Light Rail and Single Family Home Prices
The impact of the MetroLink Blue Line on St. Louis County Residential Property Values

Jill Mead

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Abstract

To date, no before and after analysis has been conducted to understand the effects of light rail service on property values in the St. Louis region. A modified repeat sales model was used to estimate whether properties in St. Louis County, Missouri, showed a significant difference in sales price following the opening of the MetroLink Blue Line in August 2006. The model used 23 years of repeat sales data from before (January 1990- August 2006) and after (August 2006-December 2012) the opening of the line, as well as data from station areas (1/4 mile radius of stations, n = 515 paired sales) and control areas (between ¾ and 1 mile from stations, n = 2212 paired sales) to understand whether properties in station areas sold at a premium when compared to properties in control areas following the initiation of light rail service. Results of the analysis indicated that station area properties sold for an average of 1.2% less than the entire sample of repeat sales properties during the 17.5-year before period, but that in the 5.5-year after period, station area properties sold for an average of 4.9% more than the repeat sales sample. Though these differences were not statistically significant, the upward trend in property prices in the vicinity of stations is encouraging in light of the overall downward trend in study area property prices as a result of the recession during the after time period. The results of this analysis indicate that proximity to light rail may be a factor that affects single family home sales price in St. Louis County.

I. Introduction

In the 1980s, transportation agencies began to pursue light rail as a more flexible and lower cost alternative to heavy rail. Compared to heavy rail, light rail is generally less expensive to build and easier to fit to specific conditions, while affording greater speed than the bus or the streetcar and offering some of the environmental and economic development benefits associated with heavy rail (EMBARQ, 2013). In general, light rail tends to have the station spacing of heavy rail (Walker, 2010) while operating at-grade on exclusive right-of-way (EMBARQ, 2013), although exceptions to all of these conditions exist.

Over 20 cities have opened light rail lines since 1981 (Figure 1), providing a combined total of over 267 million passenger trips in 2011 (INTDAS, 2013).Early light rail systems were opened in San Diego (1981), Pittsburgh (1984), Buffalo (1984), and Portland (1986). Some cities use have used light rail to supplement their bus network, while other cities have integrated light rail into a broader rail network consisting of heavy rail and/or streetcars in addition to busses. This group of light rail systems is distinguished from "first-generation" or "legacy" light rail systems in cities such as Philadelphia or San Francisco, which evolved from rail alignments that have been in use since the early 20th century. In contrast, "second-generation" light rail systems were built in cities that decommissioned their streetcar networks in the mid-20th century.

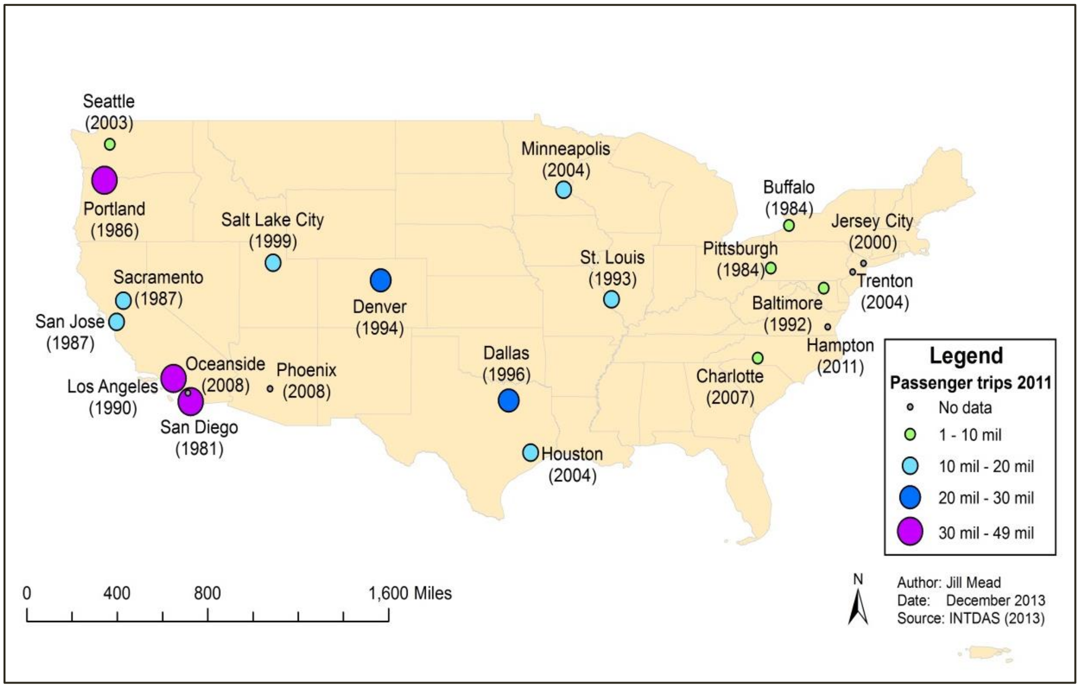

Figure 1. Second-generation light rail systems in the U.S.

Next to the bus, light rail is the most common form of public transportation system in the U.S. (INTDAS, 2013). Although the bus continues to provide the majority of public transportation in the U.S. (INTDAS, 2013), the considerable capital investment and extensive infrastructure involved in rail systems is assumed to create a perception of permanence that justifies individual or institutional long-term investment near stations. Since the 2005 enactment of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), the federal government has prioritized light rail projects which demonstrate greater potential for transit-supporting land use and local economic development effects (Arrington, 2003; Government Accountability Office, 2006). According to Kim and Lahr (2013), "the single thing that separates the current light-rail boom from the subway building era of the 1970s is that transit systems are now being designed not only to move commuters but to drive and shape urban (re)development" (p. 8).

Light rail systems are seen as having the potential to catalyze the (re)development of urban land in station areas because proximity to light rail stations has the potential to make these locations more desirable. For some individuals, proximity to light rail may decrease travel costs or travel time, making travel more efficient. For individuals who value the efficiency brought about by the proximity to light rail, access to light rail stations would be seen as an amenity afforded by a particular home or apartment, making it more attractive and therefore more valuable in monetary terms than locations more distant from the light rail station. It would be expected that the construction of a light rail system would increase demand for, and therefore the value of, properties in station areas. However, the positive effects of proximity to light rail must be weighed against any nuisance factors introduced by the presence of stations and tracks, such as noise or unwanted activity.

Although many municipalities have considered or utilized transit-oriented development strategies around light-rail stations, very few transportation agencies or municipal governments have conducted or funded analyses of how light rail investments affect station area property values. Although resources may be constrained for local governments and departments of transportation to conduct these types of studies, knowing the magnitude and location of positive price effects can provide valuable information useful for allocating resources. In cases where light rail access creates a price premium for station area land, municipalities can explore value capture strategies such as tax increment financing or public-private partnerships which help finance the cost of transportation infrastructure improvements. Likewise, the identification of specific benefits of light-rail construction can help build support for future rail transit expansions. However, it is important to note that land use policy and economic development incentives (including concurrent efforts to stimulate transit-oriented development), may also make station areas more attractive to potential residents, leading to increases in property values not attributable to transit alone.

The purpose of the present research is to understand whether the initiation of service on one light rail alignment, the MetroLink Blue Line, led to an increase in the sales price of single family homes within ¼ mile of stations in St. Louis County, Missouri. The first section of this paper consists of a review of prior studies of the effects of light rail systems on property values in the United States. The second section discusses the study area, data, and methodology, and the third section gives the results of the analysis. The paper closes with a discussion of the results and a conclusion.

II. Literature review

Methods of understanding land value changes due to transit

To date, researchers have studied whether proximity to light rail is associated with the value of single family homes adjacent to stations in 12 of the 21 cities with second-generation light rail systems. The majority of the studies use hedonic price analysis (HPA) to understand whether proximity to a light rail station is associated with an increase in the value of the home. The basic premise of hedonic price analysis is that the price of a composite good, such as housing, is related to the value of its attributes. Housing attributes include structural attributes, such as the age, size, condition, and material quality of the home, and locational attributes, which include neighborhood quality, municipal amenities such as school quality, and measures of access, including distance to employment centers (de Haan & Diewert, 2013). For the analysis, a model is created which statistically estimates the contribution of each attribute to the overall price of the home. When used to estimate the value of light rail access, a variable is added to indicate distance from the light rail station. A simplified example is given below.

$$\text{Price} = \beta_0 + \beta_1(\text{Area}) + \beta_2(\text{No. bedrooms}) \ldots \beta_{10}\ (\text{Distance to light rail}) + e$$

The value of β_{10} is then used to estimate whether proximity to light rail is associated with an increase in the price of the home and the monetary value of the increase or decrease in price.

More recently, researchers have introduced the use of repeat sales data or repeat sales analysis to understand how light rail access affects the sales price of single family homes. In the case of the former, researchers conduct hedonic price analysis as described above, but restrict the sample of home sales to those which have been sold twice or more times in a given study period (Kim & Lahr, 2013; Chatman, Tulach, and Kim, 2012). Although researchers still include housing attributes as variables in their model, the use of two data points from the same property allows them to control for unobserved (or unobservable) variables that affect the sales price of the home (Chatman, Tulach, and Kim, 2012).

Repeat sales analysis, a different method of analysis that also uses repeat sales data, was introduced in the 1960s as a method of understanding housing price change over time (Bailey, Muth, and Nourse, 1963), but remained relatively underutilized until the 1980s, when it was popularized by Case and Schiller, who modified the equation to introduce weighted time variables (Case & Schiller, 1987). Today, the weighted repeat sales method is used to compute the Federal Housing Finance Agency’s House Price Index as well as the Standard & Poor’s Case-Shiller Home Price Indices (Federal Housing Finance Agency, 2013; S&P Dow Jones Indices, 2013). Unlike hedonic price analysis, which produces a dollar value of each chosen housing attribute, the repeat sales analysis produces a housing price index which gives the change in the price of the housing sample relative to a reference time period.

