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TRANSIT PROXIMITY EFFECTS: CAPITAL METRORAIL AND ITS IMPACT ON LAND PRICES IN AUSTIN, TEXAS

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TRANSIT PROXIMITY EFFECTS: CAPITAL METRORAIL AND ITS IMPACT ON LAND PRICES IN AUSTIN, TEXAS

by

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Report

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Dedication

I would like to dedicate this report to my parents and friends who have supported every decision I have made in my life. Without their sacrificial care and support for me, this report would not have been possible.

Acknowledgements

I would like to express my deepest appreciation to my report advisor, Professor Ming Zhang, who has offered me constant inspirations and help. It is his advice and guidance that made it possible for me to finish this paper. I would also want to thank Professor Junfeng Jiao, Professor Kara Kockelman, Greg Griffin, etc. whose advice and works have given me exceptional coaching and advice.

Abstract

TRANSIT PROXIMITY EFFECTS: CAPITAL METRORAIL AND ITS IMPACT ON LAND PRICES IN AUSTIN, TEXAS

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The University of Texas at Austin, 2015

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Since its first operation in 2010, the 32-mile Austin Capital MetroRail has connected downtown Austin to the city of Leander with 9 stations operating in total. Currently, no research has investigated the impact of the Austin MetroRail on property values. This study fills the research gap by understanding its impacts on property values and other socio-economical influences. Hedonic models have been constructed to assess the effects of transit proximity on land price in this research. The model suggests Austin MetroRail has a positive impact on property values- for properties in the study area, every 100 feet further away from the train station, property values will decrease $13,068/acre. Another analysis of the rail only focused on 7 stations located in the city of Austin and suggests transit premium varies by different neighborhood. In high-income neighborhoods, transit proximity impact is positive; and in middle or low- income neighborhoods, it is negative. When stations were grouped into different study areas, models reveal transit proximity has different effects throughout the system. The research findings confirm the positive effect of Austin MetroRail although in some neighborhoods the effects vary and suggest a series of value-capture strategies to help finance future development.

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Chapter I: Introduction

1.1 Urban Rail Transit Development in United States

Urban rail transit is a term that generally refers to different types of transit rail system within or among urban areas. The most common types of rail transportation in the United States are light rail transit, subways, street cars, and commuter rail.

While virtually all cities in the United States have bus serving as the major local public transportation, most of the major American cities have rail systems in different forms such as metro rail, light rail or commuter rail. Unlike bus system service, rail transit has a higher capacity and longer operating range, as well as faster speed but it needs fixed rail tracks or upgraded transportation infrastructure in stations or along rail tracks.

During the last century, American cities have become increasingly automobile dependent and most of the land use development projects or other planning policies have been carried out in favor of auto-mobile oriented urban development. In recent decades, planners have sought to diversity transportation systems through encouraging public transportation use or cars sharing, in order to address a series of contemporary urban issues associated with auto-oriented development cities, such as urban sprawl, traffic congestion, environmental pollution and downtown blight in major American cities.

Transit ridership has increased in recent years. According to the American Public Transit Association, even though gas price has sunk significantly in 2014 which has been expected to lead to more driving, the total number of rail transit trips still continue to grow and has reached 10.8 billion---the highest annual public transportation ridership in the past 58 years (APTA, 2014).

1.2 COMMUTER RAIL

Commuter rail is now one of primary types of rail transit serving North American cities. Differing from light rail or subway systems, commuter rail system primarily operates between city centers and suburban areas or among different adjacent cities. It is usually adaptable to longer distance travelling with larger trains and more seating to accommodate more commuters. Commuter rail also need exclusive right-of-ways for its tracks that is sometimes shared with freight trains or intercity trains.

1.3 AUSTIN CAPITAL METRORAIL

Austin Capital MetroRail is a commuter rail system that serves the Greater Austin region in Texas, connecting the city of Leander to the central business district (CBD) of Austin. As the only commuter rail line in the city of Austin, it is operated by the Capital Metro, which stands for the Capital Metropolitan Transportation Authority. With approximately 32 miles rail, it is operated on existing freight tracks and has nine stations passing through the city of Leander, Lakeline, Howard, Kramer, Crestview, Highland, MLK. Jr., Plaza Saltillo and downtown Austin, respectively. Each MetroRail train vehicle has 108 seated space and 92 standing space which add up to a capacity of 200 passenger. The proposal for Capital MetroRail was passed in 2000 and it began its first operation on March 22, 2010. According to the American Public Transportation Association, in 2014 Austin Capital MetroRail has an average ridership of 2,900 each workday (APTA, 2014).

The need for urban rail in the city of Austin was first addressed in the 1970s during the 1970 energy crisis. In 1990s, a light rail was proposed by Capital Metro for a 52-mile long system with $1.9 billion investment transit rail system in Austin (Madison, 2000). In 2000, the proposal was voted down in the city's referendum and in 2004, the Capital Metro scaled down the rail plan and eventually got it approved. In the following years, Capital

Metro revised the plan to match available funding issues and community needs and finally the rail began its service on March 22, 2010.

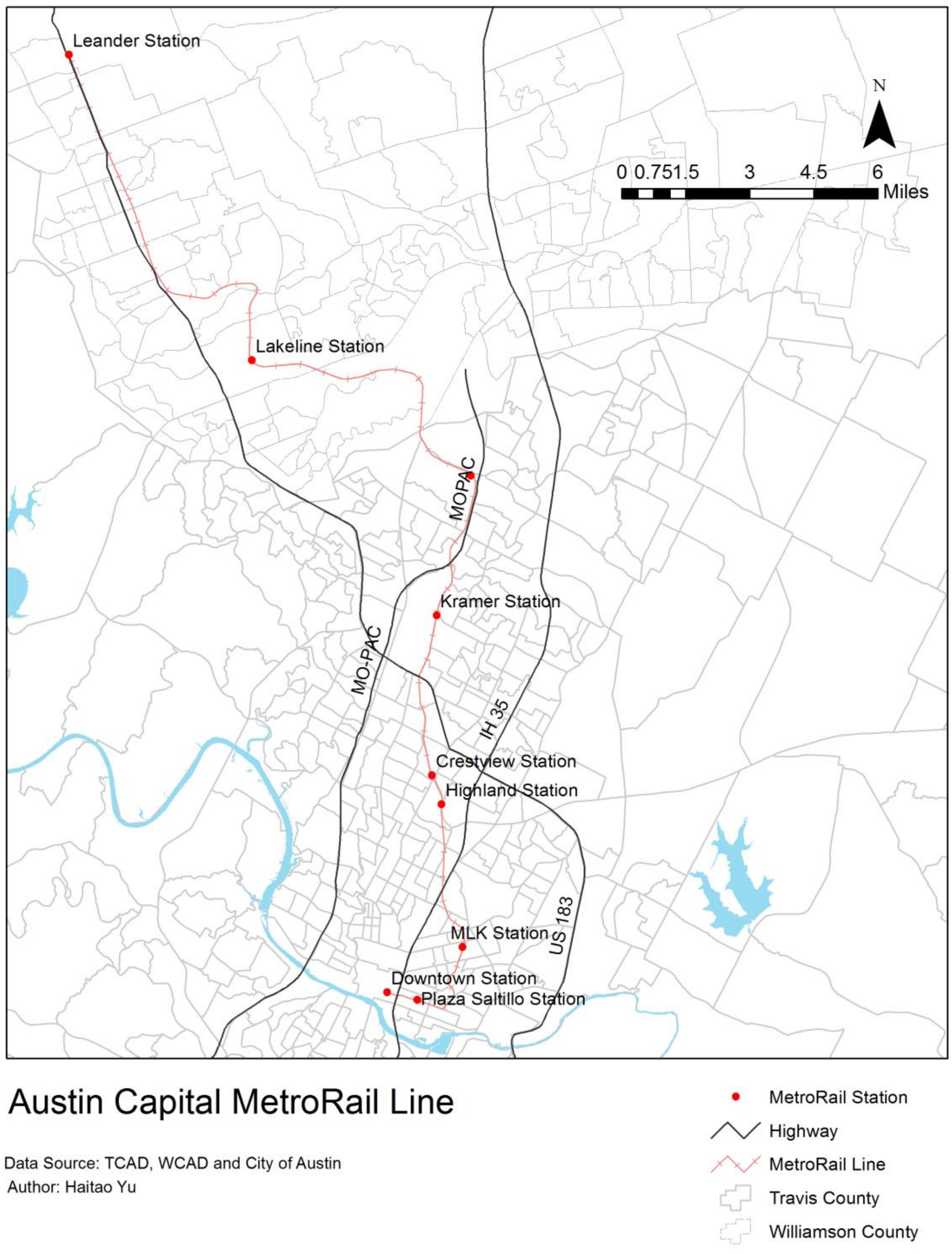

Figure 1.1 Capital MetroRail Operating Map

1.4 LOCATION THEORY

Growing studies have been conducted to explore the relationship between urban form and transit. Among those studies, significant research have studied public transit and its impact on surrounding land and shown that proximity to public transit system can be capitalized into property values. Also, researches have suggested varying magnitudes of transit proximity impacts on property values.

Theoretically, the reason for capitalization is that properties or parcels that are near public transportation can be guaranteed with higher and more convenient accessibility to active locations such as job centers, business districts, shops, restaurants, schools or hospitals and thus could enjoy the price premium; on the other hand, congestion, crime, vibration, air quality, noise and other potential negative factors from the rail line or rail stations might lead to decreasing property values with closer distance to the rail. Studying the transit impact on property values could not only inform policy makers and planners future transit investment but also offer them a clear vision of economic opportunities from transit improvement. Therefore, both the public and the private sector are interested in finding the rail transit premuim mechanism. In addition to measuring the degree of benefits of transit proximity on property values, other reasons behind these studies include:

1. Being near public transportation could increase the adjacent property values, yielding unexpected profits out of initial investment for developers and therefore to better help both parties to understand the land market.

2. Studying the transit capitalization could be used to assess to what degree the negative externalities of public transportation improvement could be offset by the accessibility benefits (Cervero & Duncan, 2002b).

3. Another benefit of research on transit capitalization is to better understand the hidden mechanism of land price change, allowing the public sector to carry out different financing strategies accordingly such as land value taxing, tax-increment financing or implementing impact fees (Mathur & Smith, 2012).

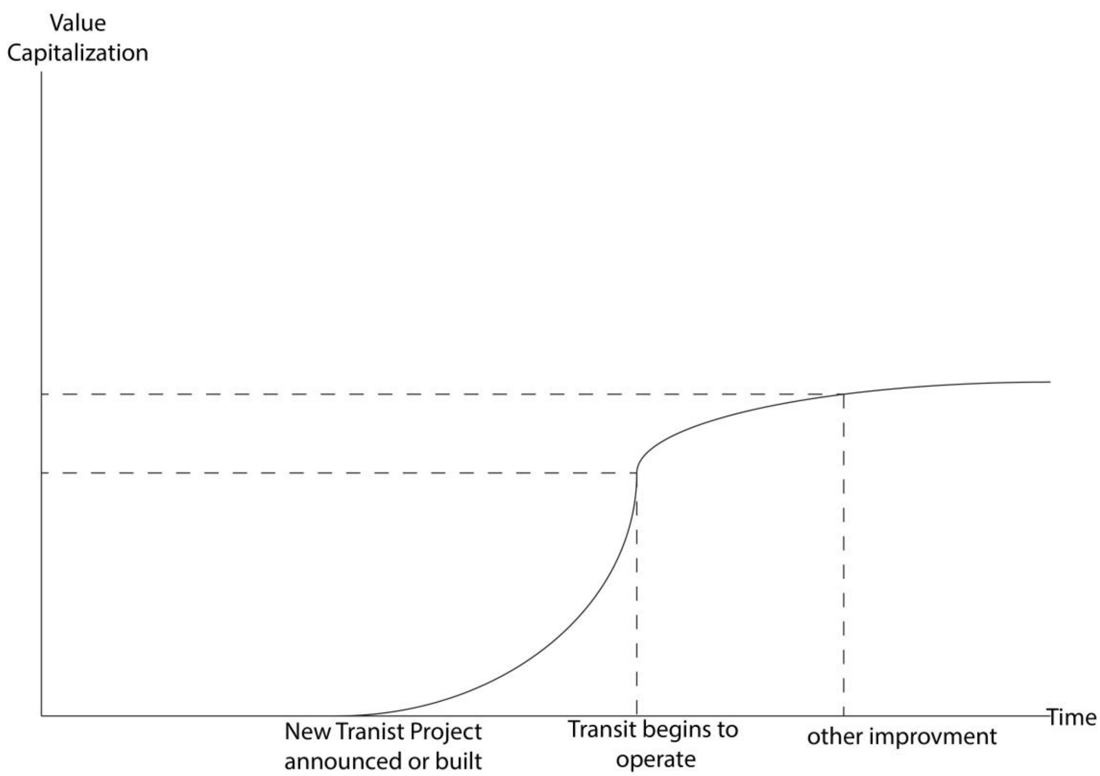

Figure 1.2: Transit Proximity Effect on Property Values Change over Time

Figure 1.2 shows how transit proximity should be capitalized into property values over time. Usually, as the new public transportation investment is announced, property values will be expected to increase, and over time, it will continue to increase as the rail transit is open and development near the station continues to grow. In addition, after property values flatten out over time, other improvement factors could then bring potential additional growth in property values, such as transit system expansion in future or newly added bus routes to increase station accessibility.

