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Impacts of Bus Rapid Transit (BRT) on Surrounding Residential Property Values

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Impacts of Bus Rapid Transit (BRT) on Surrounding Residential Property Values

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IMPACTS OF BUS RAPID TRANSIT (BRT) ON SURROUNDING RESIDENTIAL PROPERTY VALUES

Final Report

NITC-RR-894

by

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16. Abstract

As bus rapid transit (BRT) grows in popularity in the United States, a better understanding of the mode's impacts on land uses and property values is needed. Economic theory suggests, and literature has shown, that people are willing to pay higher housing costs to lower their costs of transportation to areas of economic activity. Does high-quality BRT service reliably provide such access and, thereby, increase residential property values? The hypothesis is that property values are higher closer to BRT stations, reflecting a premium for the access provided by the BRT service to various goods, services, employment, education, and recreation. There has been some work on this topic outside of the U.S.; however, due to various cultural, social, and institutional differences, those experiences may not be applicable to U.S. property values. The literature includes, to date, very little work on U.S. BRT systems' impacts on property values using robust econometric techniques and/or spatial modeling. Further, because every BRT system is different, it is necessary to analyze additional case studies to provide a more robust understanding of how modern U.S. experiences with BRT services may affect surrounding property values. This research contributes to the relatively small body of literature on property value impacts of BRT in the U.S. by conducting a case study on Lane Transit District's EmX BRT service (Eugene, Oregon) using econometric modeling techniques to estimate changes in property values associated with the BRT. The analysis is based on hedonic price regression analysis, where sale prices are modeled using several property characteristics that contribute to the market or sale price. The findings of this research indicate that the EmX BRT system does positively impact surrounding single-family home sale prices. Results are statistically significant yet, as expected, relatively small in magnitude. An interesting finding is that the impact of the EmX stations on property values increased in each of the three periods examined in this study. For 2005 single-family home sales, the price increased $823 on average for every 100 meters closer to a station. In 2010, the marginal impact increased to an average of $1,056 for every 100 meters closer to a station. In 2016, every 100 meters closer to a station adds an average of $1,128 to a home's sale price. These results provide further insight into how BRT services can enhance the livability and economic development in a community, and provide policymakers and the transit industry throughout the U.S. with the best information possible to make informed transit investment decisions in their communities.

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EXECUTIVE SUMMARY

As bus rapid transit (BRT) grows in popularity in the United States, a better understanding of the mode's impacts on land uses and property values is needed. Economic theory suggests, and literature has shown, that people are willing to pay higher housing costs in order to lower their costs of transportation to areas of economic activity. Does high-quality BRT service reliably provide such access and, thereby, increase residential property values? The hypothesis is that property values are higher closer to BRT stations, reflecting a premium for the access provided by the BRT service to various goods, services, employment, education, and recreation.

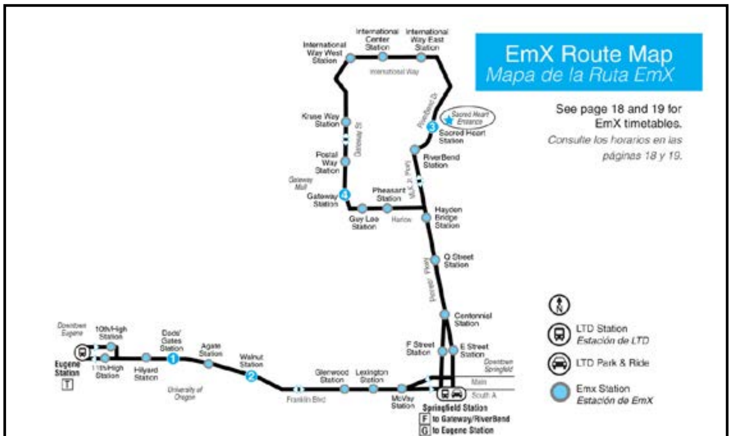
There has been some work on this topic outside of the U.S.; however, due to various cultural, social, and institutional differences, those experiences may not be applicable to U.S. experiences. The literature reveals that, to date, very little work has been done on U.S. BRT systems' impacts on property values using robust econometric techniques and/or spatial modeling (studies on Pittsburgh and Boston have been published). Further, because every BRT system is different, it is necessary to analyze additional modern U.S. case studies. This study contributes to the relatively small body of literature on property value impacts of BRT in the U.S. by analyzing Lane Transit District's Emerald Express (EmX) BRT service (operating in Eugene, Oregon), using econometric modeling techniques to estimate changes in property values associated with the BRT. The analysis is based on hedonic price regression analysis, where sale prices are modeled using a number of property characteristics that contribute to the sale price.