The repeat sales method is less data intensive than the hedonic price analysis. Unlike the hedonic model, which necessitates a dataset including the attributes of homes and neighborhoods, the repeat sales method requires only data about the address, year and price of sale because each home serves as its own control in terms of structural and locational attributes (de Haan, 2013). As mentioned above, the use of each home as its own control also allows for better control of endogeneity (Chatman, Tulach, and Kim, 2012). One drawback of using repeat sales data in either hedonic price analysis or in the repeat sales method is that the analysis is restricted to only those properties which were sold more than once. A much larger sample of homes is necessary in order to obtain a sufficient sample size for analysis once zero- and single-sale homes are eliminated. If the homes that are sold more than once during the study period differ significantly from those sold once or not at all, there may be sample selection bias (Case & Schiller, 1987). Also, the assumption that each home is identical at both points of sale may not be realistic, due to the effects of depreciation or home improvements over time (de Haan, 2013). Some researchers address improvements in stock through the addition of dummy variables to indicate home improvements when such information is available; controlling for depreciation is more challenging (de Haan, 2013).

Prior studies of the effect of light rail on single family home values

Analyses of property values around light rail stations can be divided into two main groups: Earlier cross-sectional hedonic price analysis using sales data from the post-operations period only and more recent before-after studies, which use standard hedonic price analysis, hedonic price analysis with repeat sales data, or which use repeat sales data to construct a housing price index. These two groups of studies are described below.

Cross-sectional studies

Seven studies have used cross-sectional hedonic price analysis to understand the price effects of proximity to light rail stations in six cities. These studies use data about sales prices or assessed values collected from a single span of time after the system opened to determine whether a premium can be observed for parcels located closer to existing light rail stations. Peer-reviewed cross-sectional analyses have been conducted for light rail systems in San Diego (Duncan, 2008; Landis et al., 1995), Portland (Lewis-Workman & Brod, 1997), Buffalo (Hess & Almeida, 2007), San Jose (Landis et al., 1995), Sacramento (Landis et al., 1995), and St. Louis (Garrett, 2004). All of these light rail systems opened prior to 2000. Details about the methodology, data used, and results can be found in Table 1 below.

Table 1. Cross-sectional analyses of single family residential properties near light rail

Location	Study	Method	Data description	Results
San Diego, CA Opened 1981	Landis et al., 1995	Hedonic model including home characteristics, median household income, share of homeowners, and racial composition of census tract, network distance to station, and nuisance variables (proximity to freeway and tracks).	Analyzed the 1990 sales price of 1228 single-family homes in the San Diego Trolley's service area.	Within the City of San Diego, each meter closer to a San Diego Trolley station was associated with a home price increase of $2.72.
	Duncan, 2008	Hedonic model incorporating distance to rail, property characteristics, and neighborhood characteristics.	Analyzed the 1997-2001 sales prices of 4,970 single-family homes within 1 network mile of light rail stations.	A single-family home 1/4 mi from a station is worth about $11,800 more than one that is 1 mi from a station. The premium associated with proximity to a rail stations is estimated at about 5.7% for the average single-family unit.
Buffalo, NY Opened 1984	Hess & Almeida, 2007	Hedonic model which included property characteristics, neighborhood characteristics, and locational amenities.	Analyzed the property assessment values from 2002 of 7,357 single- and multi-family homes within ½ mile of light rail stations.	Positive proximity effects were observed for properties within ¼ mile of light rail stations in high-income neighborhoods (a premium of 2-5%, compared to Buffalo median home values), but this effect was not observed in low-income neighborhoods.
Portland, OR Opened 1986	Lewis-Work-man & Brod, 1997	Hedonic model including home characteristics (size of home and lot, age, and zoning) and network distance to light rail station	Analyzed the 1994 assessed value of 4,170 single-family homes within 1 mile of 3 Portland MAX light rail stations.	Possible contamination effect from presence of adjacent major arterial street. Positive proximity effects observed for properties at a distance between 2,500 feet and 1 mile of the transit line and major arterial. Assessed property values increased by $0.76 with every foot closer to light rail stations within the 2,500-5,280 foot range.
Sacramento, CA Opened 1987	Landis et al., 1995	Hedonic model including home characteristics, median household income, share of homeowners, and racial composition of census tract, network distance to station, and nuisance variables (proximity to freeway and tracks).	Analyzed the 1990 sales price of 1131 single-family homes in the Sacramento light rail system's service area.	No price effect was observed for any variables other than home size, age, and neighborhood income.
San Jose, CA Opened 1987	Landis et al., 1995	Hedonic model including home characteristics, median household income, share of homeowners, and racial composition of census tract, network distance to station, and nuisance variables (proximity to freeway and tracks).	Analyzed the 1990 sales price of 232 single-family homes in the San Jose light rail system's service area.	A negative price effect was observed. For every one meter increase in proximity to the nearest transit station, the value of the home decreased by $1.97. A potential explanation is the location of most transit stops in commercial and industrial neighborhoods.
St. Louis, MO Opened 1993	Garrett, 2004	Hedonic model incorporating household attributes, neighborhood characteristics, distance to tracks (nuisance effect), and distance to nearest light rail station in feet.	Analyzed 1,516 single-family homes in St. Louis County that were sold between 1998 and 2001. Used the sales price of properties.	Positive price effects were observed for properties within 2300 ft. of stations. For homes within ¼ of a station, an average increase in home value of $139.92 for every 10 feet closer was observed. From ¼ mile to 2300 ft. from the station, each 10 foot increase in distance from the station was associated with a decrease in property values of $69.50.

Although some positive associations have been observed in these studies, differences in methodologies and the geographic scope and magnitude of observed associations make drawing a definitive conclusion from their results difficult. For example, positive price effects were observed within ¼ mile of light rail stations in San Diego (Duncan, 2008), St. Louis (Garrett, 2004), and in Buffalo, although only for stations high-income neighborhoods (Hess & Almeida, 2007). However, in Portland and Sacramento, no effects of any kind were observed for properties within ¼ mile radius of stations (Lewis-Workman & Brod, 1997; Landis et al., 1995), and in San Jose, proximity to stations appeared to have a negative impact on single-family home prices (Landis et al., 1995).

A major weakness of these cross-sectional studies is that they do not provide information over how property values have changed over time because data is collected from a single point in time. Secondly, because the analyses do not compare property values from before and after the opening of the light rail system, it is also impossible to attribute changes in property values to the addition of transit. For example, it is possible that the corridor chosen for light rail construction was a valuable corridor prior to the installation of transit or that stations were placed in undesirable areas of the city. A third limitation is the use of property value assessments rather than sales data in two of the studies (Hess & Almeida, 2007, Lewis-Workman & Brod, 1997). Because a property assessment is an estimation based on the value of comparable homes, it does not adequately capture the price of composite goods as traded in a free market, which is one of the fundamental principles behind hedonic price analysis (Rosen, 1974).

Before-after studies

A number of more recent studies, published after 2010, have used residential property sales data collected from before and after the opening of the light rail line in order to better account for the time dimension. At present, seven before/after property value studies have been conducted for six second-generation light rail systems, all of which involve light rail systems that opened after 2000. Such studies have been conducted in Hudson County, New Jersey (Kim & Lahr, 2013), Houston, Texas (Pan, 2013), Phoenix, Arizona, (Golub, Guhathakurta, & Sollapuram, 2012), Charlotte, North Carolina (Yan, Delmelle, & Duncan, 2012; Billings, 2011), Trenton-Camden (Chatman, Tulach, & Kim, 2012), and Minneapolis (Goetz, Ko, Hagar, Ton & Matson, 2010) (Table 3). In general, sample sizes for these studies tend to be much larger than sample sizes for cross-sectional studies, with a mean sample size of 23,501 houses for before-after studies, compared to 2943 houses for cross-sectional studies. All results are summarized in Table 2 below.

Table 2. Before-after analyses of single family residential properties near light rail