To date, no previous research has investigated the impact of Austin Capital MetroRail on adjacent property values. This study fills the research gap to better understand the impacts of Austin MetroRail on property values and its other socio-economical influences. Despite the fact of relatively low ridership of MetroRail compared with other major cities in United States, it is expected that Austin MetroRail will contribute to the land market growth along with Austin's booming economy.

Chapter II: Literature Review

2.1 Studies of Impact of Transit Proximity on Property Values in U.S Cities

The impacts of rail on property values have been widely studied throughout U.S metropolitan cities, including Buffalo, San Francisco, New York City, Miami, Portland, Dallas, and Houston.

Previous studies on rail transit and property values have shown two different impacts: the accessibility effect and the nuisance effect. The accessibility effect of the light rail on the property values means that rail transit proximity to rail transit that might lead to better connectivity or less commuting time, and this can be capitalized into property values. On the other hand, rail transit is being criticized in some studies that it might incur noise pollution, air pollution, vibration as well as increased traffic near the station area or other negative consequences for adjacent parcels and therefore will diminish property values.

A vast body of studies has proven that the impacts on property values are positive. In other words, most of the studies empirically found that the improvement of transportation infrastructure and accessibility should be directly capitalized into property values. A study of the Metropolitan Atlanta Rapid Transit Authority (MARTA) has shown in Atlanta, Georgia, rail stations have directly positive impacts on property values-more specifically, single-family homes. But the impacts vary in neighborhoods by different income levels, different distance to the central business district, or if the proximate area has parking lot (Bowes & Ihlanfeldt, 2001). According to Hess et al. (2007), in Buffalo, while the light rail has been in service for 20 years and the population and ridership has decreased, it still has positive impact on property values. Hedonic modeling was utilized in this study, showing that the average home property values in the study area increase by $2.31 for every foot closer to a light rail station in terms of geographical straight-line distance and $0.99 by network distance (Hess & Almeida , 2007). In a study of the relationship between MetroLink and residential property values, property values starting from 1460 feet will increase approximately $139.92 for every 10 feet closer to MetroLink station (Garrett, 2004). There have also been numerous studies investigating the Bay Area Rapid Transit (BART) in San Francisco and its impacts on the property values which generally have shown that proximity to light rail transit has a positive effect on property values (Cervero & Landis, 1995; Landis, Guhathakurta, Huang, Zhang, & Fukuji, 1995; Lewis & Brod , 1997).

The opposite impact of rail transit on property values, that is, the nuisance effect, has also been found in many studies. A study of the light rail transit system (MAX) in Portland, Oregon confirmed that light rail has both positive effect and nuisance effect on property values and that positive effect dominates (Al-Mosaind, Dueker, & Strathman, 1993). Another study on the MAX in Portland, Oregon found that negative effects exist within certain distances to the light rail (Lewis & Brod , 1997). In the study of Houston METRORail, Pan (2009) found light rail lines have significant net positive effects on property values but have negative effects on property values within a quarter miles due to crimes and noise generated by immediate proximity to light rail tracks or stations. In the study of MetroLink in Greater Manchester, England, both the hedonic price and longitudinal methods have been used and confirmed that proximity to train station tend to lower property values and over years transit improvement has not brought any significant benefits to the local land market although specific reasons are not well explained in the study (Forrest, Glen, & Robert, 1996).

However, there are some studies showing that rail transit would not always have significant impacts on property values. In a study of the impacts of light rail transit on the office property values in San Diego, California, results indicate that the access to highways is a determining factor in affecting office property values while access to the light rail is not playing a significant role (Ryan, 2005). In the study of five metropolitan areas in California, Landis et al. (1995) found that proximity to rail mass transit should be capitalized in the property values. However, in some cases, CalTrain in San Jose and the light rail system in Sacramento fall outside the category of capitalization effect due to several reasons such as limited service or slow speed.

Additionally, numerous studies have shown that the effects of rail transit on property values also differ in different neighborhoods based on the location or the average neighborhood income. In Atlanta, Georgia, proximity to the elevated rail transit stations could be capitalized into property values in lower income communities while in higher income neighborhoods the impact of light rail transit on the property values is negative (Nelson & McCleskey, 1992). Gatzlaff and Smith (1993) found that there were no major effects on the residential property values of the Miami Metrorail stations. However, the Metrorail has weak positive impacts on the property values in higher priced communities that were experiencing growth.

Researchers have studied property premiums from other transit or transportation improvement. A study of proximity to highway and its impact on commercial property values in Austin, Texas has shown that parcel values could be dramatically affected by roadway projects and especially values accrued to those parcels most proximate to those highway corridors (Siethoff & Kockelman, 2002).

Overall, most studies included in this review show positive impacts of transit proximity on property values. However, the extent of effects on property values varies.

And among those approaches used to investigate the relationship, hedonic modeling has been the most popular one and is employed in this study.

2.2 Study of Commuter Rail and its Impact on Property Values

Researchers have also conducted different studies that quantified and compared property premiums achieved from different types of rail transit including light rail, heavy rail and commuter rail. For example, studies have shown that commuter rail can generate higher premiums compared to light rail or heavy rail because of greater city or regional accessibility or higher speed (Cervero, 1984). In a study of commuter service in Boston, MA, Armstrong (1994) found that within a community with rail stations single-family property values are approximately 6.7% higher than others. However, he also found a 20% loss in property values within 400 feet of a commuter or freight rail right-of-way, either of which, as suggested in the study, has nuisance effects on property values. He pointed out that the study is not firmly conclusive concerning the effects of commuter rail proximity and it is hard to distinguish the different effects from the commuter rail and freight trains because they are sharing the same rail line (Armstrong R. J., 1994). In a study of San Diego County (Cervero, 2004), only properties near downtown area commuter rail stations show transit proximity benefits and other properties in the study accrued very weak or even negative capitalization benefits from being located near transit station.

In all, the effect of commuter rail on property values is different than the impact from light rail or other public transportation modes. On one hand, transit proximity from commuter rail might have higher effect on property values compared to light rail or heavy rail because of wider service coverage (Debrezion, Pels, & Rietveld, 2007), relatively faster accessibility (Cervero, 2004)or other characteristics of commuter rail (Debrezion, Pels, & Rietveld, 2007). On the other hand, because commuter rail sometimes might share the same track with the freight train or passenger train, having nuisance effect due to noise or air pollution, properties closer to the commuter train rail or stations within a certain distance will have lower value compared to other properties. Figure 2.1 shows the possible nuisance effect and land premium associated with commuter rail.

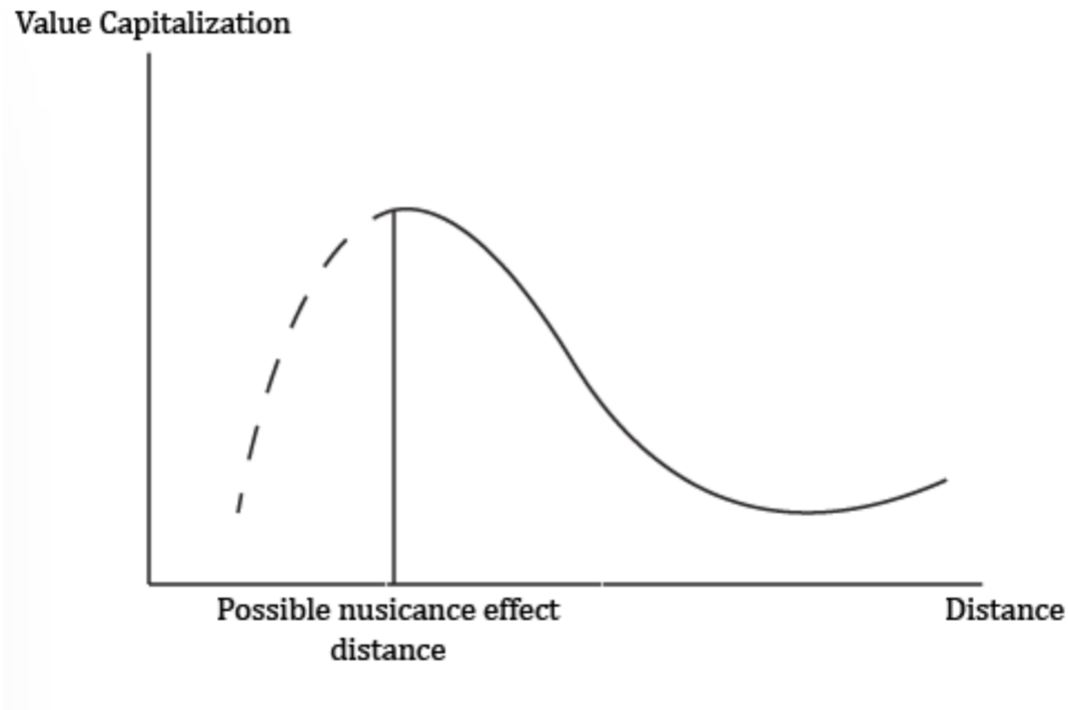

Figure 2.1 Commuter Rail and Its Impact on Property Values

Table 2.1 summarizes the impacts of rail transit on the property values, indicating different study results.

Table 2.1 Literature Review on Proximity to Transit and its Impact on Property Values

Authors	Study Area	Findings
Bowes & Ihlanfeldt, 2001	Atlanta, Georgia	Large and positive direct effects are found in high-income communities between one quarter and three miles of a station. Crime effects in downtown area. Negative direct effects found in low-income neighborhoods beyond one-quarter mile of a station.
Nelson & McCleskey, 1992	Atlanta, Georgia	Proximity to the elevated rail transit stations should be capitalized into property values in lower income communities while in higher income neighborhoods the impact is negative.
Armstrong R. J., 1994	Boston, Massachusetts	Significant impact on single-family residential property values by the accessibility of the commuter rail service.
Hess & Almeida , 2007	Buffalo, New York	Positive impacts on high-income communities and negative impacts on low-income communities. The property values, as every foot closer to a light rail station in the study area, the average property values increases by $2.31 by geographical straight-line distance and $0.99 by network distance.
Weinstein, et al., 2002	Dallas, Texas	Proximity to the DART station has a positive influence on property values.
Pan, 2013	Houston, Texas	Light rail lines have significant net positive effects on property values but have negative effects within a quarter miles due to crimes and noise generated by immediate proximity to light rail tracks or stations.
Gatzlaff & Smith , 1993	Miami, Florida	No major effects on the residential property values of the Miami Metrorail stations.

Table 2.1 (Continued) Literature Review on Proximity to Transit and its Impact on Property Values

Authors	Study Area	Findings
Lewis & Brod , 1997	New York City	Significant positive effects on property values
Voith, 1993	Philadelphia, Pennsylvania	Property values with access to light rails are higher than other properties
Chen, Rufolo, & Dueker, 1998	Portland, Oregon	Positive effects on property values
Al-Mosaind, Dueker, & Strathman, 1993	Portland, Oregon	A positive effects of proximity to LRT station on property values
Dueker & Bianco, 1999	Portland, Oregon	Positive impacts on property values.
Lewis & Brod , 1997	Portland, Oregon	Property value increased $0.76 for every foot closer within the 2,500 to 5,280ft distance to transit range
Weinberger, 2001	Santa Clara County, California	Positive impacts on property values.