This research fits well with a theme of examining the economic impact of transportation and livable communities. Interestingly, economic theory suggests that the burden of increased housing costs from transit access does not fall directly on residents because they benefit from lower costs of transportation to areas of economic activity. However, the increased property values benefit the local jurisdiction and the community as a whole because related taxes collected from these property owners can pay for transportation and other infrastructure, which can further enhance economic development (i.e., private sector investment) and the livability of the community. Therefore, this research shows that BRT investments can be justified through increased residential property values that, through increased property tax collections, help create and maintain livable communities. By focusing on proximity and walking access to BRT services, this research also relates to another key component of livable communities, which is improved physical health. In essence, this work focuses on the integration and relationship of housing, walking, and the high-quality transit mode of BRT.

Lane Transit District operates the EmX, a full-featured BRT system operating for most of its route alignment along an exclusive median guideway. The EmX is characterized by stylized transit vehicles and other rail-like features including signal priority at intersections, real-time customer information at stations, 10-minute frequencies throughout most of the day, and off-board fare collection. The EmX is distinctively branded and many of its stations include installations of unique public art. Figures ES.1 and ES.2 illustrate the EmX vehicles operating along the BRT corridor and the route alignments.

(Photos courtesy of Lane Transit District)

Figure ES.1: EmX BRT Service



(Courtesy of Lane Transit District)

Figure ES.2: EmX Route Map

Data used for this study include the property characteristics and sales information for single-family homes located within 3 miles of an EmX BRT station. Lane Transit District acted as a liaison with the Lane Council of Governments to help the research team secure the necessary data for this work. In addition, the University of Oregon provided data on students' homes within 3 miles of the EmX alignment.

Three cross-section time periods were selected for analysis;

- 2005 represents a time prior to the implementation of the EmX.
- 2010 represents a few years after the EmX began operating.
- 2016 data are the most recent information available.

Because cross-section analysis is used, each year has its own data set. Each data set was initially populated with the same variables, but the final models do not all contain each of the original variables.

The data were analyzed using ordinary least squares (OLS) regression, after ensuring that the relevant assumptions hold. To address any issues regarding heteroskedasticity of unknown origin as well as other potential pitfalls, the models were run using robust regression, which produces White-Huber robust standard errors.

The key variable of interest in this study, the distance from a home to its nearest BRT station, has the expected negative sign and is statistically significant at the 95 percent level for all three models: 2005, 2010, and 2016. Further, the magnitude of the coefficient increases from 2005 to 2010 and again from 2010 to 2016. This indicates that the effect on sale price of the distance to the BRT station is increasing as the EmX service continues to mature.

For the 2005 model, the coefficient on distance indicates that a 100-meter decrease in distance to a station (i.e., getting closer to the station) increases sale price by $823 on average, holding all other factors constant. This result, prior to the EmX service's starting, may be capturing a premium for being near the corridors. However, it may also be capturing a speculative premium from those homebuyers who knew the upgraded transit service would open in the next couple of years.

In the 2010 model, a 100-meter decrease in distance to a station increases average sale price by $1,056, all else constant. This increase in the magnitude of the coefficient indicates that being closer to the corridor/stations along the operational Franklin Street Corridor is somewhat more favorable in 2010 than in 2005, perhaps due to the implementation of the BRT service. In 2016, with both corridors having several years of operation, the magnitude of the coefficient increases yet again; a 100-meter decrease in distance is associated with a $1,128 increase in the average sale price.

One of the more interesting findings about the impact of BRT is that the magnitude of the distance coefficient increases from 2005 to 2010 and again from 2010 to 2016. This suggests that the impact of the distance to the BRT station on the average estimated sale price of a single-family home is increasing over time, as the EmX service matures.

Overall, these findings suggest that proximity to the EmX BRT stations contributes to a small (but increasing), statistically significant positive impact on the actual market sale prices of single-family homes. To be certain, an impact would be expected to be relatively small when all of the other factors that influence home sale prices are considered.