Location	Study	Method	Data description	Results
Jersey City, NJ Opened 2000	Kim & Lahr, 2013	Hedonic price analysis using repeat sales (before/after).	Analyzed 13,599 sales of residential properties (1-4 units) in municipalities served by the Hudson-Bergen light rail that were sold at least twice between 1991 and 2009. Used network distances to nearest station.	Properties near urban commuting stations appreciated at an annual average rate of 18.4 percentage points higher than did other study-area properties. The appreciation premium dissipated completely within a quarter mile of the stations.
Trenton-Camden, NJ Opened 2004	Chatman, Tulach, & Kim, 2012	Hedonic price analysis using repeat sales (before/after).	Analyzed 31,470 sales prices of homes in four county region between 1989 and 2000. Final station area sample was 1922 units.	Net impact of the line on the owned housing market is neutral to slightly negative. While lower-income census tracts and smaller houses seem to appreciate near the station, this may be a value transfer from farther-away properties not favored with access.
Houston, TX Opened 2004	Pan, 2013	Hedonic & multi-level regression model (before/after).	Analyzed 36,622 sales prices of homes within a three mile buffer of light rail stations between 1983 and 2007.	The results from both models suggest that the opening of the light rail has had significant net positive effects on some residential property values (between 1 and 3 miles away). However, immediate proximity to light rail stations and bus stops has significant negative impacts on properties located within a quarter mile of rail stops.
Minneapolis, MN Opened 2004	Goetz, Ko, Hagar, Ton & Matson, 2010	Hedonic model, pretest-posttest with comparison group	Analyzed 3,514 sales prices of single-family homes between 1997 and 2007 within a ½ mile radius of stations.	Single family homes sold within a half-mile radius increased from 16.4 lower in price than control properties before station opening in 2004 to 4.2 percent more in the after period. Development of the Hiawatha Light Rail Line has produced an average $5,229 price premium per single family home in the station areas. Location closer to the LRT stations was associated with higher property values, an effect that extends beyond a half-mile. There is also a negative, nuisance effect for properties that are close to the LRT tracks, but the effect was of a smaller magnitude than the positive, accessibility effect.
Charlotte, NC Opened 2007	Yan, Delmelle, & Duncan, 2012	Hedonic price analysis (before/after).Semi-log regression.	Analyzed 6,381 sales prices of single-family homes within a one mile buffer (network distance) of light rail stations between 1997 and 2008. Analyzed four phases: pre-planning, planning, construction, and operation.	Proximity to light rail stations contributes modestly to variation in housing value, with effect not observed until operations phase. Evidence that homes closer to light rail were becoming more desirable over time, but not quantified.
	Billings, 2011	Hedonic price analysis with repeat sales (before/after) and comparison group.	Analyzed 14,162 sales prices of single-family homes within a one mile buffer of light rail stations between 1994 and 2008, compared to the values of homes in control areas.	The significant hedonic estimates generated impacts between +4.0% and +10.6%. The estimated repeat sales coefficients indicated that single-family properties located in LRT neighborhoods experienced 4.6% higher appreciation rates.
Phoenix, AZ Opened 2008	Golub, Guhathakurta, & Sollapuram, 2012	Hedonic price analysis (before/after). Log-log regression.	Analyzed 88,308 sale prices of single family houses (adjusted using HPI) between August 1988 and September 2010 in a two mile buffer around stations and tracks. Analyzed four phases: NEPA review, planning, construction, and operation.	Observed a nuisance effect at distances within 200 feet of tracks, but value per square foot increases with proximity at distances greater than 200 feet. The value of the average unit at 200 foot distance is $101/sq. ft., falling to about $54/sq. ft. at 10,000 foot distance.

Similar to the cross-sectional studies, results of before and after studies vary by direction and magnitude of observed effect, geographical scope of effect, and presence, absence, and extent of nuisance effects. For example, Kim & Lahr (2013) found positive effects for properties near urban commuting stations, but only within ¼ mile of the station. In contrast, Pan (2013) found a negative effect on properties within ¼ mile of the station, with benefits beginning to accrue for homes between 1 and 3 miles away. In contrast to Hess and Almeida (2007), where property values appreciated only in high-income neighborhoods in Buffalo, Chatman, Tulach, and Kim (2012) observed positive effects in lower-income census tracts, but neutral and negative results elsewhere.

Although these seven studies made use of sales data from before and after the opening of the light rail line, different methods were used to analyze the data. Two studies used time series variables in standard hedonic price analysis to account for pre-planning, planning, and construction stages (Yan, Delmelle, and Duncan, 2012; Golub, Guhathakurta, and Sollapuram, 2012). Two studies made use of comparison groups in their analysis (Goetz, Ko, Hagar, Ton & Matson, 2010; Billings, 2011), four used continuous distance variables (Kim & Lahr, 2013; Chatman, Tulach, & Kim, 2012; Yan, Delmelle, and Duncan, 2012; Golub, Guhathakurta, and Sollapuram, 2012), and one used categorical distance variables (Pan, 2013) to compare groups of properties at varying distances from the light rail stations. Three studies used repeat sales data (Kim & Lahr, 2013; Chatman, Tulach, & Kim, 2012; Billings, 2011). Kim and Lahr (2013) and Chatman, Tulach, and Kim (2012) used repeat sales data in the creation of a hedonic model, and Billings (2011) compared the results of the repeat sales analysis to the results of a standard hedonic model. Pan (2013) analyzed the same data using hedonic analysis and multi-level regression and compared the results. In the case of the latter two studies, the repeat sales method and multi-level regression were observed to give more conservative results than hedonic regression techniques. Overall, the strongest studies used data from both before and after the initiation of light rail service, as well as comparison groups to control for unobserved variables, such as regional macroeconomic conditions (Goetz, Ko, Hagar, Ton & Matson, 2010). However, creating two sets of homes that are similar in every attribute save access to light rail can prove a challenge for researchers undertaking these types of studies.

In summary, the theme that emerges from the previous 14 studies is the great variability in research design, data sources, methods, and the variables included in the models. Results of the 14 studies are similarly varied by magnitude of effect and distance from the station, with some studies reporting price effects within ¼ or ½ mile and others reporting neutral or negative effects at these distances or positive effects at greater distances. In two cases, results varied with the socioeconomic characteristics of the study neighborhoods. The lack of standardization across studies makes drawing a definitive conclusion about the effects of light rail access on single-family home price difficult, and it is difficult to disentangle the effects of study design from the differences stemming from the local context, but it is clear that there is considerable interest in understanding the topic as well as the need for further research.

III. Methodology & Data

The analysis was restricted to parcels in St. Louis County, Missouri due to the availability of complete records. Likewise, an insufficient number of sales records from the period before the 1993 opening of the Red Line limited the analysis to the 9 Blue Line stations opened in 2006. Based on the availability of a sufficient number of paired sales to conduct the analysis, the repeat sales method was chosen to understand how proximity to light rail may have affected the value of single-family homes in St. Louis County. This method was chosen in order to control for the heterogeneity of the sample, which represents properties from nine municipalities and six school districts, as well as a wide range of socio-economic conditions.

Study area

The city St. Louis, population 318,527 forms the core of the St. Louis, Missouri-Illinois metropolitan statistical area (MSA) (U.S. Census Bureau, 2014a). The St. Louis, MO-IL MSA's population of 2,108,634 places it 19th in population among U.S. cities (U.S. Census Bureau, 2014b). Like many U.S. cities, public transportation in St. Louis was initially provided by privately-operated companies. A shift from private to public transit provision took place in 1963, when the Bi-State Development Agency purchased transit facilities from private operators and assumed responsibility for planning and operating regional transit (Metro, n.d.). In 1987, the East-West Gateway Coordinating Council (EWGCOG), the region's metropolitan planning organization, formally recommended the creation of a light rail system as part of a regional light rail and bus transit network (Metro, n.d.).

In 1993, St. Louis became the ninth city to open a second-generation light rail system. Construction of the MetroLink began in 1990 and the first segment, consisting of 16 stations extending 14 miles from St. Louis County, Missouri to St. Clair County, Illinois, opened in July 1993. In 1998, construction began in order to expand the alignment by 17.4 miles in St. Clair County, and operations began at 8 new stations in 2001 (Kwame, n.d.). In addition to major extensions, stations were added in 1994 (2), 1998 (1), 2001 (1), and 2003 (1). In 2008, the line was renamed the Red Line. Today, the Red Line follows the route established by the original alignment and its 2001 extension. The Blue Line, described below, serves the Cross County extension and overlaps with the middle portion of the route served by the Red Line (see Figure 2).

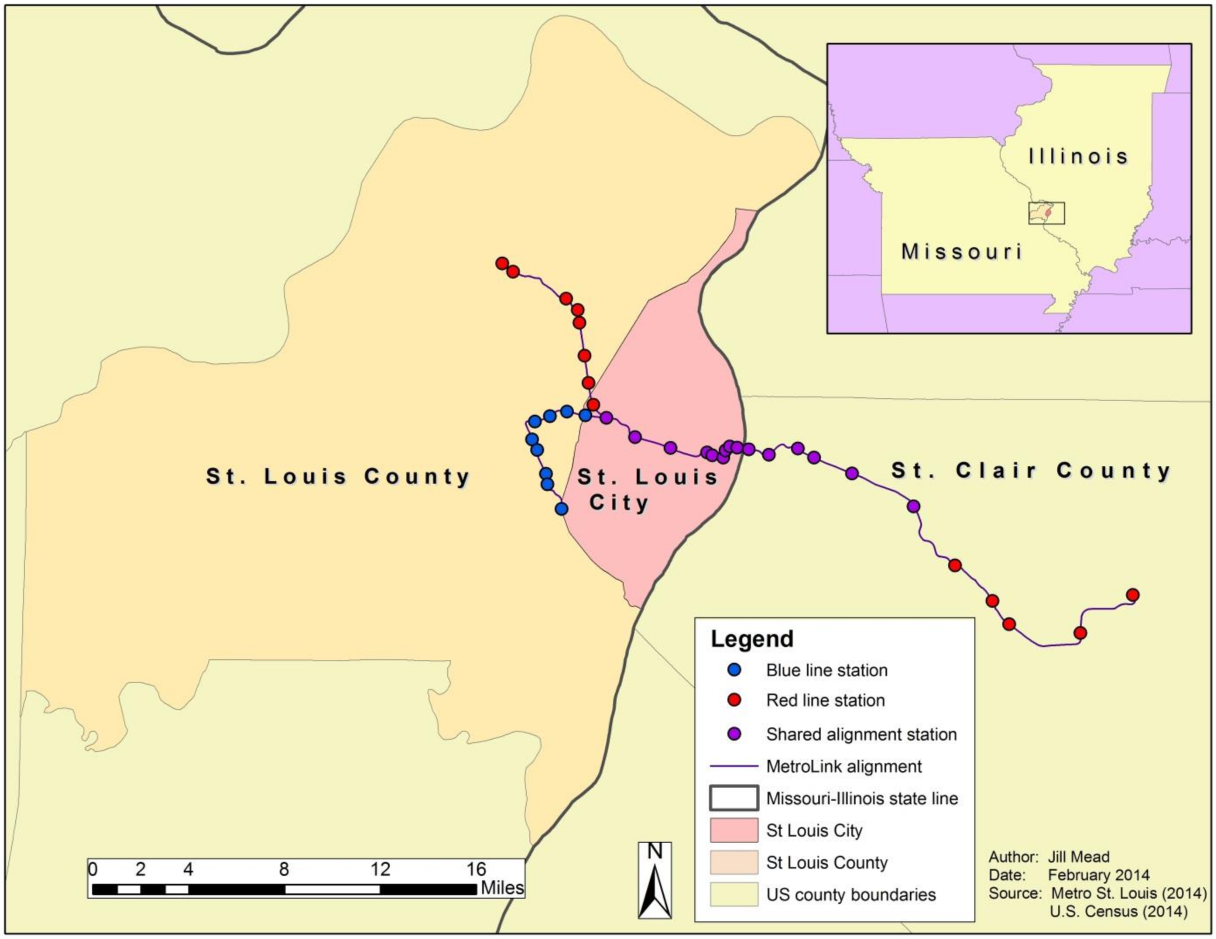

Figure 2. MetroLink alignment (2014).