Table 2.1 (Continued) Literature on Proximity to Transit and its Impact on Property Values

Authors	Study Area	Findings
Cervero & Duncan, 2002a	Santa Clara County, California	Positive impacts on property values.
Cervero, 1996	San Francisco, California	Positive effects on rent within a certain distance
Lewis & Brod , 1997	San Francisco, California	Positive effects on property values and property values decrease $15.8 for every 1 foot further from BART station.
Landis, et al, 1995	San Francisco, California	Positive effects on property values. Property values increases, as the property is closer to the station.
Garrett, 2004	St Louis, Missouri	Positive effects on property values. Property values increases, as the property is closer to the station.
Benjamin & Sirmans, 1996	Washington, DC	Distance from a metro station has an adverse impact on rent, i.e., apartment rent decreases by 2.5% for every 0.1 miles further away from a metro station.
Forrest, Glen, & Robert, 1996	Greater Manchester, England	Proximity to stations tends to lower property price. The railway corridors of Greater Manchester comprise corridors where the value of property has a negative premium. No discernible impact has been found so far.

Chapter III: Study Method and Study Result

3.1 Value Measurement

Property values could be defined into two separate categories: land value and improvement value. In this study only the land value has been examined. First, transit premium theory holds that the benefits of transit proximity is capitalized into land values instead of building or other improvement values. In other words, transit premium is about the location of property and land enjoys higher transit premium if it has greater location desirability, while buildings or other improvement could present the same magnitudes of change without the consideration of the transit proximity. Another reason is that the dataset for this study does not include detailed improvement attributes such as the number of bedrooms or the area of the buildings and therefore excluding studying the improvement values is necessary.

3.2 Hedonic Approach

Regression models are able to statistically tell the effects of different explanatory factors on the dependent factor. Most relevant studies employed a hedonic approach in studying the relationship between transit proximity and property values. When the monetary values of properties are attributed to different factors, such as the community characteristics, property characteristics or the proximity to the light rail or the rail station, the approach is called 'Hedonic Regression Model' (Cervero & Aschauer, 1998). Although increase in land price could be associated with various socio-economic outcomes such as population migration, booming economy or newly built job centers in the neighborhood, hedonic modeling is able to distinguish the transit proximity effect from other influential factors on property values.

The general regression model of the hedonic approach for analyzing the impacts of rail transit on property values usually takes the following form:

$$P_i = F\ (T_i, B_i, N_i, C_i)$$

Where,

P_i =Assessed property values of property i

T_i= Proximity to the light rail station or light rail line

B_i = Property characteristics, such as area, floors or the number of rooms etc.

N_i=Neighborhood characteristics, such as the average income of the neighborhood

C_i = other vectors

3.3 Study Area

The study area is determined by popular choice of size in most of the relevant studies---¼ miles or ½ miles, both of which have been recognized as a comfortable walking distance to a train station.

Increasing the use of public transportation has significant environmental, social and economic impacts. There are a variety of factors that affect people in making decision to take public transportation for a given rail or bus line- For example, in terms of the public transportation itself, services, available schedules, speed, accessibility to desired locations and travel time. Neighborhood design such as the street network or walking facilities improvement can influence mode choice as well.

Another reason that affects commuters' mode choice is the walkable distance to train station, which, simply put, is how far people are willing to walk to stations.

Figure 3.1 shows the results of several studies in North American cities about transit use and walking distance to transit (Transportation Research Board of the National Academies, 2003).

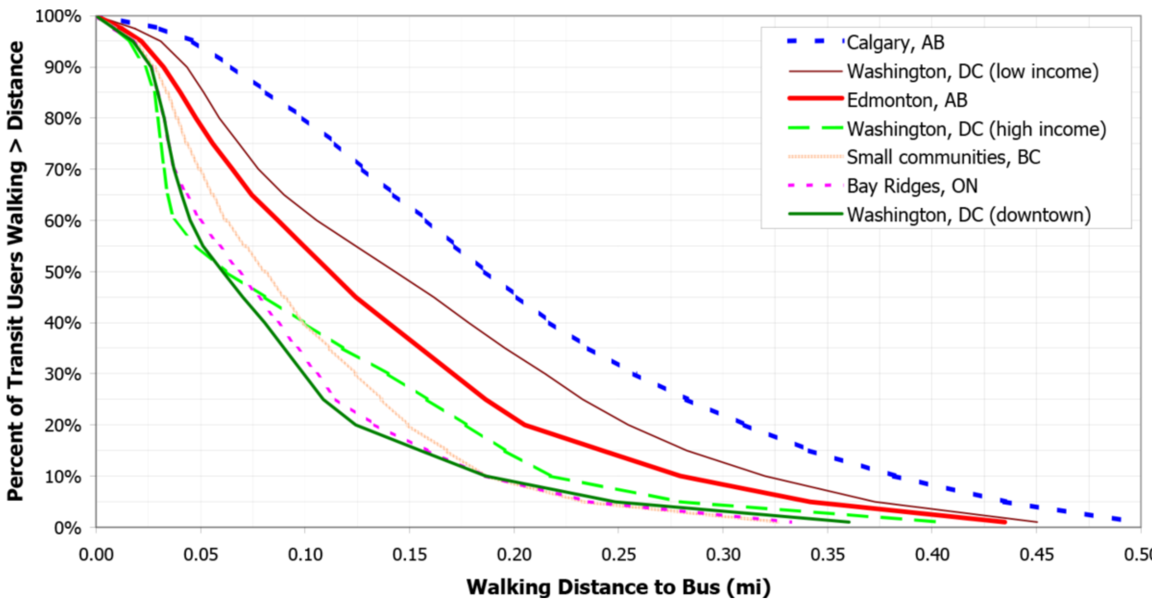

Figure 3.1 Walking Distance to Transit

Identifying the walkable distance is important in planning neighborhoods where planners expect to guide more people in choosing public transportation through design. There are many studies from different disciplines, such as urban design or transportation planning, that have been carried out in exploring the relationship of walkable distance and public transit catchment area. Transit planners have acknowledged ¼ miles as the most common standard for a walkable distance to transit stations in United States and within that distance they believe people feel more comfortable in taking trains or buses. Some recent studies have suggested that ½ mile has become the accepted distance for gauging a transit station's catchment area in the U.S (Guerra, Cervero, & Tischler, 2012). However, while walkable distance is not expected to be necessarily required in transit improvement investment, transit design or planning, it could only be a rough estimation of the willingness of how far people would like to walk to take public transit. The walkable distance could be extended beyond ¼ miles or ½ miles since people nowadays could share a ride or cycle to rail station. Although planners and designers recognize ¼ mile as the most comfortable distance for walking to transit stations, in this study ½ mile have been chosen as the study buffer due to the following reasons.

Parcels selected from the ¼ miles area consist of an extremely small sample while using ½ miles buffer as the study area allows a more comprehensive data selection and therefore leads to more precise estimations.

Studies have suggested that using ¼ miles works best in studying transit effect as a function of employment while half-mile study area is ideal for total population (Guerra, Cervero, & Tischler, 2012). Since this research would investigate both residential land and non-residential land, ½ mile buffer will capture both areas.

3.4 DATA

In this study, hedonic modeling is used to evaluate the capitalization from Austin's Capital MetroRail. Because the rail line passes through two different counties in the Greater Austin area, the primary data sources in this study are the Travis Central Appraisal District and the Williamson Central Appraisal District. These two different databases essentially provide property values in 2014 for every parcel in two counties. Data from the year 2014 are retrieved for the study because three years have passed since the rail line was firstly operated and therefore land markets have enough time to respond and reflect the transit proximity premium. However, studying the land price change over time in hopes of finding the relationship between the time before the rail line was open and the years after it was open is not possible because of limited data availability. Data before the opening of the rail line is not available in either of these two databases and the GIS data is not retrievable before 2009 from the Travis Central Appraisal District.

Both of those two databases have essentially the same data structure. But some potential study factors, which are expected to have effects on property values, are excluded because those data are not always simultaneously available in both of the two databases.

The databases contain information about assessed values or transaction values for each parcel in two counties. And assessed values are selected for study because transaction values information are only available for parcels which have been sold during 2014, forming a very small study sample. Instead, assessed values are available for every single parcel in two counties, which are more reliable and comprehensive. Because theory holds that transit proximity can only be capitalized into land price, in this study the improvement values are excluded.

3.5 Study Variables

In this study, independent variables are categorized into three groups.

Land Attributes: Land attributes are a set of vectors to describe the property itself such as the year built of improvement on the parcel or the acreage of the parcel.

Neighborhood Characteristics: Neighborhood characteristics are those unique attributes of surrounding communities where parcels are located, including community income level or education level.

Location Attributes: Location attributes are believed to have impacts on property values and are the focus variables in this study.

Table 3.1 summarizes the study variables selected in this research in details:

Table 3.1 Summary of Independent Variables

Study Variable	Description	Data Source
Land Price	The price of land for parcels (dollars per square feet in 2014)	Travis Central Appraisal District and Williamson Central Appraisal District database
Independent Variable		
	Location Attributes	
Distance to CBD	Distance to Central Business District of Austin (to the parcel centroid to Austin City Hall by feet)	Data from the city of Austin/ Calculated in the GIS
Distance to Station	Straight line distance from the parcel to the nearest MetroRail station (feet)	Data from the city of Austin/ Calculated in the GIS
Highway Accessibility	Whether the parcel is accessible to highways within 0.5 miles: 1=YES, 0=NO	Data from the city of Austin/ Calculated in the GIS

Table 3.1 (Continued) Summary of Independent Variables

Study Variable	Description	Data Source
	Neighborhood Characteristics	
Median Household Income	Median household income by block group in dollars	American Community Survey 5-year estimates
Population Density	Population density by block group per square miles	American Community Survey 5-year estimates
Employment Density	Employment density by block group per square miles	American Community Survey 5-year estimates
	Land Attributes	
Median Building Built Year	Median building built year by block group (year)	American Community Survey 5-year estimates
Improvement value	Improvement value on parcels (2014 dollars)	Travis Central Appraisal District and Williamson Central Appraisal District database

The independent variables, in addition to the distance to MetroRail stations, are the distance to CBD, a dummy variable for if the parcel is accessible to highway within ½ miles (0=NO, 1=YES), the median household income, the median built year, the total improvement values, neighborhood population density and neighborhood population density.

Data from 2013, the most updated information, for neighborhood and land attributes variables such as the median household income or the median built year have been collected primarily from the American 5-year Community Survey since five-year ACS survey has the largest sample body with most reliable information. Independent variables that present community attributes are collected at the block group level. And study parcels were assigned with the community attributes from the block groups in which they are located. Information for improvement values could be collected in the TCAD and WCAD databases and were calculated by the sum of non-homestead improvement values and homestead improvement values. Data for the median house income is from the year 2013 and were converted for the year 2014 to be comparable with the land price using the Austin Consumer Price Index data that are available from the U.S. Bureau of Labor Statistics.

ArcGIS was used in this study to finish calculation of most of the location variables. In this study, distance measurement was calculated using straight-line distance. For example, distance to the central business district (CBD) is calculated as a straight-line distance from each parcel to the Austin City Hall as a proxy for the CBD. Also ArcGIS was used to determine if parcel is accessible to highways within ½ half miles study area.

Distance to the nearest station is the focus variable in this study and was calculated by using the straight-line distance from each parcel to the nearest station as well. However, some of the study areas overlaps with each other due to the range of each study area is ½ mile. ArcGIS could therefore be used to find the nearest station for each parcel.

Figures 3.2, 3.3, 3.4 and 3.5 roughly show the relationship between parcels values and all the nine rail stations. In downtown station study area, the trend is that land values are relatively higher than any other stations. Generally, four maps have shown that land values of parcels near the stations are higher than those are further away from train stations. However, interestingly, some of the sampled parcels do not follow the general trend and through hedonic model in a future study it could be statistically understood and explained. In addition, comparing the three maps from Travis County and one map from the Williamson County, it can be concluded that land values of parcels are generally higher in Travis County than those in Williamson County.