While the EmX BRT is only one case study, the contribution is expected to be significant on a national scale because it is only the third U.S. study on this particular topic for the BRT mode. As such, there is still a need for even more research on this topic. Future research ideas include applying the methodology to other BRT systems in the U.S., as well as to other types of properties, and also refining the method by using increasingly advanced econometric and/or geo-spatial techniques.

Research questions presented in this report are answered with the results of this study. First, these findings show that residential property values increase with increasing proximity to the Eugene EmX BRT stations. Further, the results from the EmX BRT are comparable in magnitude to those of the other recent studies on BRT in the U.S., and are even comparable, although some cases somewhat lower than, results on BRT outside the U.S. and research results on other modes such as light rail. Finally, the findings of this work provide additional insight into how BRT services can play a measurable role in livability and economic development in a community. These results will provide policymakers and those in the U.S. transit industry with the best, most recent information to assist in making informed transit investment decisions.

1.0 INTRODUCTION

1.1 BACKGROUND

As bus rapid transit (BRT) grows in popularity in the United States, a better understanding of the mode's impacts on land uses and property values is needed. Economic theory suggests, and literature has shown, that people are willing to pay higher housing costs to lower their costs of transportation to areas of economic activity. Does high-quality BRT service reliably provide such access and, thereby, increase residential property values? The hypothesis is that property values are higher closer to BRT stations, reflecting a premium for the access provided by the BRT service to various goods, services, employment, education, and recreation.

There has been some work on this topic outside of the U.S.; however, due to various cultural, social and institutional differences, that may not be applicable to U.S. experiences. The literature includes, to date, very little work on U.S. BRT systems' impacts on property values using robust econometric techniques and/or spatial modeling (studies on Pittsburgh and Boston have been published within the last ten years). Further, because every BRT system is different, it is necessary to analyze additional case studies to provide a more robust understanding of how modern U.S. BRT services may affect surrounding property values. This research contributes a case study on Lane Transit District's Emerald Express (EmX) BRT service (operating in Eugene, Oregon), using econometric modeling techniques to estimate changes in property values associated with the BRT. The analysis is based on hedonic price regression analysis, where sale prices are modeled using several property characteristics that contribute to the market or sale price. The findings of this research provide further insight into how BRT services can enhance livability and economic development in a community. The results will provide policymakers and the transit industry throughout the U.S. with the best information possible to make informed transit investment decisions in their communities.

This research fits well with a theme of examining the economic impact of transportation and livable communities. Interestingly, economic theory suggests that the burden of increased housing costs from transit access does not fall directly on residents because they benefit from lower costs of transportation to areas of economic activity. However, the increased property values benefit the local jurisdiction and the community as a whole because related taxes collected from these property owners can pay for transportation and other infrastructure, which can further enhance economic development (i.e., private sector investment) and the livability of the community. Therefore, this research shows that BRT investments can be justified through increased residential property values that, through increased property tax collections, help create and maintain livable communities. By focusing on proximity and walking access to BRT services, this research also relates to another key component of livable communities, which is improved physical health. In essence, this work focuses on the integration and relationship of housing, walking, and the high-quality transit mode of BRT.

1.2 RESEARCH QUESTIONS

This work contributes to the existing relatively small body of literature on property value impacts of BRT in the U.S. by conducting a case study on Lane Transit District's EmX BRT service, which operates in Eugene, Oregon. Econometric modeling techniques are used to estimate changes in property values (actual market sale prices) for associated with the BRT. Specifically, the research questions are:

- Do residential property values increase with increasing proximity to the Eugene EmX BRT stations?
- Are the results from the EmX BRT comparable in magnitude to other recent studies? How do they compare to research on BRT outside the U.S. or to studies on other modes such as light rail?
- What can the results contribute to the overall understanding of BRT's impacts on residential property values in the U.S.?

The hypothesis of the work is that the marginal effect on residential property values of proximity to the BRT stations is positive. In other words, as the distance from a residence to a BRT stations decreases, its property value increases. This study confirms this hypothesis, reflecting a premium for the access provided by the BRT service to various goods, services, employment, education, and recreation.

While the EmX BRT is only one case study, its contribution is expected to be significant on a national scale because it is only the third such study in the U.S. This research helps to fill the gap in knowledge by contributing to the robustness of the body of literature on this topic in the U.S. The results provide further insight into how BRT services can enhance the livability and economic development in a community, and provide policymakers and the transit industry throughout the U.S. with the best information possible to make informed transportation and transit investment decisions in their communities.