The focus of the present analysis is the third major expansion of the MetroLink, originally called the Cross County extension and renamed the Blue Line in 2008. Planning for the extension began in 1991 with the identification of the corridor as a priority extension by the EWGCOG. The East-West Gateway Board selected the preferred alignment and conceptual design in 1999. In 2001, Metro Board of Commissioners released the official timeline for completion and budget of $550 million (Montee, 2008). The project was funded locally, using revenue collected in St. Louis City and St. Louis County through the Proposition M ¼ cent sales tax. Construction began in 2003, and the alignment opened on August 26, 2006, 15 months later than the May 2005 projected completion date. The Blue Line extended the MetroLink 8.2 miles into St. Louis County and added 9 new stations to the network (Montee, 2008). Most of the extension was built at-grade, with some subsurface segments and two underground stations.

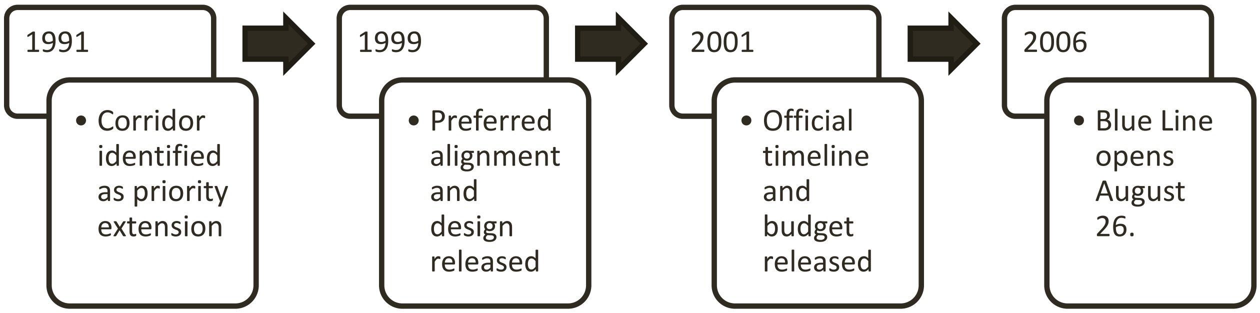

Figure 3. Major milestones in the completion of the Blue Line

It is common for light rail systems to use existing rail right of way. The Blue Line is unique in that the northern half of the alignment passes largely at-grade through a series of neighborhoods originally served by streetcar lines in the first half of the 20th century. For this portion of the alignment, new rail was built. However, the north-south portion of the line beyond Clayton Station uses mostly existing railroad right-of-way. As seen in Figure 4, the station areas located on that portion of the alignment, between Richmond Heights-Galleria and Sunnen, are home to larger parcels and a greater amount of industrial land use. Though placing light rail lines in formerly industrial or low-rent corridors is much less expensive, this practice also challenges attempts to integrate light rail stations with existing residential or commercial land uses, as has been observed in Charlotte, St. Louis, and Minneapolis (Yan, Delmelle, & Duncan, 2012; Goetz, Ko, Hagar, Ton & Matson, 2010). However, experience with streetcar projects in cities such as Portland and Seattle indicates that underutilized or unused industrial land is also easier to alter or repurpose than residential neighborhoods and may therefore have greater development potential, although it should be noted that successful repurposing projects generally take place in a context of economic growth and high demand (Brookings Institution, 2009).

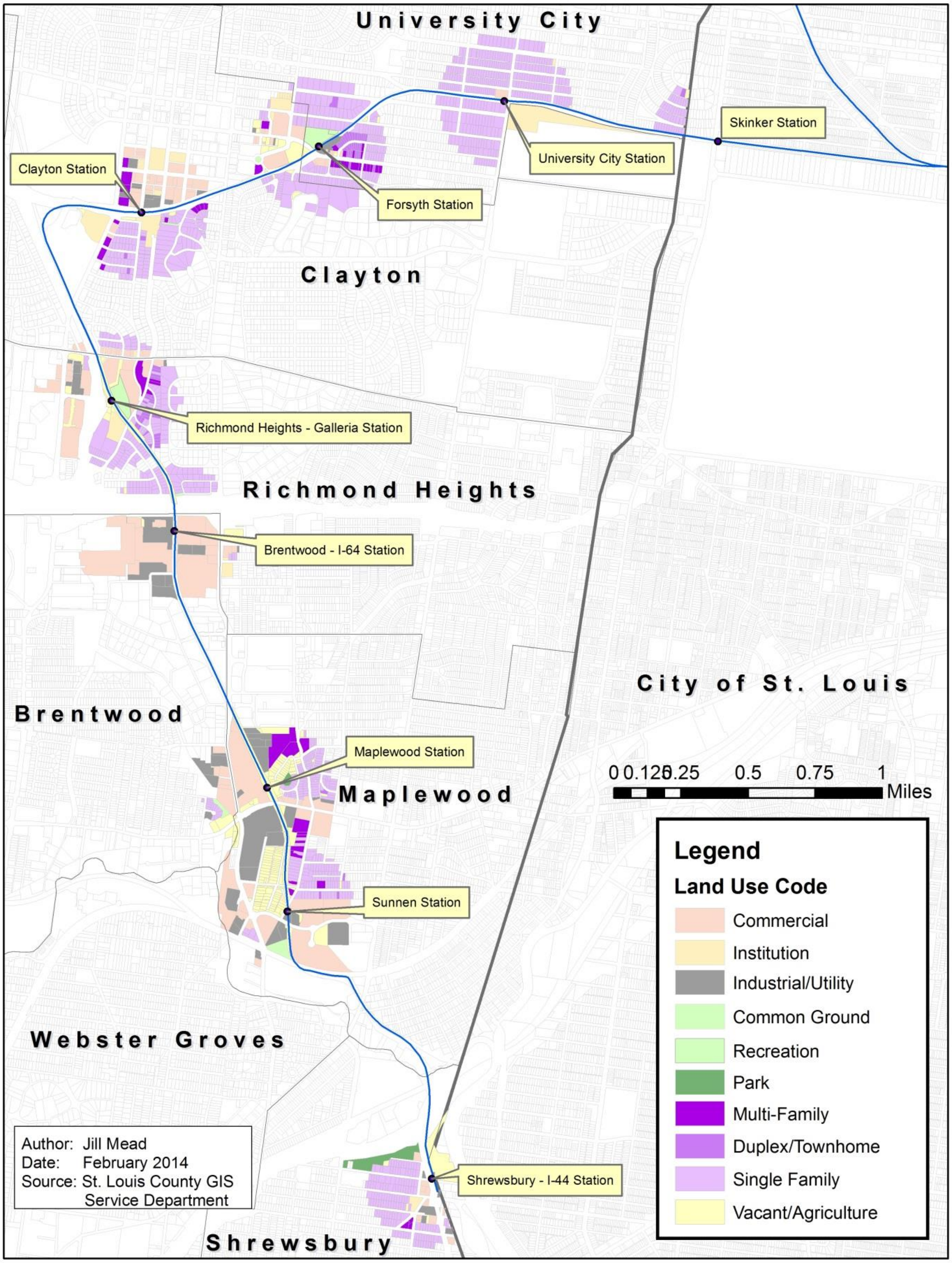

Figure 4. Blue Line station area zoning

Today, the MetroLink system consists of 37 stations on 46 miles of track. In 2011, MetroLink provided 16,209,098 passenger trips, making it the 7th most heavily-used second generation light-rail system in the U.S. (INTDAS, 2014). The question of whether light rail access has a positive effect on property values in St. Louis is particularly relevant. The 20th anniversary of the opening of the original light rail system in summer 2013 spurred a broader discussion of its impact on regional transportation and local economic development (Phillips & Lloyd, 2013). Since 2011, the Economic Development division of Metro has undertaken TOD planning around 37 MetroLink stations (Metro, 2013). At the same time, two local streetcar projects, one proposed (downtown) and one underway (the Loop Trolley), have also launched a dialog about the economic development effects of fixed guideway projects in general (Logan, 2012). In spite of this interest, only one study of the effects of rail projects on property values in St. Louis has been published (Garrett, 2004).

Data

A dataset containing St. Louis County shapefiles and parcel data was obtained from the St. Louis County GIS Service Center. Although previous studies yielded contradictory findings about the effects of light rail within ¼ mile of stations, it was assumed that any price effects of light rail access would be strongest within ¼ mile of MetroLink stations because these locations offered the greatest ease of access for pedestrians. It was assumed that effects would be weaker at distances greater than ½ mile. Two datasets of interest were created using ArcMap (ESRI, 2010): a set of single-family properties within ¼ mile of Blue Line stations (n = 1285) and a control set of single-family properties within ¾ and 1 mile of Blue Line stations (n = 4579) (see Figure 5 below). Properties within a half-mile of stations from the 1993 Red Line were excluded from the analysis. The corresponding *Property and Sales* record for each parcel, containing data about home attributes and sales, was obtained from the St. Louis County Department of Revenue in December 2013.