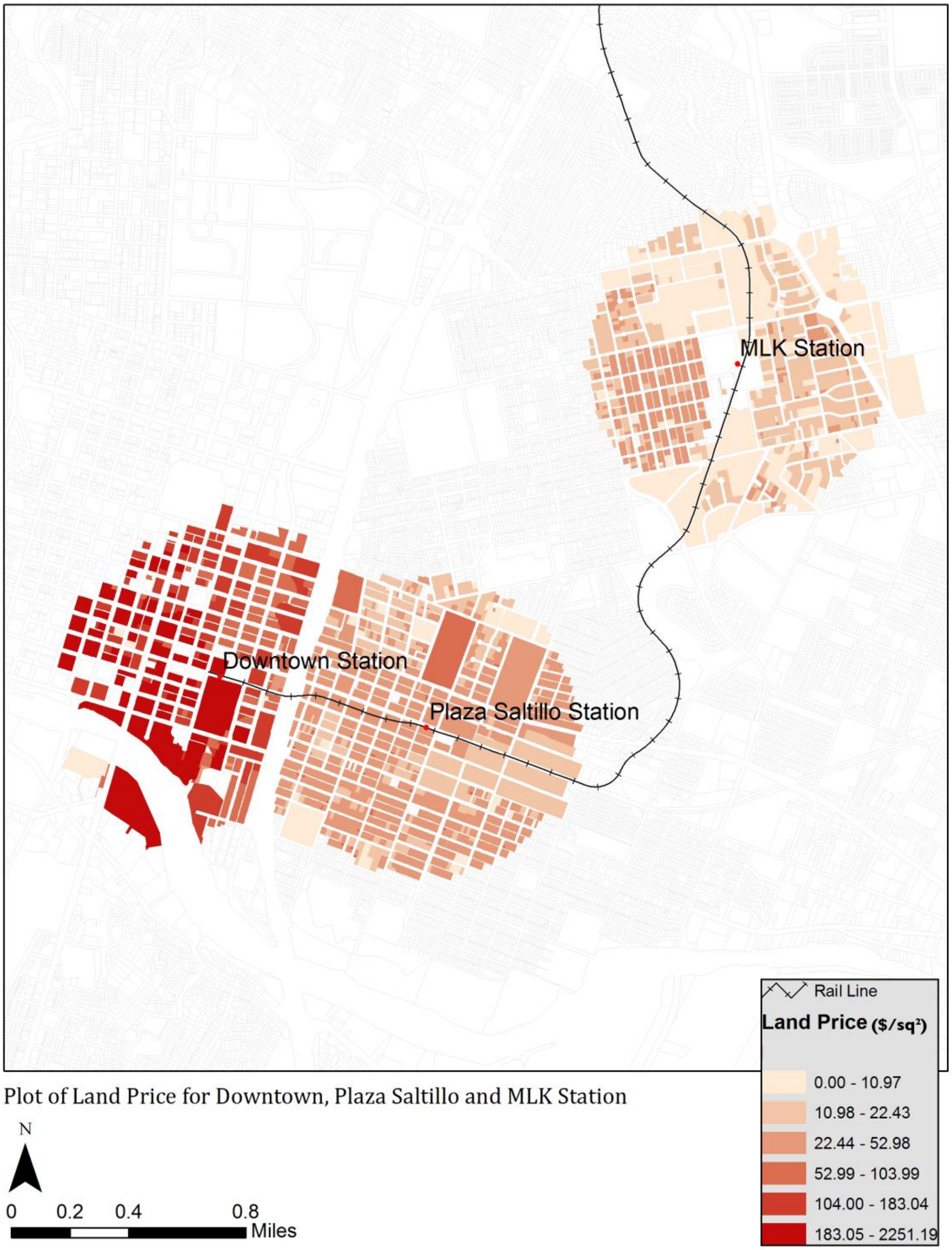

Figure 3.2 Plot of Land Price for Downtown, Plaza Saltillo and MLK Station.

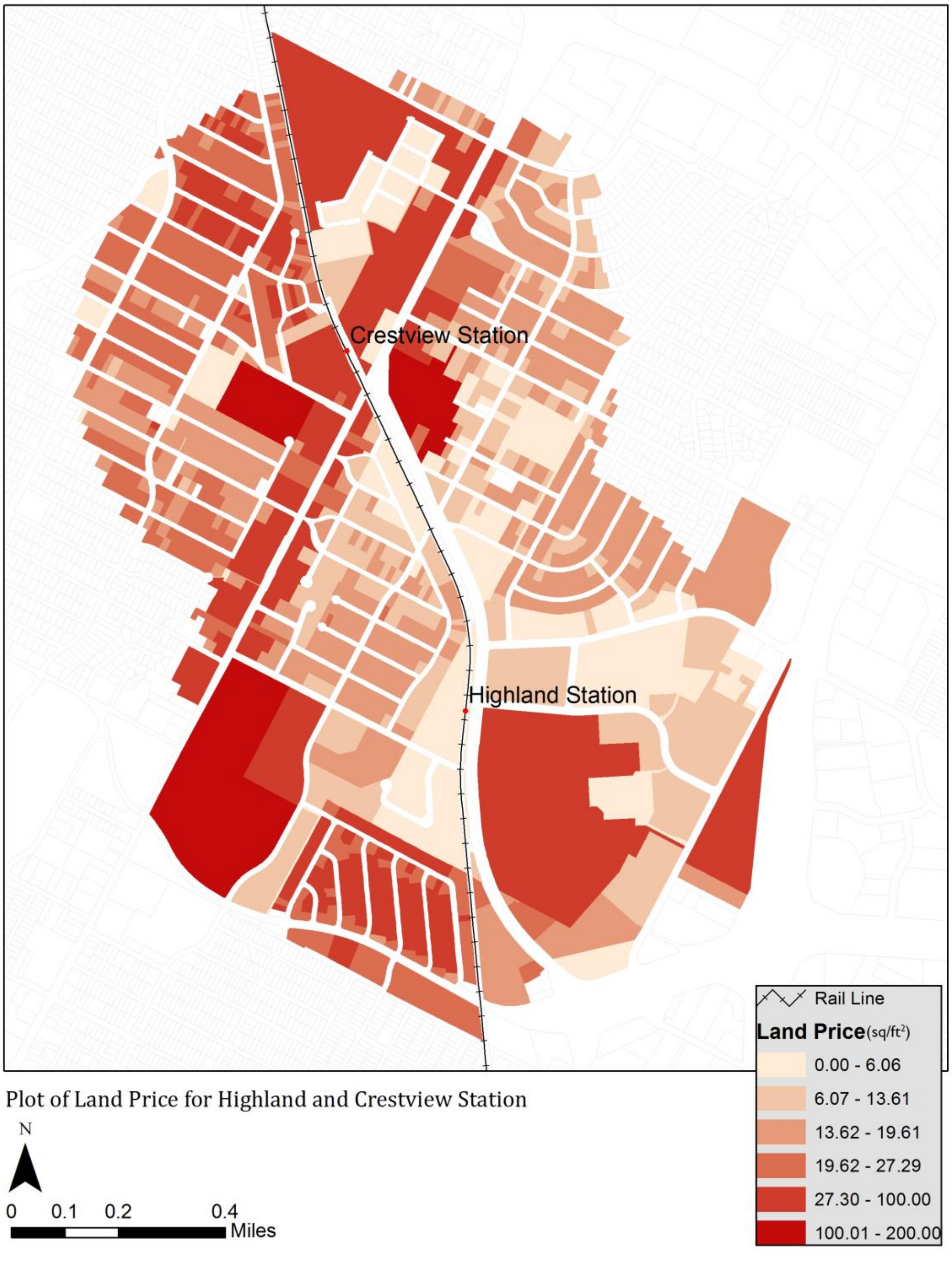

Figure 3.3 Plot of Land Price for Highland and Crestview Station.

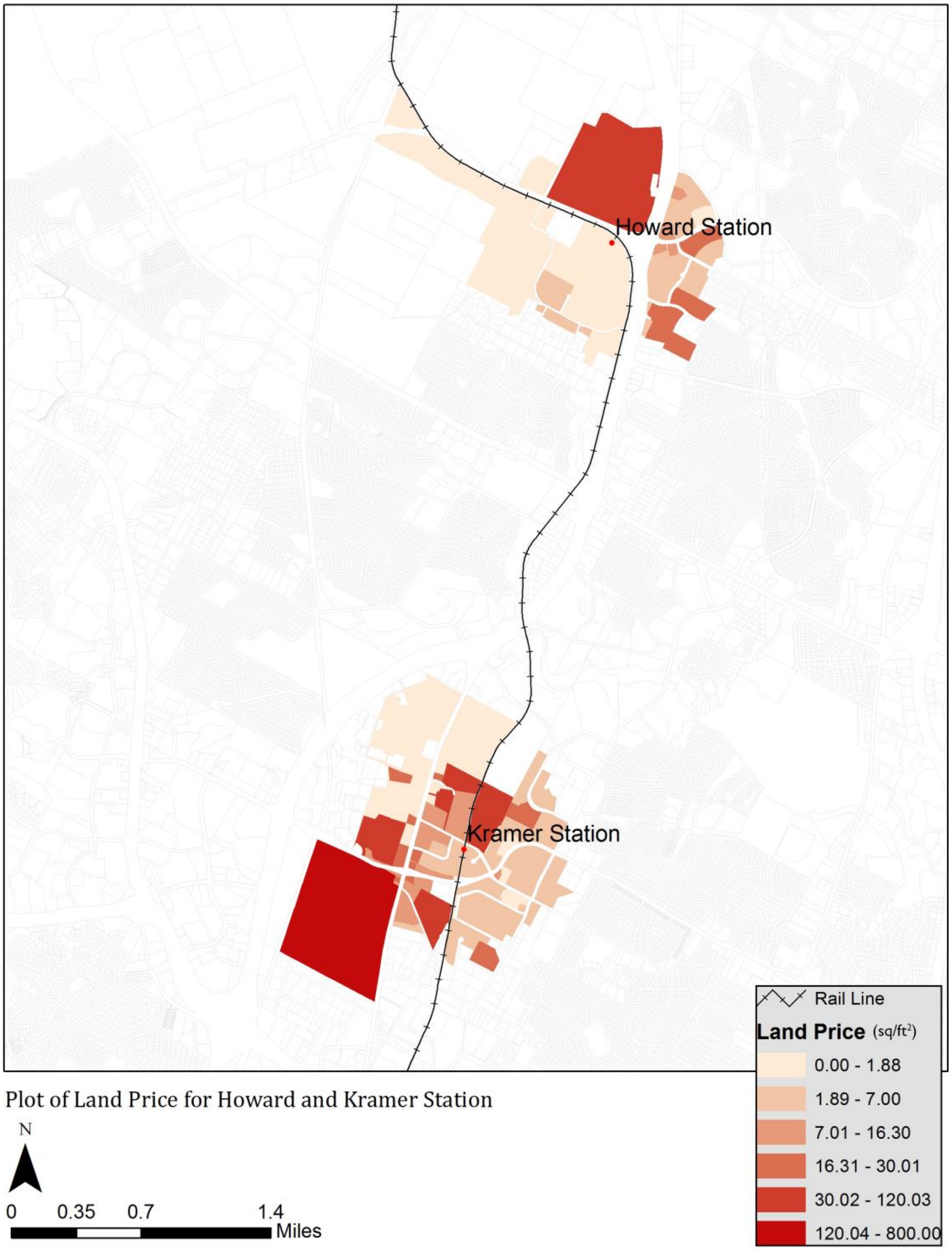

Figure 3.4 Plot of Land Price for Howard and Kramer Station.