1.3 BUS RAPID TRANSIT

According to the Federal Transit Administration, BRT is a

"*high-quality bus-based transit system that delivers fast and efficient service that may include dedicated lanes, busways, traffic signal priority, off-board fare collection, elevated platforms and enhanced stations*" [1].

This definition, however, applies to a wide variety of rapid bus services currently operating and in the planning stages in the U.S. A BRT system comprises the integration of seven service characteristics: type of running way, stations, vehicles, method of fare collection, intelligent transportation systems, service delivery plans and unique branding [2]. It is important to note that, to be considered as BRT, the service must incorporate some form of each of these seven elements. Typical limited-stop services or express bus services are not regarded as BRT.

As of this writing, at least 25 cities in the U.S. are operating some form of BRT. These systems range from BRT "Lite" services such as the Metro Rapid in Los Angeles and the MAX in Kansas City, to the full-featured rail-like operations of Cleveland's HealthLine and the EmX in Eugene, Oregon.

BRT can be constructed and implemented relatively quickly, can operate flexibly, and can have its service elements tailored to the particular needs, desires and characteristics of the community which it serves. Typically, BRT systems are less expensive to construct and operate than light rail transit (LRT) systems, although the more the BRT resembles a rail system, the higher the costs. Interestingly, BRT's flexibility can result in the assumption that it is not as "permanent" an investment as rail and, consequently, there are those who believe it cannot attract economic development to the extent that rail transit, with its fixed tracks, might [3]. Nonetheless, if decision-makers consider the marginal return per dollar of investment, even if LRT generated more development in absolute terms, BRT could still look more favorable given its lower costs. Further, the extent to which public transit in general, and rail specifically (particularly LRT), can contribute to economic development is often a subject of debate [3], [4].

Figure 1.1 provides photos of some operating BRT systems in the U.S. Two BRT systems operating in Los Angeles are the full-featured, more rail-like Metro Orange Line, which is branded with a color like Metro's rail system lines and operates along an exclusive guideway, and the Metro Rapid, considered BRT "Lite," which operates in mixed traffic. The Kansas City MAX is another BRT "Lite" system, operating in mixed traffic with the typical 40-foot transit buses that are branded differently from the rest of the transit system. The Las Vegas MAX operates with stylized vehicles that appear to be rail cars. Three other BRT systems exhibited in Figure 1.1 are also the subjects of the only research (completed and ongoing) to date in the U.S. on the mode's impact on residential property values: the Cleveland HealthLine (ongoing), Pittsburgh's East Busway, and the Boston Silver Line Washington Street Corridor [5], [6]. In Eugene, Oregon, the case study site for this research, Lane Transit District operates EmX, a more full-featured BRT system that runs for most of its alignment in an exclusive median guideway. The EmX is characterized by stylized transit vehicles and other rail-like features including signal priority at intersections, real-time customer information at stations, and off-board fare collection. Distinctive branding of the service is coupled with aesthetically pleasing, vibrant public art in and around the stations.

While a mode like LRT has a very straightforward definition, the information provided in this section provides evidence that the BRT mode is defined and applied quite broadly. BRT has such a wide variety of applications that it can be more difficult to discern conclusions regarding its impacts, because no two systems are exactly alike. More research continues to be conducted on the various types of BRT services in operation to provide a good sense of the mode's overall impacts.

(For photo credits, see Appendix A)

Figure 1.1: Select BRT Systems Operating in the U.S.

2.0 PREVIOUS LITERATURE

2.1 THEORETICAL FOUNDATION

Based on land-rent theory, it is hypothesized that people are willing to pay a premium for reliable and convenient access via BRT to a central business district (CBD) or other locations with employment, educational, recreational and shopping opportunities. The basis for this goes back to Alonso, Muth and Mills, who used economic theory to suggest that households will be willing to pay higher costs for housing as a trade-off to lower their costs of transportation to areas of economic activity [7], [8], [9].

Brueckner updated these early works by finding that the price per square foot of housing can be represented as a decreasing function of the distance of a residence to the CBD [10]. The question relevant to this research then becomes whether public transit, in general, provides this access to a CBD or other areas of economic activity for which households are willing to pay a housing premium [11].

