to serve as centers for Transit Oriented Development. Commuter rail systems are unlike light rail systems. While light rail systems may have a variety of goals in addition to providing transportation benefit, commuter rail systems tend to be built as congestion mitigation mechanisms. Like Tri-Rail, several commuter rail systems began operations as relief measures during highway expansion. Because it is primarily a congestion mitigation mechanism, commuter rails systems like Tri-Rail are unable to get ‘ahead’ of congestion. Ideally, commuter rail systems could be used to connect satellite cities rapidly to the metropolitan core. Typically, only after transportation corridors are failing beyond the cost of reasonably expensive roadway improvements are they considered as alternatives. Because of their long lengths, constructing new track is typically financially unfeasible, so existing freight corridors are inevitably used. Consequently, stations are located in peripheral locations, and rely on other transit modes to make the connections to actual trip generating locations.

Ideally, comparing the jobs-housing ratio for different industries should show which industries are transit compatible, with transit compatible industries showing better matches. At the corridor scale, it

seems unable to do so. The jobs-housing ratio is very far from parity for most industries. While improving the job-worker ratio along the corridor towards parity would be a positive result, the failure to do so may not capture the whole story. Effectively gauging the effect on jobs-housing balance would require evaluating the jobs-worker balance over the whole transit network.

# 8-SUMMARY OF FINDINGS

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

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

## Q1: Attractiveness to NAICS sectors (Location quotient)

Transit corridor

- Substantial Increases: Real Estate and Management
- Notable Increases: Transportation and Information
- Substantial Reductions: Public Administration, Wholesale and Construction
- Transit Induced Improvement likely: Information, Real Estate and Management

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

Numeric Change in Transit corridor

- Employment in transit corridor shrank while metro employment grew
- Most substantial numeric increase: Health Care
- Other major numeric increases: Transportation and Real Estate
- Substantial percent increases: Management and Education
- Substantial reductions: Manufacturing and Construction

Effect of corridor, as per shift-share

- Overall Corridor Effect is strongly negative
- Benefits the most: Transportation and Real Estate
- Strongly negative for: Public Administration and Retail

## 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 similar $R^2$ values.

Transit corridor before 2008

- Greatest numerical increase: Public Administration
- Greatest percent increase: Management, Utilities, and Public Administration
- Declining: Numerous with single digit percent declines

Transit corridor after 2008

- Strong positive trends: Utilities, Education, and Transportation
- Strong negative trends: Construction, Manufacturing, and Public Administration

Differences before and after Great Recession

- Biggest positive change: Transportation
- Resilient (Positive trend before and after): Utilities, Education
- Emergent (Negative trend before, positive trend afterward): Transportation

## Q4: Do TODs create more affordable housing measured as H+T? (Housing affordability)

Unlike other analyses in this report, this analysis measures changes in more than just the 0.5-mile buffers. The magnitude of the effect of transit should be proportional to proximity to transit.

Transit corridor

- H+T costs for the transit corridor are higher than the metropolitan average
- H+T costs display no pattern in regards to proximity to transit stations
- Both Housing and Transportation costs highest 0.75 miles from transit stations

Transit corridor transportation costs and housing costs by tenure

- Transportation costs highest closest to transit stations
- Housing costs for renters similar to metropolitan area average
- Housing costs for renters has rent ridge at 0.75 miles
- Housing costs for renters lowest near transit corridor
- Housing costs for owners higher than metropolitan area average
- Housing costs for owners has same pattern as that of renters

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

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

- Job rich at start of study period, with jobs-housing ratio greater than that of the metropolitan area
- Erratic trends, big year on year changes
- Changes in jobs-housing ratio caused by both declining number of workers, and declining number of workers resident in the corridor
- For industries, improvements in jobs-housing balance typically a result of job-losses
- Extreme movements away from parity: Utilities, Real Estate, and Management

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# 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 |