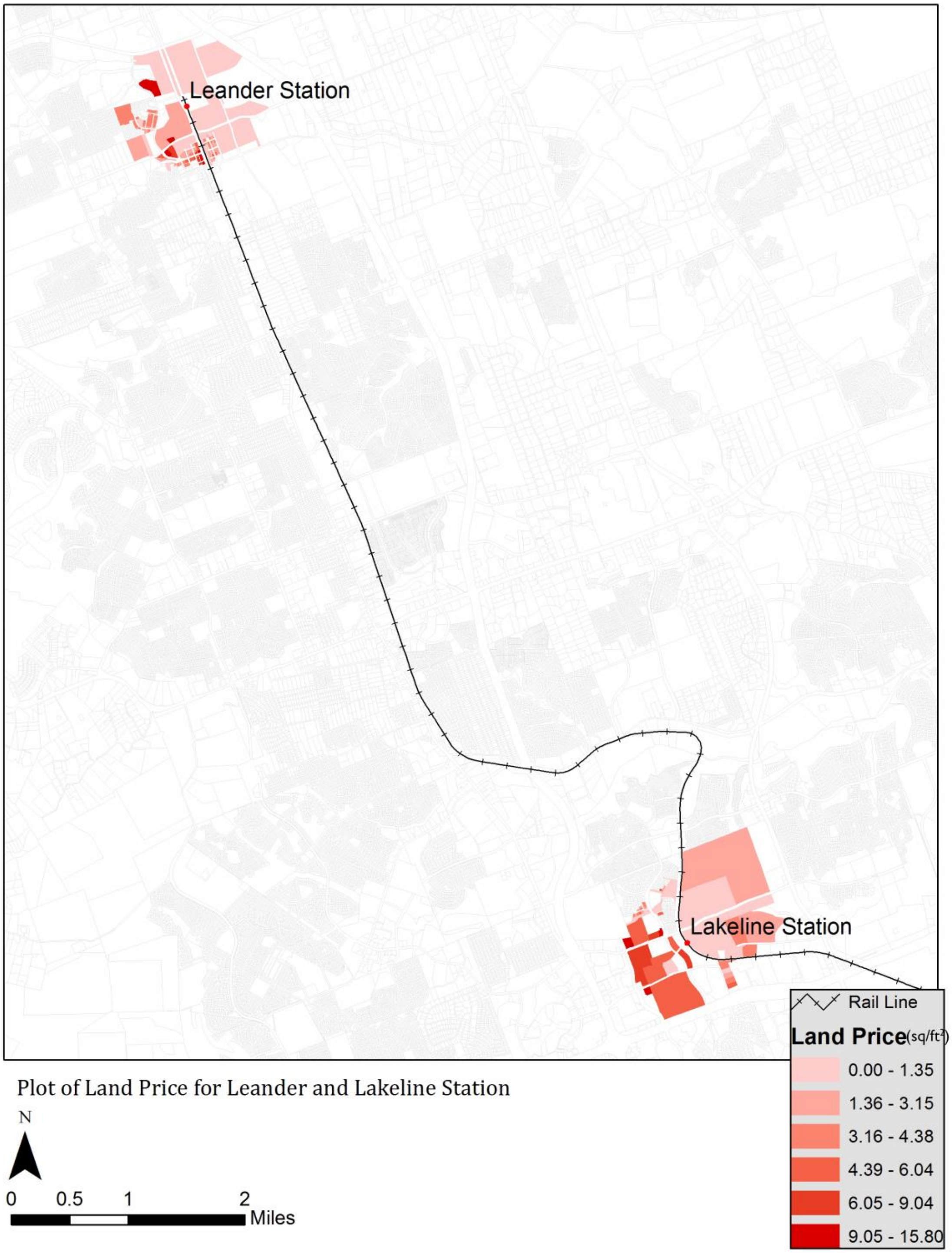

Figure 3.5 Plot of Land Price for Leander and Lakeline Station.

3.6 Nuisance Effect Study

In some studies researchers have found that proximity to commuter rail is associated with nuisance effects on property values. In other words, due to noise from the rail or air pollution from the train, properties that are located near the station might have lower prices. Figure 3.6 shows the plot of land price and the distance to the station (Four sampled properties have extremely high values and they are excluded from the plot to make the curve and plot more clear). It is clear that nuisance effect of Austin MetroRail exists along the rail line. However, the approximate range of the nuisance effect could be

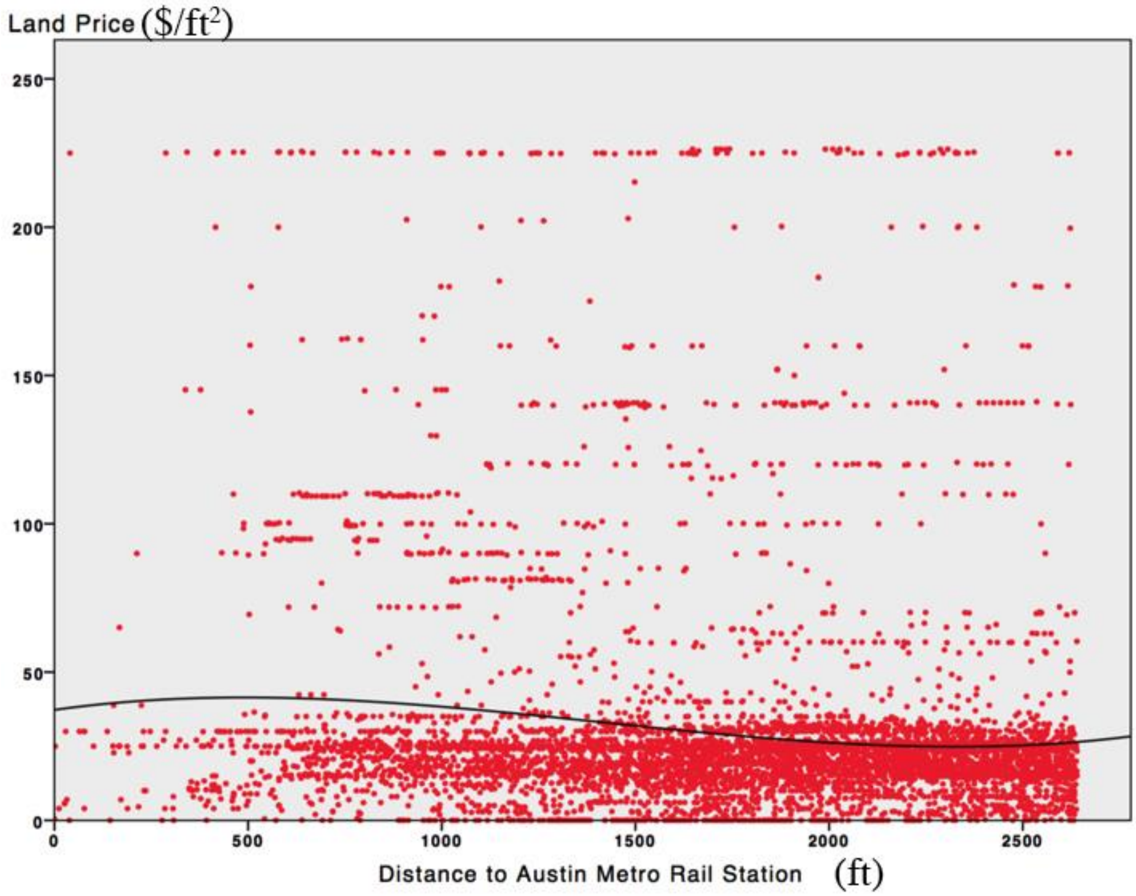

Figure 3.6 Plot of Land Price and Distance to the Transit Station

estimated in the plot is less than 500 ft., which only includes a very small sample.

Therefore, in the following study, nuisance effect will not be studied. The weak nuisance effect of the Austin MetroRail line can be accounted for several reasons. For one, compared to other commuter rail systems, Austin MetroRail runs very quietly thanks to high technology of the train, not generating too much noise along the rail line. Therefore the following study will only focus the general land value change along the line.

3.7 DESCRIPTIVE STATISTICS

Table 3.2 summarized the basic statistics of independent and dependent variables in the study including the means and standard deviations. After initial selection of parcels in the ArcGIS using the ½ mile buffer (parcels which are completely located within or partially intersect with the buffer area), there were 6696 parcels selected including 439 parcels from the Williamson County and 5830 parcels from the Travis County. However, most of the data from the Williamson County have missing property value information and were excluded in ArcGIS, leaving only 120 sampled parcels in the end. Travis County database is much more accurate and comprehensive and basically contains complete information for every sample parcel.

The average land price in 2014 in sampled areas is 30.63 dollars per square foot with a standard deviation of 48.96.

Table 3.2 Descriptive Statistics

Descriptive Statistics							
	N	Range	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Dependent Variable							
Land Price ($/sq. ft.)	5955	2251.19	0.00	2251.19	30.63	0.63	48.96
Independent Variable							
Distance to Central Business District (ft.)	5955	124215.25	0.00	124215.25	18407.56	220.89	17046.08
Distance to Train Station (ft.)	5955	2639.95	0.00	2639.95	1758.07	7.56	583.41
Dummy Variable for Highway Accessibility (1=YES, 0=NO)	5955	1.00	0.00	1.00	0.33	0.01	0.47
Median Household Income ($)	5955	110366.00	19397.00	129763.00	55519.73	324.69	25055.50
Population Density (sq. miles)	5955	9908.73	96.70	10005.43	4659.42	23.15	1786.28
Employment Density (sq. miles)	5955	6830.69	44.62	6875.31	2775.69	14.66	1131.02
Median Year Built	5955	63.00	1943.00	2006.00	1968.86	0.23	17.99
Improvement Values ($)	5955	196807678.00	0.00	196807678.00	673691.13	76225.93	5882251.50

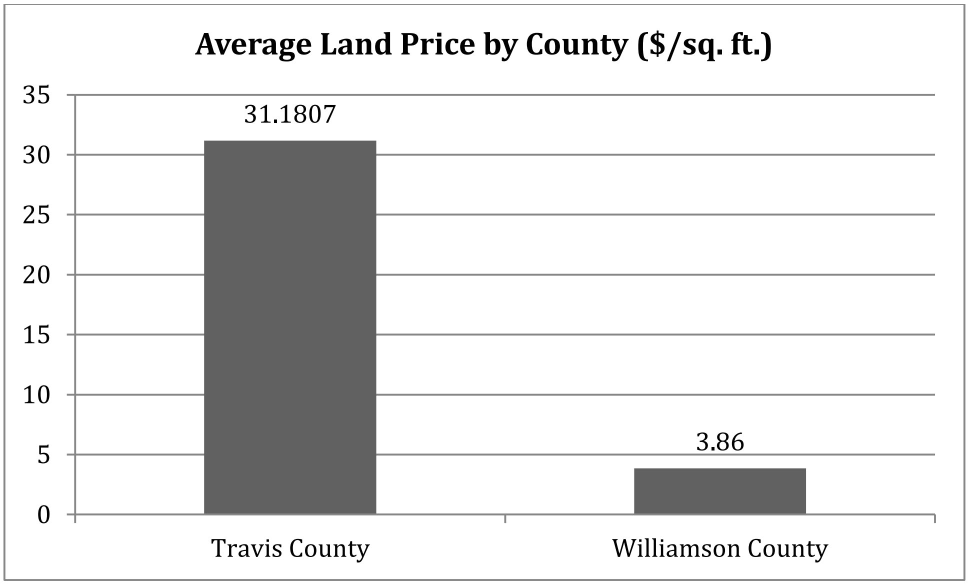

Figure 3.7 Average Land Price in the Study Area for Two Counties

Figure 3.7 shows different average land price of properties located in the study area for two different counties. Since the land price data are only from the study area, it might not reflect the total average land price for two entire two counties.

The average land price for Williamson County is approximately 3.86 dollars per square foot in the sampled area while the average price in Travis County reaches 31 dollars per square foot, which could indirectly implies the unchallenged economic leading role of Austin in the Greater Austin area. In terms of the improvement values, some extreme values have been identified by ArcGIS and those parcels whose improvement values are extremely high are all located near the Central Business District study area. However, those extreme cases would not have significant influences on the study results. Before the study, Pearson's correlation was also calculated to avoid multicollinearity in the model for all the independent variables. Independent variables which have Pearson's value larger than 0.7

or smaller than -0.7 have been eliminated to guarantee the precision of estimation. Also Pearson's value could be used as the pre-test tool to examine the relevance between the dependent variable and independent variables.

3.8 Findings from Hedonic Model

3.8.1 All Station Model

In this study, the first model was run to estimate the impact of Austin Capital MetroRail on property values for all the nine stations that are located throughout two different counties. All the eight selected independent variables listed in the Table 3.1 are included in the first model.

3.8.2 Hypothesis

A vast body of studies has proved the positive impact of transit proximity on property values. This study assumes that within the study area, as distance to the station decreases, property values will increase.

3.8.3 Study Results

Two different regression models were developed as different forms of hedonic model to explain the relationship between study variables, as the purpose of using different models is to test the reliability of the result. The first regression model is the linear regression model and the second is the semi-log regression model.