2.2 EMPIRICAL APPLICATIONS AND OTHER RELATED WORK

Most of the previous research on this topic has been focused on rail transit modes and is represented by both qualitative and quantitative studies. It is often the anecdotal, qualitative work that attracts the most attention in the media and in the transit industry. However, more-rigorous quantitative studies often find that closer access to rail transit does increase property values in a statistically significant way, although the increases are relatively small in magnitude.

Some examples of this empirical work regarding the impacts of rail transit include Baum-Snow and Kahn, who studied five rail systems, including the heavy rail systems in Atlanta, Boston, Chicago, and Washington, D.C.; and the light rail system in Portland, Oregon. They found that decreasing transit distance from 3 to 1 kilometers (9,843 to 3,281 feet) increased monthly rents by $33 and home values by $8,557 (in 2011 dollars)[12]. TCRP Report 118 summarizes six studies on the impacts of light rail transit on residential property values (three of the studies are on the Portland system). Positive effects are found in Portland, San Diego, and Manchester, U.K., but no appreciable impacts are found in Sheffield, U.K. [13]. Table 2.1 summarizes literature on the impacts of rail transit on residential property values.

Table 2.1: Summary of Literature Estimating Impacts of LRT on Residential Property Values

Study Authors, Year	Study Information	Key Findings

Gatzlaff and Smith, 1993 [14]	Miami-Dade County Property Tax Records data on sales for a pooled sample of properties surrounding Miami Metrorail stations.	No significant change in sales index of homes before and after establishing Metrorail. Overall, weak evidence of positive residential property impacts, with high-income households accruing greater net benefits than low-income households.
Gruen, Gruen and Associates, 1997 [15]	Data on sales price of single-family homes, structural data, social data, and station and transportation access data for Chicago Transit Authority.	Home prices decrease as distance from a rail station increases, for both low- and high-income neighborhoods.
Chen, et al., 1998 [16]	Prices of single-family homes sold from 1992 to 1994 in Portland, Oregon.	As distance to a MAX light rail station increases, housing price decreases, but at a decreasing rate.
Baum-Snow and Kahn, 2000 [12]	1980 and 1990 U.S. Census tract-level data for rail transit in Boston, Atlanta, Chicago, Portland (OR), and Washington, D.C.	Decreasing transit distance from 3 to 1 km (9,843 to 3,281 ft) increased monthly rents by $33 and home values by $8,557 (2011 $)
Bowes and Ihlanfeldt, 2001 [17]	Atlanta sales of single-family homes and crime density of the census tract from 1991 to 1994.	Proximity to MARTA rail stations has a positive effect on the value of single-family homes.
Garrett, 2004 [18]	1,516 single-family homes in St. Louis County (Missouri) within 1 mile of a Metrolink light rail station, sold from 1998-2001.	Home values increase an average of $185.63 (2011 $) for every 10 feet closer to a station, starting at 1,460 feet. The “nuisance” effect associated with the Metrolink is weak.
Hess and Almeida, 2007 [19]	City of Buffalo 2002 assessed value of single-family properties, 1990 and 2000 U.S. Census.	A property’s value increases $1.24-2.89 (2011 $) for every foot closer to a light rail station.
Kent and Parilla, 2008 [20]	Used a repeat-sales approach but with assessed market values of single-family homes for two time periods, 1997-2000 and 2003-2006, representing before and after the Hiawatha line opened in Minneapolis.	Within a half-mile buffer of the stations, it was found that proximity to the stations resulted in an $18,723 (2011 $) increase in assessed values.
Yan, Delmelle and Duncan, 2012 [21]	Applied hedonic regression using single-family home sale prices in Charlotte, NC to four time periods: pre-planning (1997-1998), planning (1999-2005), construction (2005-2007), and operation (2007-2008).	Using a 1-mile buffer around stations, a positive relationship between distance and sale price was found in all four periods. However, the effect was smallest in the operation period, suggesting that the light rail system was beginning to influence sale prices.