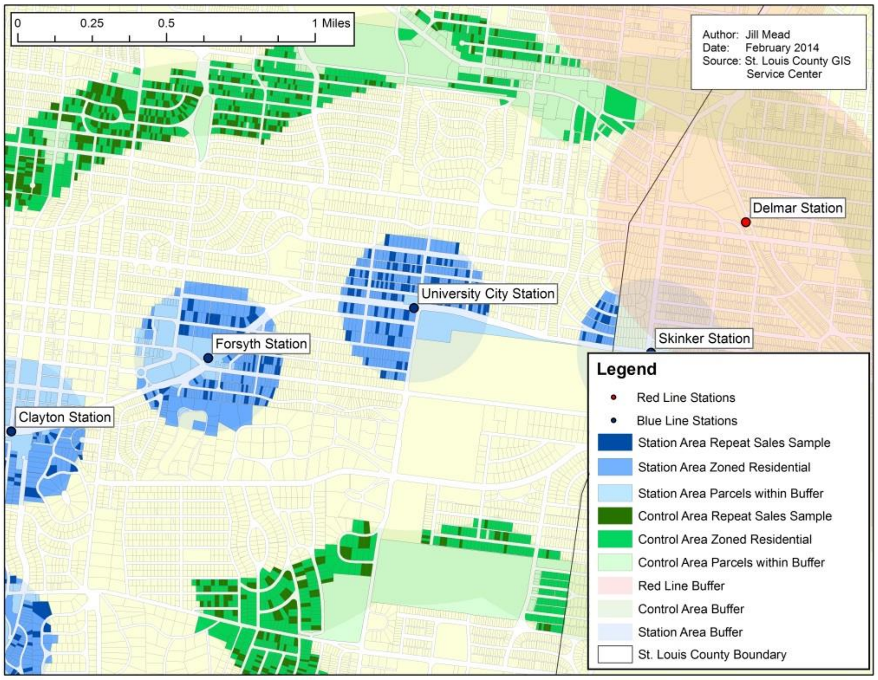

Figure 5. Portion of study area showing selection of parcels

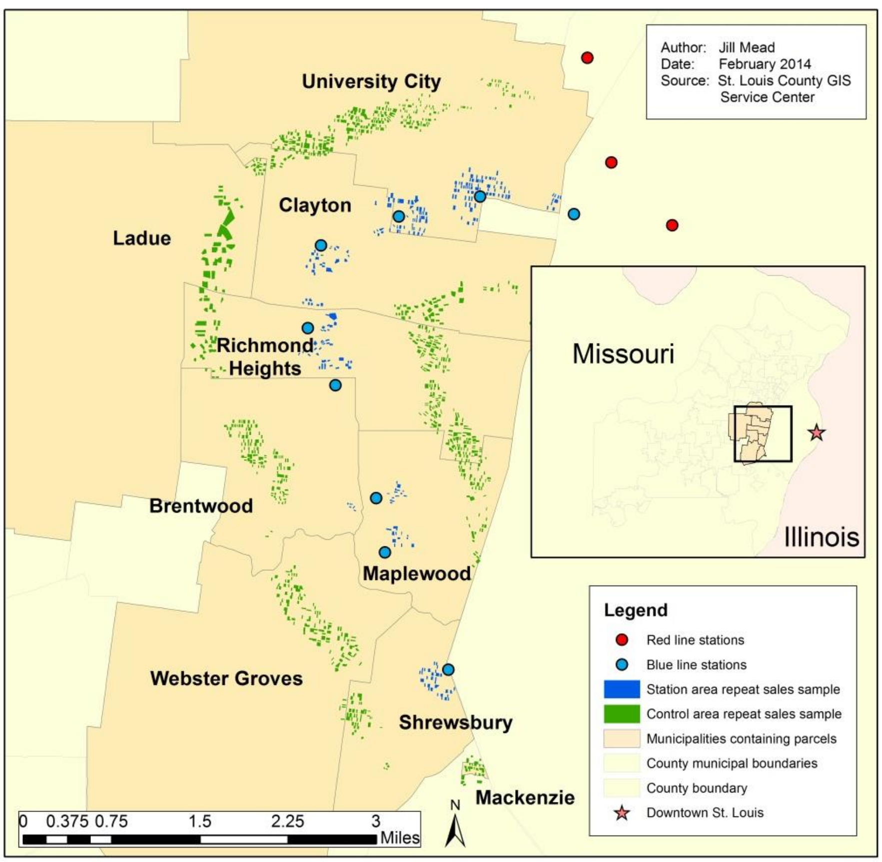

Figure 6. Spatial distribution of the homes in the repeat sales sample

A study period of 1990 to 2012 was selected to compare differences in the prices of station area and control area homes from both before and after the August 2006 opening of the MetroLink Blue Line. Therefore, each home in the sample was categorized according to the recorded number of valid sales (*Sale Type*: Land and Building and *Sale Validity Code*: "X –Valid Sale") between 1990 and 2012. Sales of homes from the station or control area that had two valid sales in two different years between 1990 and 2012 were included in the repeat sales analysis. The final sample consisted of 515 paired sales from 336 station area homes and 2212 paired sales from 1349 control area homes, for a total of 2727 paired recorded sales from 1685 homes, or 28.7% of all study area homes. Table 3 below gives the composition of the sample by number of valid sales between 1990 and 2012, analysis group (excluded or included properties), and study area (station or control).

Table 3. Composition of sampled properties.

	Station area	Control area	Total
Excluded properties	**949** ***16.2%***	**3230** ***55.1%***	**4179** ***71.3%***
Never sold	*556* *9.5%*	*1927* *32.9%*	*2483* *42.3%*
Sold once only	*393* *6.7%*	*1295* *22.1%*	*1688* *28.8%*
Sold more than once in the same year	*0* *0%*	*8* *0%*	*8* *0%*
Included properties	**336** ***5.7%***	**1349** ***23.0%***	**1685** ***28.7%***
All single-family residential properties	**1285** ***21.9%***	**4579** ***78.1%***	**5864** ***100.0%***

A dataset of the home attributes of all study area single-family homes was created in order to determine whether there were any significant differences between the homes that were included in the repeat sales analysis and those that were excluded. T-tests and chi-square tests were conducted to understand whether there was a significant difference between the two sets of properties with respect to network distance from the central business district (calculated using ArcMap 2010), number of stories, age, number of bedrooms, number of bathrooms, floor area, condition, desirability, and utility score (CDU)[1], exterior wall material, and presence of a basement, central heat, garage, deck, or pool.

[1] According to the St. Louis County Department of Revenue, the "C.D.U. (Condition, Desirability, Utility) code is a rating which is intended to reflect judgment of the physical condition of a dwelling considering its age and the level

Methodology

The basic model of the repeat sales index is:

ln $(P_2\text{-}P_1) = \beta_0 + \beta_{1\ldots}\ \beta_n$(Time series variables) + *e*

For each sales pair, the value of the time series value will be -1 for the period of the first sale (P_1), 1 for the period of the second sale (P_2), and 0 otherwise (de Haan, 2013). One time period is excluded from the model and serves as the index time period. The coefficients of the time series variables give the percent difference the price of the good in question for that time period when compared to the index time period. The basic repeat sales model produces a single index of sales prices over time. To study the role of a particular attribute, for example, proximity to transit, interaction variables (time series value*attribute) are added to the above model. The resulting coefficients of the interaction variables give the percent difference in price between the good with the attribute (or one unit of the attribute, e.g. distance in miles from transit) relative to the overall price index (McMillen & McDonald, 2004).

For the purposes of this analysis, the time period 1990-2012 was divided into years, with the exception of the year 2006, which was divided into 2006a (pre-opening) and 2006b (post-opening) time periods. Consistent with de Haan (2013), time dummy variables of -1 (year of first sale), 1 (year of second sale), and 0 (no sale) were assigned to the time series variables of each sales pair. To study the effects of proximity to light rail, a station area dummy variable was created, and an interaction variable (time series variable*station area dummy variable) was added to the model. Results were indexed to 1990, the first year of the analysis time period.

The final repeat sales model was modified to incorporate four controls for common weaknesses of the model. First, in order to control for differences between properties that made up the repeat-sales sample and the properties that were excluded from analysis, the structural attribute variables that varied significantly between the two groups were included in the model (see the *Results* section for a discussion of these variables). Second, to address the issue of homes that were improved between the two sales dates, three dummy variables were included to account for renovations, garage additions, or pool additions that took place between sales as recorded in the *Property and Sales* record. Third, to account for autocorrelation as a result of the inclusion of multiple records from homes with more than one sales pair, errors were clustered using each property's unique identifier.

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of maintenance that is normally expected in a dwelling given that age. C.D.U. condition ratings are established for all residential properties and are based on appraisal experience as well as judgment.[…]." C.D.U. ratings consist of the following: Unsound [1], Very Poor [2], Poor [3], Fair [4], Average [5], Good [6], Very Good [7] and Excellent [8].

$$\ln(P_2 - P_1) = \beta_0 + \beta_{1990\ldots}\ \beta_{2012} + \beta_{\text{station area dummy}} + \beta_{1990*\text{station area dummy}\ldots}\ \beta_{2012*\text{station area dummy}} + \beta_{\text{structural attribute1,2,3, etc}} + \beta_{\text{renovationdummy1,2,3, etc}} + e$$

To address the heteroskedacity of the error term, each observation was weighted using the method described in Ambrose, Coulson, & Yoshida (2013). The original model was estimated using ordinary least squares regression, and the squares of the residuals were calculated. These were then regressed using the number of years between sales and the squared number of years between sales. The square root of the fitted values of this equation were then used as weights in the computation of the original equation, which produced a weighted repeat sales index (Ambrose, Coulson, & Yoshida, 2013).