Table 3.3 Linear and Semi-Log Regression Model Results

Linear Regression Model					**Semi-Log Regression Model**				
Dependent Variable: Land Price $/square foot					**Dependent Variable: log (Land Price) $/square foot**				
Independent Variable	**Coefficients**	**Std. Error**	**t value**	**Sig.**	**Independent Variable**	**Coefficients**	**Std. Error**	**t value**	**Sig.**
Location Attributes					***Location Attributes***				
Distance to CBD	-0.001	0	-25.963	.000	Distance to CBD (In Thousand feet)	-.013	.000	-51.811	.000
Distance to Station	-0.003	0.001	-3.214	.001	Distance to Station (In Thousand feet)	-.015	.007	-2.209	.027
Highway Accessibility	2.848	1.179	2.416	.016	Highway Accessibility	.082	.009	9.487	.000
Neighborhood Characteristics					***Neighborhood Characteristics***				
Median Household Income	0.001	0	28.115	.000	Median Household Income	.005	.000	4.780	.000
Population Density (per mile^2)	0.003	0.001	4.493	.000	Population Density (in 1000 People per mile^2)	.007	.005	1.253	.210
Employment Density per mile^2)	-0.006	0.001	-5.2148	.000	Employment Density (in 1000 People per mile^2)	.014	.009	1.615	.106

Table 3.3 (Continued) Linear and Semi-Log Regression Model Results

Linear Regression Model					**Semi-Log Regression Model**				
Dependent Variable: Land Price $/square foot					**Dependent Variable: log (Land Price) $/square foot**				
Independent Variable	**Coefficients**	**Std. Error**	**t value**	**Sig.**	**Independent Variable**	**Coefficients**	**Std. Error**	**t value**	**Sig.**
Land Attributes					***Land Attributes***				
Median Building Built Year	0.581	0.033	17.589	.000	Median Building Built Year	.001	.000	4.780	.000
Improvement value	0.001	0	13.132	.000	Improvement value	4.831E-06	.000	7.649	.000
(In Thousand Dollars)					(In Thousand Dollars)				
(Constant)	-1132.866	64.637	-17.526	.000	(Constant)	-1.051	.462	-2.273	.023
Summary Statistics					***Summary Statistics***				
No. Observations	5955	**P<0.05, significant at the 0.05 level			No. Observations	5955	**P<0.05, significant at the 0.05 level		
R squared Value	0.371				R squared Value	0.515			

R squared value in statistics shows the general proportion of dependent variables that could be explained by independent variables in regression models. Usually it could be used as to estimate the association of the whole regression model. In the linear regression model for all the nine stations, the R squared value is 0.371, implying that approximately 37% of the variability of the dependent variable could be explained in this regression model and for the semi-log regression model, the R squared is 0.515.

P value and t value in the model result suggest the statistical significance of coefficients of independent variables and the statistical significance of independent variables in regression model, accordingly. When the absolute value of a T value for an independent variable is larger than 2, it means that the independent variable is statistically significant. When P value is smaller than the significance level used in the regression analysis, it means that coefficient of a given independent variable is statistically significant. Table 3.3 shows that the all of the nine independent variables as well as their coefficient are statistically significant except for employment density and population density in the semi-log model.

a. Transit Proximity

Although most of the transit proximity studies have suggested transit proximity should be capitalized into property values, some studies proved the existence of nuisance effect from the transit or insignificant impact of transit proximity. In this model, because measurement of continuous scales could more accurately measure the extent of transit proximity impact, proximity to transit is measured as continuous scales rather than the distance bands, which have been very popular in relevant studies.

Regression model result suggests proximity to Austin Capital MetroRail transit should be capitalized into property values. More accurately, regression results show every

1-foot closer to transit station, property values will increase approximately \$0.003 /ft^2. Since land is always sold in the measurement of acres, the regression result could be then explained as every 100-foot further away from the train station, property values will decease about \$13,068/acre. Although being near Austin Capital MetroRail generates relatively small transit premium compared with the capitalization benefits of transit systems in other major U.S cities, the finding still shows the reflection that the land market in Austin values the transit proximity to some extent.

Austin, as one of the fastest growing metropolitan in United State, has seen a rapid population growth in recent years. However, transportation infrastructure has not been able to cope with the fast expansion of the city. According to a study, Austin ranks the fourth among U.S metropolitan areas in terms of traffic congestion score (23.3) in 2014 and it is among the only five cities with a score above 20 (INRIX, 2014). It is expected that being near transit could attract more commuters to turn to public transportation. However, the low ridership of Austin rail transit from its opening to now also fails to bring the city with improvement which people would usually expect-traffic congestion or long commuting time as before. While the existing rail line still has its own financial or ridership issues, another controversial light rail transit, which was to alleviate traffic congestion, has been proposed and was voted down recently (see figure 3.8). In addition to measuring how land market values transit proximity, the study result could shed light on public transportation investment and help in decision-making process in future.

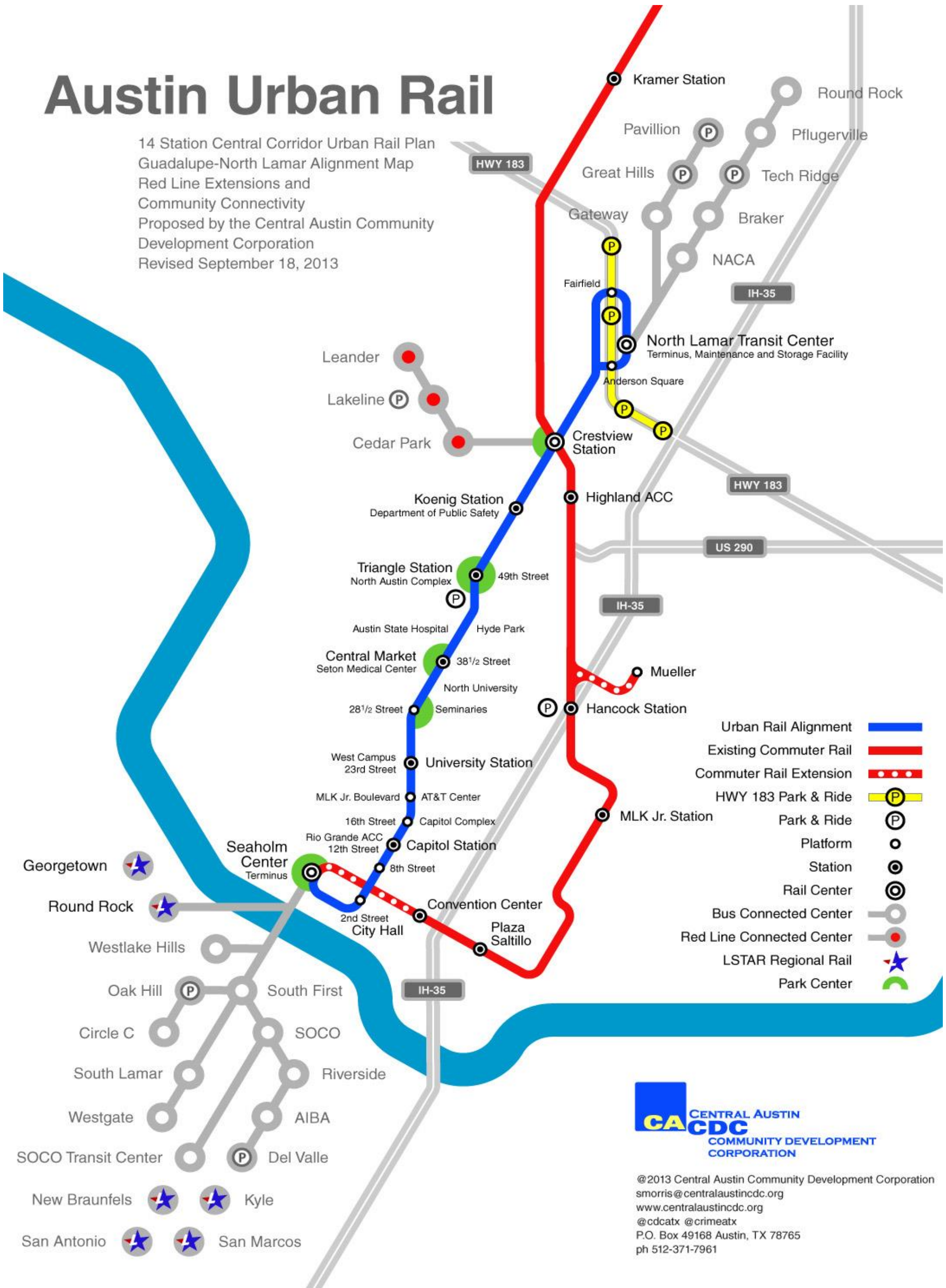

Figure 3.8 Austin MetroRail Map and Proposed Rail Map

Source: centralaustincdc.org

3.8.4 Interpretations of Other Study Variables

a. Location Attributes

Land price will increase approximately $1/ft^2, or $43,560/acre for every 1000 feet closer from property to the central business district. This finding is consistent with the empirical location theory. In terms of the highway accessibility, the models suggest a positive effect. For properties that have access to highways within ½ mile distance, land price will be $2.8/ft^2 higher than those fall out of the area without highway access, indicating land market values highway accessibility.

b. Neighborhood Characteristics

Among variables that describe neighborhood characteristics, median house values and neighborhood population density show positive impact on property values. Every $10,000 increase in household income leads to $10/ft^2 in land price, indicating that land is sold with higher price in higher income neighborhoods; and in neighborhood that are denser land price is higher. Regression results suggested that employment has a negative effect on property values, which is contrary to most of the empirical studies. In fact, two regression models show different results from each other regarding the employment density. And in the semi-log model, the results of relationship between employment and land price matches with empirical studies. Several reasons could be accounted to this result. For one, it should be aware of the possible multicollinearity problem exists between different independent variables (see Appendix F). To solve this problem, partial regression analysis should be used to look into their relationship in which the independent variable will be separated in the study. Another reason might be along the rail line the relationship among land use pattern, employment and land price does not follow the general trend found in other studies and therefore more detailed study should be conducted. However, it should be kept in mind that most of the study variables are consistent in the two models and it is more important to keep the focus variables consistent in different models.

c. Land attributes

Both improvement values and median year built for land have shown positive relationship with the land price. Researchers have studied the relationship between improvement values and land prices and found that improvement values have positive effects on property values, that is, higher value of improvements on land will cause higher land price in America cities (Brigham, 1965; Haughwout, Orr, & Bedoll, 2008)

The regression results of the relationship match with most of the empirical studies. For every $100,000 increase in improvement values, land price will be $0.114 higher per square foot. In terms of the median year built, newly built neighborhood have higher land price----every 10 years younger for a community, the land price will have a $5.8 premium.

3.8.5 Standardized Coefficient

While the regression model only measures separate impacts of independent variables, comparison of all the independent variables is impossible. The standardized coefficient from the linear regression model then can be calculated to help overcome this issue.

Table 3.4 Standardized Coefficient

Independent Variable	Standardized Coefficients
Location Attributes	
Distance to CBD	-.295
Distance to Station	-.035
Highway Accessibility	.027
Neighborhood Characteristics	
Median Household Income	.369
Population Density	.121
Employment Density	-.140
Land Attributes	
Median Building Built Year	.213
Improvement value	.137

Table 3.4 shows that the distance to central business district and the median household income are the most influential study variables in this study. Proximity to rail station and highway accessibility have the least influence on land price.

While the regression model for all the nine stations can only be used to interpret the cumulative effects of the rail line, specific studies for individual station or residential property study could explore more about the transit proximity impacts. To better assess how residents value the transit proximity, another model is run to measure the transit proximity on only the residential property. However, due to limited data availability, Williamson Central Appraisal District database is not providing the information on property types while Travis Central Appraisal District database does. So the two stations in Williamson County have to be excluded. In addition, the excluded two stations-the

Lakeline station and the Leander station-are both located in the suburb area of Austin where rail transit is not traditionally being valued as important. Therefore, the second model is only limited to seven stations, all of which are located in Travis County.

3.9 REGRESSION MODEL FOR PROPERTY LOCATED IN CITY OF AUSTIN

Independent variables are kept the same with the first model except for several newly added independent variables. In addition, median household income was categorized into three groups: low median household income (x<36,000), middle household income (36,000<x<100,000) and high median household income (x>=100,000). By doing this, the impact of transit proximity impact could be explored in more comprehensive dimensions. In following data analysis, these three groups were created into two dummy variables. Another newly added independent variable is the property type. In addition, to better explore the location theory, two independent variables-highway accessibility and distance to transit station- have been interacted with dummy variables representing the neighborhood income levels. More specific description of new independent variables is shown in Table 3.5.