Very little research has been conducted on BRT as it operates in the present day in the United States. Studies have been conducted on the topic of property value impacts of BRT operating in other countries, including Bogotá, Colombia; Seoul, South Korea; and Sydney, Australia. Due to difficulties accessing data on sales transactions in Bogotá, researchers relied upon asking prices instead of actual final prices. In a Bogotá study, Rodriguez and Targa used asking prices for properties and found a premium of 6.8 to 9.3 percent for every 5 minutes of walking time closer to a BRT station [22]. In another study from Bogotá, Muñoz-Raskin also used asking prices for properties and found that properties within a five-minute walk of the BRT lines were valued more highly than those within a five- to 10-minute walk [23]. In Seoul, Cervero and Kang used assessed values and found premiums of 10 percent for residences within 300 meters of BRT stations [24]. Mulley examined the BRT system in Sydney, and found that prices were primarily determined by the characteristics of the properties and the neighborhood features; however, small effects were found for access times to the BRT transitway [25].

Because of various social, cultural, political, and institutional differences, it is unlikely that the experiences in the countries discussed above will necessarily correlate to the U.S. experience. In the U.S., there have been only a few studies on BRT's potential impacts on economic development, as well as anecdotal evidence of positive impacts [4], [26], [27]. Nelson, et al., studied whether the EmX BRT system in Eugene had attracted new employment using a shift-share analysis technique, and found that some additional jobs, particularly in the public sector, had located close to the BRT corridor [28].

There have been quantitative studies on residential property value impacts of two BRT systems. These two studies, for the BRT systems in Pittsburgh and Boston, demonstrate positive, statistically significant impacts from proximity to the BRT stations. Perk and Catalá published a study on Pittsburgh's Martin Luther King Jr. East Busway in 2009. While several routes operate on this busway, most of them exhibit characteristics of modern BRT services. This 2009 study found decreasing marginal effects: Moving from 101 to 100 feet from a station increases assessed value approximately $19.00, while moving from 1,001 to 1,000 feet increases assessed value approximately $2.75. Another finding of this study is that a property 1,000 feet away from a station is valued approximately $9,745 less than a property 100 feet away, all else being equal [5].

For the Boston Silver Line Washington Street service, Perk, et al., used actual market transactions for condominium units along the corridor. A key result is that for condo sales that occurred in 2007 or 2009, the BRT premium was approximately 7.6 percent. For condo sales in 2000 and 2001, prior to the opening of the Silver Line, no sales premium existed for proximity to the corridor [6]. This finding emphasized that, although local bus service operated along the corridor prior to the implementation of the BRT, there was no evidence of a transit premium until the Silver Line began.

For this research on the EmX BRT system, the hypothesis is that proximity to the BRT stations will have a statistically significant, positive impact on the sale prices of residential properties. It is also anticipated that the results will be similar to the previous studies described in this literature review. To test this hypothesis, hedonic price regression models are used to estimate the impact of access to BRT stations on the actual market sales of surrounding single-family homes.

3.0 METHODOLOGY

This research applies hedonic regression analysis to estimate the impact of access to BRT stations on residential properties surrounding the EmX BRT system operated by Lane Transit District in Eugene, Oregon. Hedonic methods express housing prices as a function of various housing characteristics with distinctions made between physical and locational characteristics.

Hill writes that the hedonic approach dates back to "at least" 1928; however, Goodman credits Andrew Court with the first work and coining the term "hedonic" in a 1939 paper [29], [30]. Rosen gives the theoretical basis for hedonic price regression. Housing is an example of a highly differentiated product, as every house is unique. Rosen developed a "model of product differentiation based on the hypothesis that goods are valued for their utility-bearing" attributes or characteristics [31].

The analysis for this work is based on the method of hedonic price regression analysis, where sale prices of residential properties are estimated using several property characteristics that contribute to the market or sale price. The relevant characteristics for hedonic price regression analysis include the typical property attributes — size, number of bedrooms, bathrooms, etc. — but also include other variables such as neighborhood effects and distances to key amenities, including transit stations.

Theory does not dictate a functional specification for hedonic price analyses [31], [32]. Because of this, several model specifications were tested to determine the most robust. Only the final models are presented and discussed in this report. Variables were selected with the intention of explaining as much of sale prices as possible, although not all variables tested were found to be statistically significant. In some cases, statistically insignificant variables were removed from the analysis and do not appear in the final models (the researcher can exhibit discretion regarding which variables to eliminate; in the case of a variable being theoretically known to affect sale price, it may be kept in the model even if not statistically significant). The key variable in this research is the distance from a property to its nearest EmX BRT station. The coefficient on this key variable, resulting from the models, is used to estimate the marginal impact (sign and magnitude) of the distance on the sale price of a residence.