IV. Results

Table 4 below gives a summary of housing characteristics across the entire sample of single family homes used in this analysis. All variables were drawn from the *Property and Sales* record of each property, with the exception of "Distance," which was calculated using ArcMap (ESRI, 2010).

Table 4. Descriptive statistics, all properties

Variable	**Description**	**Entire sample n = 5864**
		Mean value (95% confidence interval)
Distance	Network distance to CBD (miles)	8.46 (8.44-8.48)
Stories	Number of stories	1.52 (1.51-1.54)
Age	Age of home (years)	76.66 (76.15-77.17)
Bedrooms	Number of bedrooms	3.15 (3.12-3.17)
Baths	Number of bathrooms	1.91 (1.89-1.94)
Area	Floor space in sq. ft.	1983 (1958-2008)
CDU	"Condition, desirability, and utility" assessment	6.32 (6.29-6.35)
		Proportion
Brick	Brick exterior	72.7%
Basement	Basement	94.9%
Heat	Central heat	76.3%
Garage	Garage	56.7%
Pool	Pool	4.4%

Table 5 below gives the results of t-tests and chi-square tests conducted to understand whether there were significant differences between homes in the repeat sales groups and homes that were excluded from the repeat sales groups. The two groups of homes did not vary significantly by distance to downtown, number of stories, age, number of bathrooms, or the presence of a pool. However, single family homes in the repeat sales group were significantly more likely to have fewer bedrooms, a smaller floor area, brick exterior walls, a basement, central heating, and a garage, as well as be in a better condition as measured by property assessors. As a result, these variables were included in the repeat sales model.

Table 5. Characteristics of repeat and non-repeat sales subsamples

Variable	Description	Repeat sales group n = 1685	Non-repeat sales group n = 4179	Difference between subgroups significant at 0.05?
		Mean value (95% confidence interval)		**T-tests**
Distance	Network distance to CBD (miles)	8.46 (8.42-8.51)	8.46 (8.43-8.49)	No
Stories	Number of stories	1.52 (1.50-1.55)	1.52 (1.51-1.54)	No
Age	Age of home (years)	75.95 (75.00-76.90)	76.95 (76.34-77.56)	No
Bedrooms	Number of bedrooms	3.07 (3.03-3.12)	3.17 (3.14-3.21)	Yes
Baths	Number of bathrooms	1.90 (1.86-1.95)	1.92 (1.89-1.95)	No
Area	Floor space in sq. ft.	1926 (1881-1971)	2006 (1976-2036)	Yes
CDU	"Condition, desirability, and utility" assessment	6.65 (6.60-6.71)	6.19 (6.15-6.23)	Yes
		Proportion		**Chi-square tests**
Brick	Brick exterior	75.4%	71.6%	Yes
Basement	Basement	96.5%	94.3%	Yes
Heat	Central heat	78.0%	75.6%	Yes
Garage	Garage	60.2%	55.4%	Yes
Pool	Pool	3.9%	4.6%	No

Figure 7 below shows the frequency distribution of the number of valid sales per home within the 1990-2012 study period. A t-test comparison of average sales between the station area and control area groups indicated that control area groups had a significantly higher number of sales per home. However, this was not expected to bias the analysis.

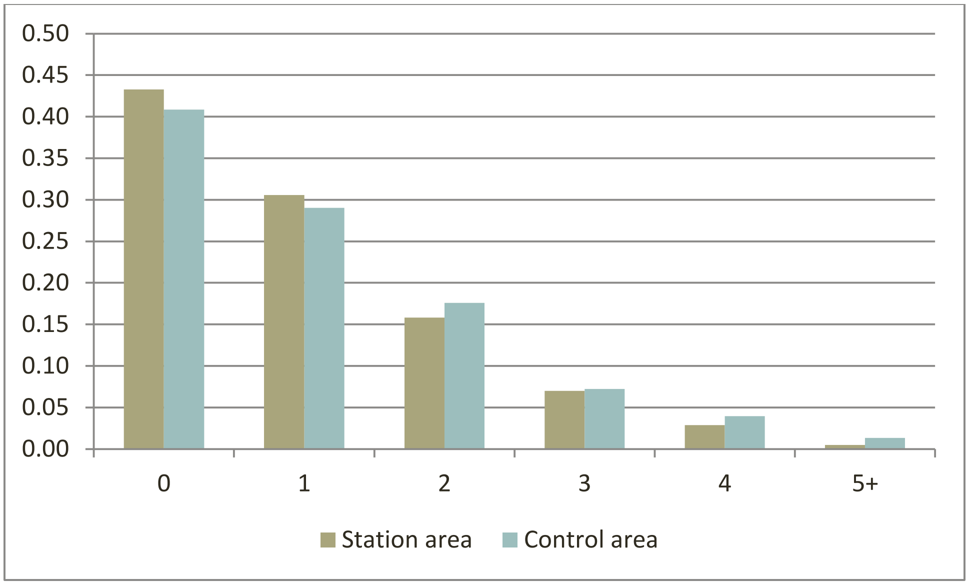

Figure 7. Number of sales by frequency, station area and control area

Results of the regression model are shown in Table 6. The coefficients, 95% confidence intervals, t-statistics, and p values are shown for all of the variables included in the model: time series variables 1990-2012, station area and time series inter action variables 1990-2012, the station area identifier variable, the three remodeling variables (general remodel, added garage, and added pool), and the seven variables to control for attributes (number of bedrooms, floor area, “condition, utility, and desirability,” brick exterior, basement, central heating, and garage). It is important to note that none of the interaction coefficients were statistically significant at 0.05.

Table 6. Results from the repeat sales regression model, N = 2727 sales pairs

Variable	Coefficient	95% Confidence intervals	t-statistic	p value
t1991	0.04	-0.01, 0.10	1.48	0.14
t1992	0.06	0.01, 0.12	2.19	0.03
t1993	0.09	0.03, 0.15	2.95	0.00
t1994	0.10	0.04, 0.16	3.28	0.00
t1995	0.13	0.07, 0.19	4.30	0.00
t1996	0.21	0.14, 0.27	6.58	0.00
t1997	0.22	0.16, 0.29	6.57	0.00
t1998	0.32	0.26, 0.38	10.12	0.00
t1999	0.42	0.35, 0.48	12.43	0.00
t2000	0.50	0.43, 0.57	14.50	0.00
t2001	0.55	0.48, 0.63	15.09	0.00
t2002	0.66	0.59, 0.73	18.53	0.00
t2003	0.74	0.67, 0.81	20.02	0.00
t2004	0.80	0.73, 0.87	21.65	0.00

Variable	Coefficient	95% Confidence intervals	t-statistic	p value
t2005	0.87	0.77, 0.93	18.27	0.00
t2006a	0.89	0.80, 0.99	18.08	0.00
t2006b	0.81	0.72, 0.89	19.15	0.00
t2007	0.85	0.77, 0.93	20.12	0.00
t2008	0.78	0.69, 0.87	16.97	0.00
t2009	0.80	0.70, 0.89	16.11	0.00
t2010	0.80	0.70, 0.89	16.78	0.00
t2011	0.73	0.62, 0.84	13.05	0.00
t2012	0.67	0.57, 0.76	13.43	0.00
station area	-0.02	-0.06, 0.02	-1.01	0.31
station area*1990	0.04	-0.09, 0.17	0.60	0.55
station area*1991	-0.11	-0.28, 0.06	-1.27	0.21
station area*1992	-0.02	-0.15, 0.10	-0.37	0.71
station area*1993	-0.03	-0.14, 0.09	-0.42	0.67
station area*1994	0.00	-0.12, 0.12	-0.06	0.96
station area*1995	-0.02	-0.14, 0.10	-0.31	0.76
station area*1996	-0.04	-0.15, 0.07	-0.72	0.47
station area*1997	0.02	-0.10, 0.13	0.31	0.75
station area*1998	-0.01	-0.11, 0.09	-0.13	0.90
station area*1999	0.00	-0.10, 0.10	0.03	0.97
station area*2000	0.01	-0.09, 0.11	0.20	0.84
station area*2001	0.04	-0.07, 0.14	0.66	0.51
station area*2002	-0.03	-0.12, 0.06	-0.64	0.52
station area*2003	0.00	-0.09, 0.10	0.09	0.93
station area*2004	0.00	-0.09, 0.09	-0.07	0.95
station area*2005	-0.02	-0.12, 0.07	-0.47	0.64
station area*2006a	-0.02	-0.14, 0.09	-0.39	0.70
station area*2006b	0.02	-0.09, 0.12	0.32	0.75
station area*2007	-0.01	-0.11, 0.09	-0.16	0.88
station area*2008	0.08	-0.02, 0.18	1.60	0.11
station area*2009	0.05	-0.08, 0.17	0.78	0.44
station area*2010	-0.01	-0.12, 0.10	-0.18	0.85
station area*2011	0.03	-0.10, 0.16	0.49	0.63
station area*2012	0.18	-0.06, 0.42	1.46	0.15
remodeled	0.09	0.00, 0.18	2.03	0.04
addedgarage	0.15	0.05, 0.26	2.82	0.01
addedpool	0.15	-0.31, 0.61	0.63	0.53
bedrooms	0.01	0.00, 0.03	1.59	0.11
area	0.00	0.00, 0.00	0.93	0.35
cdu	-0.01	-0.02, 0.00	-1.62	0.11
brick exterior	-0.01	-0.04, 0.01	-0.87	0.39

Variable	Coefficient	95% Confidence intervals	t-statistic	p value
basement	0.00	-0.09, 0.10	0.02	0.98
heat	0.00	-0.02, 0.03	0.33	0.74
garage	0.00	-0.02, 0.02	0.30	0.76
constant	0.04	-0.10, 0.18	0.59	0.55
R^2				0.585

To facilitate interpretation, a housing price index was created using the dummy variables estimated from the repeat sales data. Figure 8 below shows the housing price index for all 5864 repeat sales properties in the station and control areas. Housing prices reach their peak in 2006, before the opening of the Blue Line on August 26, 2006 (2006a indicates the period before the Blue Line opened, while 2006b is the period after). It is important to note that the sales prices in this analysis were not adjusted for inflation, so this index also includes the effects of inflation on housing price during this time period. Figure 9 below shows the number of observations used to create the index of all properties, as well as the subset of observations used to analyze the difference between station area properties and the entire sample. As expected, there are a greater number of observations from the middle eight years of the sample, where a greater number of first and second sales overlap. A marked decrease in both the housing price index and the number of sales is observed in the years following the collapse of the housing bubble beginning in 2007. The trajectory of the housing price index mirrors the housing price index of the St. Louis MO-IL MSA, that shows a steady increase in prices from 1990-2007, with a trend of decreasing prices in the 2008-2012 period (Federal Reserve Bank of St. Louis, 2014).