Table 3.5 New Independent Variable Description

Independent Variable	Description	Data Source
Median Household Income Level	1.Low (Income<$36,000) 2.Middle (36,000<x<100,000) 3.High (x>=100,000)	American Community Survey 5-year estimates
Property Type	1= Residential 2= non-residential	TCAD and WCAD database

**TCAD and WCAD: Travis/ Williamson Central Appraisal District*

Table 3.6 Regression Model for Property Located in city of Austin

Independent Variable	Coefficients	Sig.(p value)
Location Attributes		
Distance to CBD	-0.0005	.000
Distance to Station	-0.038	.000
Highway Accessibility	-26.348	.000
Neighborhood Characteristics		
Low Income Neighborhoods	-123.709	.000
Middle Income Neighborhoods	-122.396	.000
Population Density	-0.005	.000
Employment Density	0.005	.000
Land Attributes		
Median Building Built Year	0.474	.000
Improvement value (In Thousand Dollars)	0.001	.000
Dummy Variable		
Low Income (1=Yes;0=No)	-155.183	.000
Middle Income (1=Yes;0=No)	-146.945	.000
Interaction		
Distance to Transit Station by Low Income	0.045	.000
Distance to Transit Station by middle Income	0.04	.000
Highway accessibility by low income	37.087	.000

Table 3.6 (Continued) Regression Model for Property Located in city of Austin

Independent Variable	Coefficients	Sig.(P Value)
Highway accessibility by middle income	18.38	.000
(Constant)	-749.692	
Summary Statistics		
No. Observations	5835	
R squared Value	0.417	

*Property type (1=residential; 0=non-residential) is not statistically significant at either 0.05 or 0.10 level so it is excluded from this model.

**All independent variable significant at .05 significant level

3.10 REGRESSION RESULTS

Because of different station selection (seven stations in Austin) this regression model shows different outcomes compared to the first model with all the nine stations. For location attributes, distance to CBD has a very slight impact on property values and the impact of highway accessibility on property values varies in different neighborhoods. Table 3.7 shows the detailed impacts after taking the interaction terms into consideration.

Table 3.7 Highway Accessibility and Its Impact on Property Values.

Neighborhood	Income	Highway Accessibility Impacts
High Income	100,000 or more	-26.348
Median Income	36,000-100,000	-8
Low Income	0-36,000	10.8

For low-income neighborhoods, highway accessibility within one-half miles is valued and should be capitalized into land values. The premium for low income neighborhoods is $10.8 if the land is within a half-mile radius of highway. However, for both high-income and middle-income neighborhoods, highway accessibility has negative effects and is much more significant in high-income neighborhoods, indicating nuisance effect of highway and different land purchase preferences for middle or higher class from low income class.

The cumulative effect of rail transit for the seven stations located only in city of Austin suggests different results in different neighborhoods. Table 3.8 shows the study results,

Table 3.8 Transit Proximity Effect in Different Neighborhoods

Neighborhood	**Income**	**Transit Proximity Impacts (coefficients)**
High Income	100,000 or more	-0.04
Median Income	36,000-100,000	0.002
Low Income	0-36,000	0.007

Interestingly, study results show different transit proximity impacts in different neighborhood. In high-income neighborhoods, transit proximity is capitalized into property values-for every 100 feet closer to station, the price premium is $4/ft^2 and compared to other groups, transit proximity has more significant impact on property values in higher income neighborhood. For middle-income neighborhoods and low-income neighborhoods, every 100 feet further away from transit station will lead to $0.2/ft^2 and $0.7/ft^2 decrease in land price. Traditionally, transit proximity theory holds that transit can provide higher access to job centers, restaurants, schools and other activity centers because of the tendency of mode choice of rail transit. But the study shows that only in high-income neighborhoods can transit proximity be capitalized into property values. It is always assumed that low-income neighborhood residents might value more about transit proximity due to high gas price of driving alone. However, considering the facts of very low ridership of Austin MetroRail line and most of people in those study areas still prefer driving, land market doesn't value transit proximity as an influential factor in deciding land price. Along with the first model, this one suggests that proximity to transit should be capitalized into property values but shouldn't be considered influential. As the rail line passes through different neighborhoods in Austin and its suburban areas, transit proximity effect might be different at station level.

3.11 STATION LEVEL STUDY

To better understand the transit proximity effects, stations were then grouped into different groups based on location-Adjacent stations are in the same study group because their potentially similar effects of parcels nearby. Table 3.9 shows the groups of different stations. Detailed regression model results are shown the appendix A, B, C, D and E.

Table 3.9 Transit Proximity Effect in Different Study Area

Station Group	**Transit Proximity Impact (Regression model coefficient)**	**sig**	**Sample Size**
Downtown and Plaza Saltillo	-0.008	.000	2030
MLK Station	Not significant		1593
Highland and Crestview	0.003	.000	2006
Kramer	-0.007	.000	130
Howard	-0.008	.000	76
Leander	Not significant		67
Lakeline	Not significant		54

As it is shown in table 3.9, MLK, Leander and Lakeline station study areas don't have significant transit proximity premiums. For Downtown and Plaza Saltillo study area, transit proximity has negative relationship with land price-as the distance to station decreases, land price will increase. This study area is located near Austin CBD where there are large numbers of job opportunities and city residents. Proximity to the Kramer study area and Howard study area has statistically significant relationship with the land price as well. However, the Highland and Crestview study area is different- proximity to transit is has a positive relationship with land price. One of the reasons which lead to the opposite result might be the inaccurate predictability of the regression model- some study variables are not significant. Another reason could be the fact that nuisance effect is strong in this study area, which leads to the opposite results.

Chapter IV: Conclusion and Policy Suggestions

Although Austin CapMetro currently is running the train at a faster speed, providing upgraded station or riding services with more available schedules, since its first operation in 2010 Austin MetroRail still has relatively low ridership compared with similar transit systems in other major U.S cities.

This study used Hedonic model approach to analyze the relationship between transit proximity and its impact on property values in Austin. As most empirical studies have suggested, transit proximity should be capitalized into property values. Ultimately, the model results confirm the traditional transit capitalization theory that accessibility to the rail transit can cause increase in property values.

Generally, in terms of the rail line as a whole, despite the fact that commuter rail has not been significantly valued by the locals- controversial opinions about the rail line and the low ridership- transit proximity to Austin MetroRail should be capitalized into property values. The price premium is for every 1,000 feet closer to the station, land price will increase around $3/ft^2. However, the impact is not significant and the weak relationship could be explained by several possible reasons. For instance, limited regional accessibility of the rail might lead to relatively low ridership between origins and destinations and subsequently make the rail line less influential. Among other study variables, the proximity to downtown Austin, highway accessibility, population and employment density, median household income, median year built and improvement values have significant impacts on land prices. When converted to standardized coefficients, among those study variables, median household income, house built years and distance to downtown Austin are the most influential ones.

For aggregated station level study, regression models have shown different results. For some stations areas including the downtown and Plaza Saltillo, Kramer and Howard areas, transit proximity have relatively higher impact on land price changes and transit proximity should be capitalized into property values. In the meantime, the relationship between transit proximity and land prices is not always consistent with traditional transit proximity theory in this study---Station area study results also suggested that for some of the study areas transit proximity should not be capitalized into property values. These stations include the Highland and Crestview area where property values will decrease, as properties get closer to these stations.

Research has also been conducted to study the impact of transit proximity on property values in different neighborhoods. It is expected that residents in low-income neighborhoods will be likely to pay more in transit premium. However, it is interesting to see that transit premium only happens in high-income neighborhoods while in low-income and middle-income neighborhoods transit proximity doesn't have any positive effect on land prices.

These findings confirm the hypothesis that transit proximity should be capitalized into property values in Austin. However, the transit proximity effect is very weak in this case, suggesting that Austin is still dominantly auto-oriented. In addition, for some certain locations, transit proximity has either no effects or nuisance effects. And this seemingly complicated relationship between transit proximity and land prices might indicate the unimportance of MetroRail in Austin.

Study results of the relationship between transit proximity and its impact on land prices could inform several possible recommendations in terms of future planning and policy making.

The statistical result confirmed the measurable transit premium values of Austin MetroRail and might indicate revenue opportunities for future capital investment or public improvement. While the local governments use different strategies to capture added value from public transit improvement through enlarging tax base, increased property tax or Tax-Increment Financing, etc., this study might provide certain guidance in making those decisions. Therefore for some neighborhoods, transit proximity indicates as potential revenues for local governments and value captured from the land premium in those benefiting neighborhoods can be used to fund improvement projects in low-income neighborhoods which currently don't not enjoy transit proximity premium.

'Mass transit needs mass.' It has been long recognized that local commitment to ridership from either employment or population density should be supportive to make public transit investment pay off. Therefore, increasing land use densities around station areas, encouraging local business to bring more employment or changing zoning or land use planning patterns should be prioritized in future planning design around transit stations.

Study results also imply development opportunities around station areas along the Austin MetroRail line. Relevant research has suggested that higher land values around the transit station will encourage 'high-density and transit-oriented development' (Knaap, Ding, & Hopkins, 2001). These development patterns can lead to more condensed development, less congestion and increased ridership of the transit and subsequently attract more land development and investment around the station areas, especially considering the fact that the city of Austin is focusing its long-term transportation plan in creating transit-supportive city by optimizing land use around high-quality transit (Planning and Development Review Department, 2014).

Appendix A: Regression Result of Study Area Level for Downtown and Saltillo Station

Model Summary					
R	R Square	Adjusted R Square	Std. Error of the Estimate	Sample Size	
.655	.429	.427	56.003	2030	
ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	4770267.223	8	596283.403	190.123	.000[b]
Residual	6338457.081	2021	3136.297		
Total	11108724.304	2029			
Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-322.050	135.499		-2.377	.018
Distance to CBD	-.018	.001	-.487	-15.525	.000
Distance to Station	-.008	.003	-.069	-3.302	.001
Improvement Value	8.018E-07	.000	.104	6.016	.000
Median Year Built	.244	.068	.083	3.567	.000
Population Density	.005	.002	.119	2.709	.007
Employment Density	-.010	.004	-.142	-2.685	.007
Income	.000	.000	.215	4.979	.000
Highway Accessibility	-31.047	3.235	-.198	-9.596	.000

Appendix B: Regression Result of Study Area Level for MLK station

Model Summary					
R	R Square	Adjusted R Square	Std. Error of the Estimate	Sample Size	
.620	.385	.382	5.93901	1593	
ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	34950.670	8	4368.834	123.862	.000[b]
Residual	55870.564	1584	35.272		
Total	90821.233	1592			
Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	275.099	83.725		3.286	.001
Distance to CBD	-.002	.000	-.380	-15.262	.000
Distance to Station	**.000**	**.000**	**.035**	**1.440**	**.150**
Improvement Value	-2.933E-06	.000	-.127	-6.220	.000
Median Year Built	-.123	.042	-.139	-2.959	.003
Population Density	.000	.000	.074	1.540	.124
Employment Density	.001	.000	.079	1.609	.108
Income	.000	.000	.269	4.828	.000
Highway Accessibility	.968	6.165	.003	.157	.875

Appendix C: Regression Result of Study Area Level for Highland and Crestview

Model Summary					
R	R Square	Adjusted R Square	Std. Error of the Estimate	Sample Size	
.541[a]	.292	.289	10.756	2006	
ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	95409.338	8	11926.167	103.079	.000[b]
Residual	231051.769	1997	115.699		
Total	326461.108	2005			
Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1799.145	107.708		16.704	.000
Distance to CBD	-.001	.000	-.167	-6.871	.000
Distance to Station	.003	.000	.132	6.465	.000
Improvement Value	1.557E-06	.000	.152	7.885	.000
Median Year Built	-.901	.055	-.452	-16.345	.000
Population Density	-.001	.001	-.121	-1.092	.275
Employment Density	.002	.001	.195	1.825	.068
Income	8.215E-05	.000	.083	3.309	.001
Highway Accessibility	1.441	.924	.048	1.560	.119

Appendix D: Regression Result of Study Area Level for Kramer

Model Summary					
R	R Square	Adjusted R Square	Std. Error of the Estimate	Sample Size	
.590[a]	.348	.311	59.598	130	
ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	231457.103	7	33065.300	9.309	.000[b]
Residual	433336.375	122	3551.938		
Total	664793.479	129			
Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-5828.341	2923.730		-1.993	.048
Distance to CBD	-.022	.005	-.387	-4.107	.000
Distance to Station	-.007	.008	-.070	-.883	.079
Improvement Value	-2.536E-06	.000	-.315	-3.042	.003
Median Year Built	3.433	1.531	.511	2.243	.027
Employment Density	.028	.015	.291	1.894	.061
Income	.000	.001	-.077	-.397	.692
Highway Accessibility	182.039	30.478	.612	5.973	.000