The conceptual hedonic model is:

$P = f(\boldsymbol{D}, \boldsymbol{H}, \boldsymbol{L}, \boldsymbol{N})$

where the dependent variable, *P*, representing the property value, is a function of four vectors of independent variables. The four vectors are ***D***, a vector of variables that measures the distance of parcels to transit stations (and to any other locations of interest); ***H***, a vector of variables that describes housing characteristics; ***L***, a vector of variables that describes locational amenities; and ***N***, a vector of variables that describes neighborhood characteristics.

The next section will describe the application of this methodology to the EmX BRT corridor and includes a discussion of the data and variables used in the analysis.

4.0 CASE STUDY SITE AND DATA

4.1 BRT IN EUGENE, OREGON

As mentioned previously, the case study site for this research, Lane Transit District in Eugene, Oregon, operates the the Emerald Express (EmX) a full-featured BRT system operating for most of its route alignment along an exclusive median guideway. The EmX is characterized by stylized transit vehicles and other rail-like features including signal priority at intersections, real-time customer information at stations, and off-board fare collection. The EmX is distinctively branded and many of its stations include installations of unique public art. Figures 4.1 and 4.2 illustrate the EmX vehicles operating along the BRT corridor.

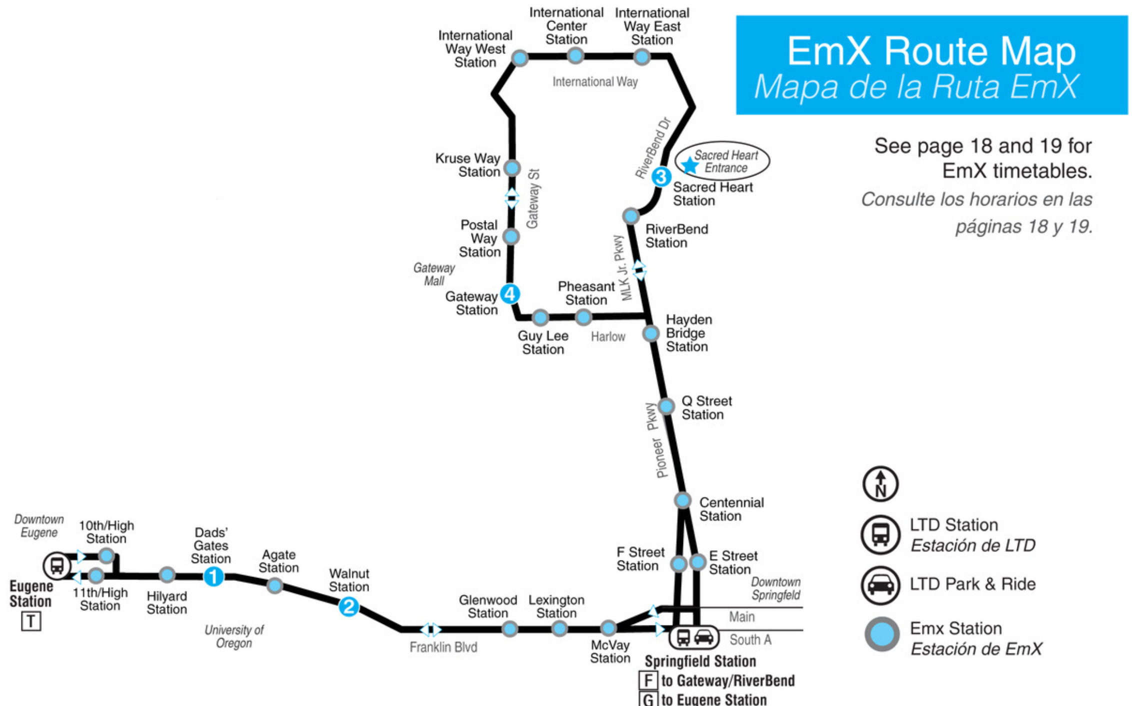
(Photos courtesy of Lane Transit District)

Figure 4.1: EmX BRT Service

(Photos by Victoria A. Perk)