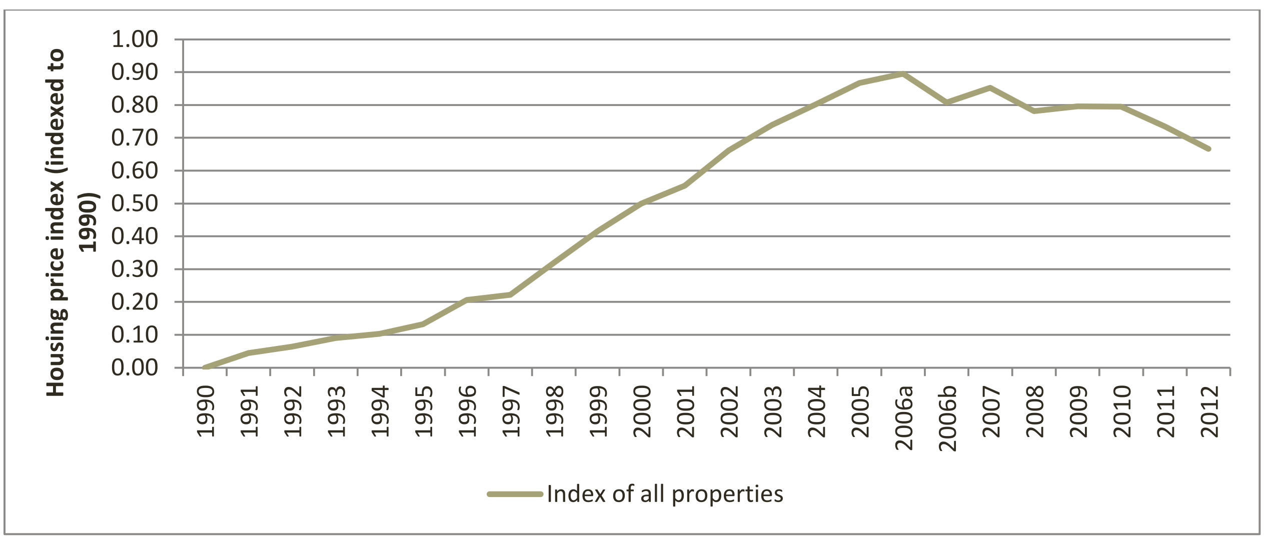

Figure 8. Repeat sales housing index, all properties, indexed to 1990

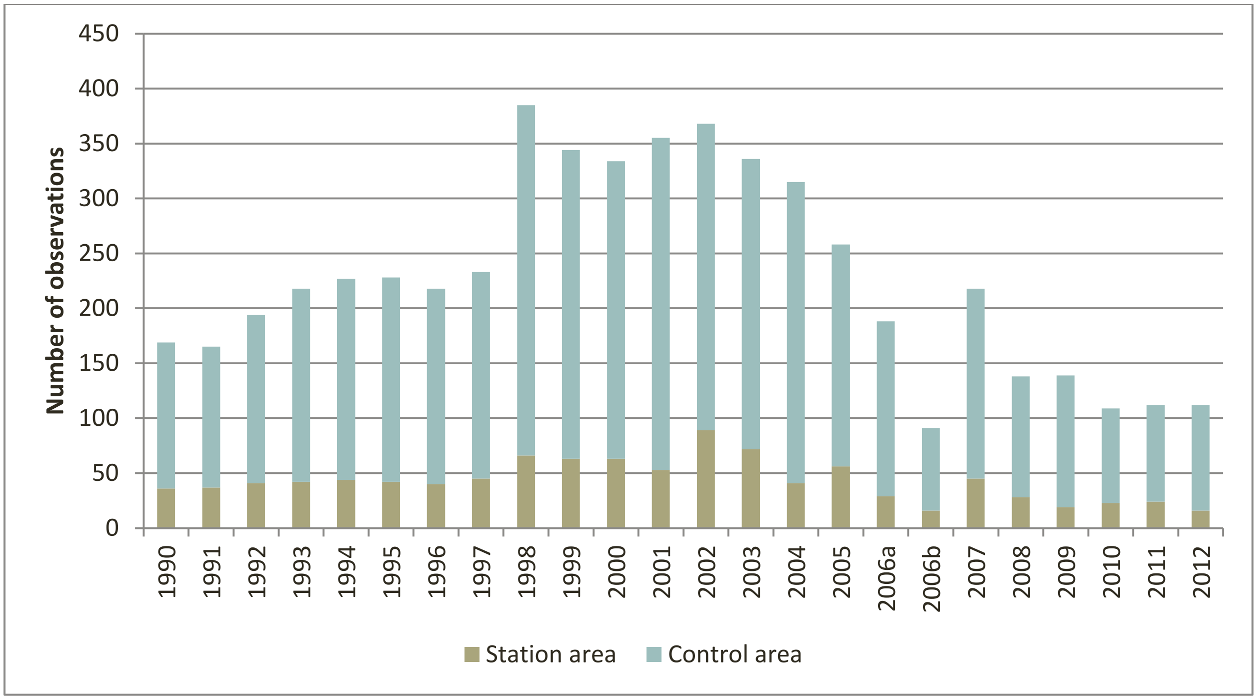

Figure 9. Number of properties sold by year.

The graph below (Figure 10) shows the percent difference in price between the station area homes and the index for all repeat-sales homes shown in Figure 8. Between January 1, 1990 and December 31, 1998, homes in station areas sold for an average of 1.9% less than all homes in the sample. From January 1, 1999, when the preferred alignment was selected, until August 26, 2006, when the Blue Line was opened, station area homes sold for an average of 0.3% less. From August 26, 2006 until December 31, 2012, single-family homes in station areas sold for an average of 4.9% more than all homes in the sample. This price change is in contrast to the all-property index, which increased every year from 1990, peaking in the 2006 pre-opening period, before decreasing in 3 of the 6 years following the opening of the Blue Line. However, as shown in Figure 10 by the 95% confidence intervals, none of the differences in any of the years were statistically significant.

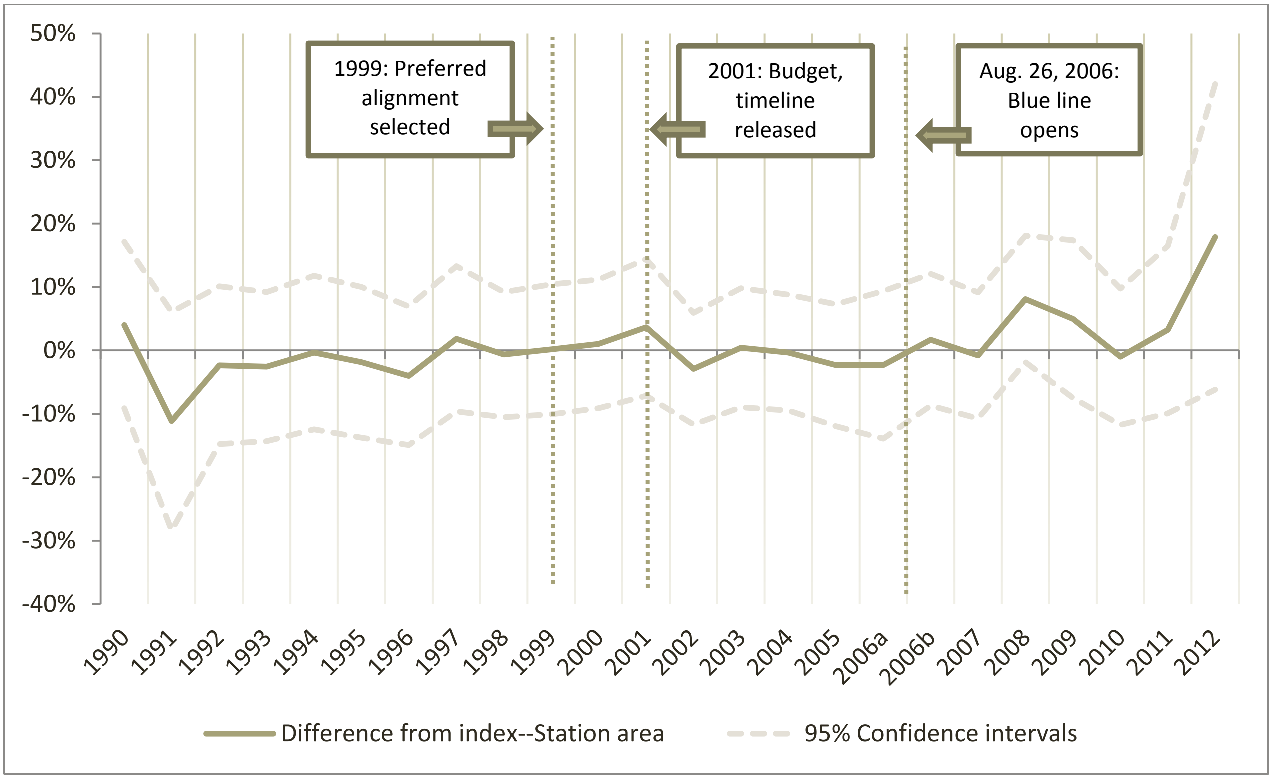

Figure 10. Sales price of station area properties relative to all properties

V. Discussion

This study was the first of its type to study the change in property values around St. Louis MetroLink stations using data from before and after the initiation of service. Likewise, it is the first to use a control group, and the first to use repeat sales in the creation of a housing price index to analyze price differences in station areas. Though no statistically significant results were observed, the positive trend in station area housing prices following the opening of the Blue Line in 2006 is encouraging, especially in light of the overall decrease in housing prices in the entire sample and in the MSA as a result of the 2007-2012 financial crisis. The increase in the sales price of station area homes relative to all analyzed repeat sales home may indicate increased demand for homes within ¼ mile of Blue Line stations.