Appendix E: Regression Result of Study Area Level for Howard

Model Summary					
R	R Square	Adjusted R Square	Std. Error of the Estimate		
.532	.283	.209	11.1794		

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Regression	3348.905	7	478.415	3.828	.001[b]
Residual	8498.507	68	124.978		
Total	11847.413	75			

Coefficients					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-2105.719	897.937		-2.345	.022
Distance to CBD	-.006	.002	-.613	-2.890	.005
Distance to Station	-.008	.003	-.362	-3.147	.002
Improvement Value	2.743E-07	.000	.113	.991	.325
Median Year Built	1.284	.495	.661	2.592	.012
Employment Density	-.002	.002	-.274	-1.320	.191
Median Income	-.001	.000	-.786	-3.658	.000
Highway Accessibility	-.357	4.461	-.009	-.080	.936

Appendix F: Multicollinearity Table of Study Variables

Correlations										
		Land Price	Distance to CBD	Distance to Station	Highway Accessibility	Median Income	Population Density	Employment Density	Median Year Built	Improvement Values
Land Price	Pearson Correlation	1	-.285**	-.123**	.203**	.469**	.065**	.105**	.372**	.230**
	Sig. (2-tailed)		.000	.000	.000	0.000	.000	.000	.000	.000
	N	5955	5955	5955	5955	5955	5955	5955	5955	5955
Distance to CBD	Pearson Correlation	-.285**	1	.098**	-.070**	-.005	-.359**	-.296**	.106**	-.024
	Sig. (2-tailed)	.000		.000	.000	.728	.000	.000	.000	.060
	N	5955	5955	5955	5955	5955	5955	5955	5955	5955
Distance to Station	Pearson Correlation	-.123**	.098**	1	-.027*	-.139**	.196**	.095**	-.068**	-.025
	Sig. (2-tailed)	.000	.000		.039	.000	.000	.000	.000	.053
	N	5955	5955	5955	5955	5955	5955	5955	5955	5955
Highway Accessibility	Pearson Correlation	.203**	-.070**	-.027*	1	.201**	-.111**	-.177**	.277**	.068**

	Sig. (2-tailed)	.000	.000	.039		.000	.000	.000	.000	.000
	N	5955	5955	5955	5955	5955	5955	5955	5955	5955
Median Income	Pearson Correlation	.469**	-.005	-.139**	.201**	1	.046**	.225**	.447**	.138**
	Sig. (2-tailed)	0.000	.728	.000	.000		.000	.000	.000	.000
	N	5955	5955	5955	5955	5955	5955	5955	5955	5955
Population Density	Pearson Correlation	.065**	-.359**	.196**	-.111**	.046**	1	.898**	-.186**	-.027*
	Sig. (2-tailed)	.000	.000	.000	.000	.000		0.000	.000	.038
	N	5955	5955	5955	5955	5955	5955	5955	5955	5955
Employment Density	Pearson Correlation	.105**	-.296**	.095**	-.177**	.225**	.898**	1	-.112**	-.012
	Sig. (2-tailed)	.000	.000	.000	.000	.000	0.000		.000	.360
	N	5955	5955	5955	5955	5955	5955	5955	5955	5955
Median Year Built	Pearson Correlation	.372**	.106**	-.068**	.277**	.447**	-.186**	-.112**	1	.155**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.000

	N	5955	5955	5955	5955	5955	5955	5955	5955	5955
Improvement Values	Pearson Correlation	.230**	-.024	-.025	.068**	.138**	-.027*	-.012	.155**	1
	Sig. (2-tailed)	.000	.060	.053	.000	.000	.038	.360	.000	
	N	5955	5955	5955	5955	5955	5955	5955	5955	5955
**. Correlation is significant at the 0.01 level (2-tailed).										
*. Correlation is significant at the 0.05 level (2-tailed).										

BIBLIOGRAPHY

Al-Mosaind, M. A., Dueker, K. J., & Strathman, J. G. (1993). Light-Rail Transit Stations and Property Values: A Hedonic Price Approach. *Transportation Research Record*, *1400,* 90-94.

American Public Transportation Association (APTA). (2014, 12 10). *Ridership Report Archives*. Retrieved 1 20, 2015, from American Public Transportation Association (APTA): http://www.apta.com/resources/statistics/Documents/Ridership/2014-q3-ridership-APTA.pdf

Armstrong, R. J. (1994). Impacts of Commuter Rail Service as Reflected in Single-Family Residential Property Values . *Transportation Research Record* (1466), 88-98.

Armstrong, R. J., & Rodríguez, D. A. (2006). An Evaluation of the Accessibility Benefits of Commuter Rail in Eastern Massachusetts using Spatial Hedonic Price Functions. *Transportation, 33*(1), 21-43.

Arndt, J. C., Morgan, C., Overman, J. H., & Clower, T. L. (2009). *Transportation, Social and Economic Impacts of Light and Commuter Rail.* Texas Transportation Institute.

Benjamin, J. D., & Sirmans, S. (1996). Mass Transportation, Apartment Rent and Property Values. *Journal of Real Estate Research*, *12*(1), 1-8.

Bowes, D. R., & Ihlanfeldt, K. R. (2001). Identifying the Impacts of Rail Transit Stations on Residential Property Values. *Journal of Urban Economics*, *50*(1), 1-25.

Brigham, E. F. (1965, 11). The Determinants of Residential Land Values. *Land Economics, 41*(4), 325-334.

Capital Metro. (2014). *Data and Statistics*. Retrieved from Capital Metro Web site: http://www.capmetro.org/stats/

Central Austin CDC. (2014). *Austin Urban Rail*. Retrieved 3 20, 2015, from Central Austin CDC: http://centralaustincdc.org/transportation/austin_urban_rail.htm

Cervero, R. (1984). Light Rail Transit and Urban Development. *Journal of the American Planning Association*, *50*, 133-147.

Cervero, R. (1996). Transit-Based Housing In The San Francisco Bay Area: Market Profiles And Rent Premiums. *Transportation Quarterly, 50*(3), 33-49.

Cervero, R. (2004). Effects of Light and Commuter Rail Transit on Land Prices: Experiences in San Diego County. *Journal of the Transportation Research Forum, 43*(1), 121-138.

Cervero, R., & Aschauer, D. (1998). *Report 35: Economic Impact Analysis of Transit Investments: Guidebook for Practitioners.* Washington, D.C.: National Academy Press.

Cervero, R., & Duncan, M. (2002a). Benefits of proximity to rail on housing markets: Experiences in Santa Clara County. *Journal of Public Transportation, 5*(1), 1-18.

Cervero, R., & Duncan, M. (2002b). Transit's Value-Added Effects: Light And Commuter Rail Services And Commercial Land Values. *Transportation Research Record*(1805), 8-15.

Cervero, R., & Landis, J. (1995). BART at 20: land use impacts. *74th Annual Meeting of the Transportation Research Board.* Washinton,DC: Transportation Research Board.

Chen, H., Rufolo, A., & Dueker, K. J. (1998). Measuring the Impact of Light Rail Systems on Single-Family Home Values: A Hedonic Approach with Geographic Information System Application. *Transportation Research Record, 1617*(1), 38-43.

Debrezion , G., Pels , E., & Rietveld , P. (2007, 8 1). The impact of railway stations on residential and commercial property value: a meta-analysis . *The Journal of Real Estate Finance and Economics , 35*(2), 161-180.

Dueker, K. J., & Bianco, M. J. (1999). Light-Rail-Transit Impacts In Portland: The First Ten Years. *Transportation Research Record*(1685), 171-180.

Forrest, D., Glen, J., & Robert, W. (1996, 1). the Impact of a Light Rail System on the Structure of House Prices. *Journal of Transport Economics and Policy, 30*, 15-29.

Garrett, T. A. (2004). *Light-Rail Transit in America ： Policy Issues and Prospects for Economic Development.* Federal Reserve Bank of St. Louis. St. Louis: Federal Reserve Bank of St. Louis.

Gatzlaff, D. H., & Smith, M. T. (1993, 2). The Impact of the Miami Metrorail on the Value of Residences near Station Locations. *Land Economics, 69*(1), 54-66.

Guerra, E., Cervero, R., & Tischler, D. (2012). Half-Mile Circle: Does It Best Represent Transit Station Catchments? *Transportation Research Record: Journal of the Transportation Research Board , 2276*, 101-109.

Haughwout, A., Orr, J., & Bedoll, D. (2008). The Price of Land in the New York Metropolitan Area. *14*(3).

Hess, D. B., & Almeida , T. M. (2007). Impact of Proximity to Light Rail Rapid Transit on Station-area Property Values in Buffalo, New York. *Urban Studies, 44*(5-6), 1041-1068.

INRIX. (2014). *The INRIX Traffic Scorecard*. Retrieved 3 20, 2015, from INRIX Company Web site: http://www.inrix.com/scorecard/

Knaap, G. J., Ding, C., & Hopkins, L. D. (2001, September). Do Plans Matter? The Effects of Light Rail Plans on Land Values in Station Areas. *Journal of Planning Education and Research , Vol. 21*(no. 1), 32-39.

Kockelman, K. (1997). The Effects Of Location Elements On Home Purchase Prices And Rents: Evidence From The San Francisco Bay Area. *Transportation Research Board*(1606), 40-50.

Landis, J., Guhathakurta, S., Huang, W., Zhang, M., & Fukuji, B. (1995). *Rail Transit Investments, Real Estate Values, and Land Use Change: A Comparative Analysis of Five California Rail Transit Systems.* UC Berkeley , Institute of Urban and Regional Development.

Lewis, W. S., & Brod , D. (1997, 11). Measuring The Neighborhood Benefits Of Rail Transit Accessibility. *Transportation Research Record*(1576), 147-153.

Madison, M. C. (2000, 10 13). *The Facts So Far*. Retrieved 3 16, 2015, from the Austin Chronicle: http://www.austinchronicle.com/news/2000-10-13/78940/

Mathur, S., & Smith, A. (2012). *A Decision-Support Framework for Using Value Capture to Fund Public Transit: Lessons from Project-Specific Analyses.* San José, CA: Mineta Transportation Institute.

McMillen, D., & McDonald, J. (2004). Reaction of House Prices to a New Rapid Transit Line: Chicago's Midway Line, 1983-1999. *Real Estate Economics, 32*(3), 463-486.

Nelson, A., & McCleskey, S. (1992). Elevated Rapid Rail Transit Station Price Impacts on Single Family Residential Neighborhoods. *Transportation Research Board*(1359), 127-132.

Pan, Q. (2013). The impacts of an urban light rail system on residential property values: a case study of the Houston METRORail transit line. *Transportation Planning and Technology, 36*(2), 145-169.

Planning and Development Review Department. (2014). *TRANSIT ORIENTED DEVELOPMENT*. Retrieved 4 19, 2015, from City of Austin: https://austintexas.gov/department/transit-oriented-development

Ryan, S. (2005). The Value of Access to Highways and Light Rail Transit: Evidence for Office and Industrial Firms. *Urban Studies, 42*(4), 751-764.

Siethoff, B., & Kockelman, K. M. (2002). Property Values and Highway Expansions: An Investigation of Timing, Size, Location, and Use Effects. *Transportation Research Record, 1812*, 191-200.

Transportation Research Board of the National Academies. (2003). *Transit Capacity and Quality of Service Manual, 2nd Edition.* Washington, D.C.: Transportation Research Board of the National Academies.

Voith, R. (1993, May). Changing Capitalization of CBD-Oriented Transportation Systems: Evidence from Philadelphia, 1970–1988. *Journal of Urban Economics, 33*(3), 361-376.

Weinberger, R. R. (2001, 1). Light Rail Proximity: Benefit Or Detriment In The Case Of Santa Clara County, California? *Transportation Research Record, 1747*, 104-113.

Weinstein, B. L., Clower, T. L., Means , F., Gage, L. G., Pharr, M., Pettibon, G., & Gillis, S. (2002). *An Assessment Of The Dart LRT On Taxable Property Valuations And Transit Oriented Development.* University of North Texas, Center for Economic Development and Research, Dallas.