It should be noted that three modifications to the sampling procedure might yield different results. First, a ¼ mile straight-line radius of stations was chosen as an easily walkable distance for transit access. However, defining network distance to stations might be a more realistic measure, although it would be expected to decrease the number of properties in the station area sample. Second, it is possible that the effects of station access might be felt at greater distances than ¼ mile. Two prior before-after studies in Minneapolis and Charlotte observed price premiums as far as a ½ mile from stations (Billings, 2011; Goetz, Ko, Hagar, Ton & Matson, 2010). A third before-after study in Jersey City indicated that price premiums dissipated beyond ¼ mile and in Houston, the opposite was observed negative effects were observed for properties within ¼ mile of stations, with positive effects observed at greater distances (Kim & Lahr, 2013; Pan, 2013). Therefore, it is possible that enlarging the station radius to ½ mile could change the intensity of the observed effect. Third, the method of selecting control properties could influence results. It is possible that positive effects are observed at a distance of ¾-1 mile from the station, which would attenuate the observed effect. However, the effects of moving the buffer further from the station area must be measured against the effects of introducing properties that may be less comparable due to spatial differences in development patterns. It is also important to acknowledge that any inferences drawn from the difference between station area and control property prices depend on the true comparability of these two sets of properties.

Just as the property market response to light rail varies by city, it is possible that any property price increase may be due to certain housing submarkets rather than the sample as a whole. It is possible that certain housing types responded more quickly or readily than other types to increased transit accessibility brought about by MetroLink. For example, there might be greater demand for smaller or less expensive housing around transit stations due to younger or less affluent buyers who are more likely to rely on transit for economic or lifestyle reasons. For example, the before-after study of the light rail line connecting Trenton and Camden indicated that smaller homes appreciated near the stations, while neutral or negative effects were observed for other property types (Chatman, Tulach, & Kim, 2012). Though the sample of station area properties in this analysis may be too small to conduct analysis by size or price category, it is worthy of consideration because of its implications for station area redevelopment.

It is also possible that the station area property price increase or decrease may be affected by the larger municipal context. The table below gives 2000-2012 population change for the six Blue Line station municipalities. Four municipalities experienced population loss during this time period, with Maplewood and Richmond Heights losing over one in ten residents between 2000 and 2012. In contrast, two municipalities registered increases in population, with Clayton growing by over 24% residents during this same time. This population growth, coupled with a much higher median home price than the other municipalities, sets Clayton apart from the other inner-ring suburbs. Another unique feature of Clayton is that it is the only one of the six municipalities to have enacted transit-oriented development districts at its two Blue Line stations (City of Clayton, 2014). However, because properties from the Clayton make up only 14.6% of the station area repeat sales property and represent only 13.8% of the station area sales, it is unlikely that an overrepresentation of sales from Clayton are wholly driving the positive price trend around Blue Line stations.

Table 7. Population, home value, and contributions to final samples by municipality

	Population 2000	Population 2012	Percent change 2000-2012	Median value of owner-occupied housing 2012	No. of station area repeat sales properties in sample	No. of station area sales in sample
University City	37,428	35,228	-5.9%	$190,900	163	273
Clayton	12,825	15,910	+24.1%	$615,000	49	71
Richmond Heights	9,602	8,566	-10.8%	$252,500	42	56
Brentwood	7,693	8,035	+4.4%	$180,800	5	9
Maplewood	9,228	8,017	-13.1%	$145,300	34	40
Shrewsbury	6,644	6,243	-6.0%	$169,400	42	66

Source: (U.S. Census, 2002; U.S. Census, 2014c).

Clayton's establishment of transit-oriented development districts raises an important point. Though the present research hypothesizes that it is a change in transportation access that causes station-area properties to become more valuable over time, the establishment of new light rail alignments is rarely the only investment occurring in station areas. In fact, investment in station area land use is a selection criterion for federal funding. Although the Blue Line was funded entirely with local funds, efforts such as the establishment of transit-oriented development districts in Clayton and station area redevelopment efforts in Maplewood can also lead to improvements in station area environments that can also cause housing prices to rise as these areas become more attractive. Therefore, the extent of simultaneous efforts by municipalities to complement light rail construction through station area improvements will make it impossible to isolate the role of the transportation improvement in affecting station area property values or inducing development.

Because this analysis was limited to single family homes, data were not collected about the prices of residential or commercial rents, nor from the sales of multi-family properties or condominiums. However, further study to determine whether these property types have appreciated due to proximity to light rail would provide more information about the overall economic development effects of light rail in St. Louis County. The literature on these types of properties suggests that the presence of light rail affects the prices of these property types as well. For example, a 2002 cross-sectional study by Cervero and Duncan using hedonic price analysis found a 23% premium for commercial property value per square foot within ¼ of Santa Clara light rail stations when compared to control properties located at greater distance. A later cross-sectional study by Duncan (2008) found that condominiums were associated with a 17% increase in value within ¼ mile of a light rail station, compared to 6% for similarly-situated single family homes. In terms of planning transit oriented development, the change in price of multi-family housing and commercial space is perhaps the most important consideration because those types of development represent a much more efficient use of the limited space around transit stations than single family homes.

VI. Conclusion

In 1997, the East West Gateway Board recommended the extension of the MetroLink as one of the best strategies to increase community vitality, decrease congestion, and increase access and mobility in the inner-ring suburbs of the St. Louis region. According to the Cross-County Corridor Major Transportation Investment Analysis (MTIA), these communities were affected by decreases in population, businesses, and tax base brought about by suburbanization. According to the MTIA, "Investment or reinvestment in transportation facilities should then take into consideration their ability to induce new development in the inner, older suburbs, as investments in these facilities can strongly affect land use patterns, population and/or business densities, and building prices" (p. 14) (EWGCOG, 1998).

The purpose of the present research is to understand whether the initiation of service on one light rail alignment, the MetroLink Blue Line, led to an increase in the sales price of single family homes within ¼ mile of stations in St. Louis County, Missouri. Today, 17 years after the publication of the MTIA, and over 7 years since the completion of the Blue Line, there is evidence that the presence of light rail may be causing station area properties to increase in value, although the differences in station area sales prices in the before and after periods are not statistically significant. Furthermore, as in any study of this type, any development efforts to complement light rail may result in a change in home values that is not strictly attributable to light rail access. As more homes are sold and resold in the near future, a recalculation of the repeat sales model with new data may yield more conclusive results. An increase in the number of sales pairs may also allow for the analysis of effects by submarket or municipality, potential giving greater insight into the determinants of housing price in St. Louis County.

As the St. Louis region plans future light rail extensions, it is important to understand both the transportation and land use impacts of extending rail transit service to new areas. The results of any analysis to studying the effects of light rail access on station area property values not only benefits regional planners in St. Louis, but also adds to the body of literature on the effects of light rail nationwide.

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Appendix

Appendix A. List of second-generation light rail lines/systems in the U.S.

	Name of system	Location	Opened	Annual passenger trips
1	San Diego Trolley	San Diego, CA	1981	31,612,877
2	Pittsburgh T	Pittsburgh, PA	1984	6,918,141
3	Metro Rail	Buffalo, NY	1984	6,061,323
4	MAX	Portland, OR	1986	41,172,344
5	Sacramento RT	Sacramento, CA	1987	12,543,866
6	Santa Clara VTA Light Rail	San Jose, CA	1987	10,014,514
7	Metro Rail	Los Angeles, CA	1990	49,252,315
8	Baltimore Light Rail	Baltimore, MD	1992	8,752,463
9	MetroLink	St. Louis, MO	1993	16,209,098
10	Denver RTD	Denver, CO	1994	20,694,715
11	DART	Dallas, TX	1996	22,302,390
12	TRAX	Salt Lake City, UT	1999	15,333,491
13	Hudson-Bergen Light Rail	Jersey City, NJ	2000	n/a
14	Link Light Rail	Seattle, WA	2003	983,924
15	River Line	Trenton-Camden, NJ	2004	n/a
16	METRORail	Houston, TX	2004	10,618,061
17	METRO Blue Line	Minneapolis, MN	2004	10,400,864
18	LYNX Rapid Transit	Charlotte, NC	2007	4,769,933
19	METRO Light Rail	Phoenix, AZ	2008	n/a
20	SPRINTER	Oceanside, CA	2008	n/a
21	Tide	Hampton, VA	2011	n/a

Source: Classifications are from INTDAS, with two streetcar systems removed (Tucson, Little Rock) and four light rail systems added (Jersey City, Trenton-Camden, Phoenix, and Oceanside).