Figure 4.2: EmX Vehicles and Public Art at Stations

The EmX BRT services were selected over a light rail option to connect downtown Eugene with the Gateway area of Springfield. The first line, approximately 4 miles, runs east/west along the Franklin corridor connecting downtown Eugene with downtown Springfield. It was originally dubbed the Green Line. This first line, which also serves the University of Oregon, opened in 2007. In 2011, the approximately 6-mile Springfield north/south extension opened, connecting to Gateway Mall and Sacred Heart Medical Center. According to the National Transit Database, in fiscal year 2015, the EmX services generated 2,762,085 unlinked passenger trips over 429,059 annual revenue miles of service using eight vehicles operating in maximum service. The service operates on 10-minute frequencies for most of the day. At this time, a west Eugene extension is under construction, with a planned opening in September 2017. Figure 4.3 on the following page depicts the route alignments of the current EmX services.



(Image courtesy of Lane Transit District)

Figure 4.3: EmX Route Map

4.2 CASE STUDY DATA

The data used for this study include the property characteristics and sales information for single-family homes located within three miles of an EmX BRT station. A three-mile buffer was used to be able to demonstrate the gradient of the marginal impacts of the distance variable on sale prices. Lane Transit District acted as a liaison with the Lane Council of Governments to help the research team secure the necessary data for this work. In addition, the University of Oregon provided data on students' residences within 3 miles of the EmX alignment.

Geographic Information Systems (GIS) tools were used to merge the property characteristics with the sales data and student information, to complete the construction of the data set. The application of GIS allowed for spatial analysis of the data. GIS tools were also used to calculate the key variable of interest in this work: network distance from a single-family home to the nearest BRT station.

In total, three cross-section time periods were selected for analysis. First, 2005 was chosen to represent a time period prior to the implementation of the EmX. 2010 was then chosen to represent a few years after the first EmX line (Franklin Corridor) began operating. Finally, data for 2016 were also included to represent the most recent information available. Because cross-section analysis is used, each year has its own separate data set. Each data set was initially populated with the same variables, but the final models do not all contain each of the original variables.

Variables considered in this analysis include those listed below. A brief description of each variable follows the list.

- Market sale price of single-family home (dependent variable)
- Network distance (meters) from single-family home to nearest BRT station
- Total square feet of living area
- Year the home was built
- Number of bedrooms
- Interaction term between number of bedrooms and total living area
- Number of full bathrooms
- Number of half-bathrooms
- Median household income by census block group
- Dummy variable to indicate if university students reportedly live at the home
- Dummy variable to indicate whether a home has a fireplace
- Dummy variable to indicate whether a home has an attached garage
- Dummy variables to indicate the class of the single-family home
- Dummy variables to indicate elementary school districts and high school districts
- Dummy variables to indicate whether the nearest station is on the Franklin corridor, the Gateway corridor, or common to both corridors
- Dummy variables to indicate distance buffers around the EmX BRT stations

First, the dependent variable is the actual market sale price of a single-family home. Price per square foot and the natural log of the sale price were also calculated, but not ultimately used. The data were filtered to ensure that only recorded market sales were included. After an examination of the distribution of sale prices, very low and very high prices were eliminated. The final data sets included only prices greater than $30,000 and less than $600,000.

The network distance, in meters, from a home to the nearest BRT station was calculated. This is the key variable in the analysis, as the objective of this work is to determine whether this distance has a statistically significant positive impact on the sale price. As described later in this report, it will be demonstrated that it does have this marginal effect. To see this effect, a negative sign on the coefficient would be expected, indicating that as distance to a station decreases, the sale price increases. The distance variable was squared to allow for the possibility of increasing or decreasing marginal effects of distance. However, this squared term was found to not be significant in the models and is therefore not included.

The total square feet of living space in a home is often one of the strongest predictors of sale price. This proved to be true with these data, as well. A statistically significant, positive effect would be expected, because sale price should rise if total square feet increases, while holding all other variables constant.

The age of a home is also expected to influence sale price. All else constant, a newer home would have a higher selling price, while an older home would sell for a lower price. This relationship with the year the home was built would lead to a positive coefficient on this variable.

The number of bedrooms in a home is usually considered to have some effect on sale price. With more rooms, the sale price might be higher. Yet this is not necessarily true for relatively smaller homes (as each additional room would be smaller). An interaction term was added, by multiplying the number of bedrooms by the total square feet of living area. The purpose of this interaction term is to allow the living area to vary with the number of bedrooms.

Similar to bedrooms, the number of full bathrooms and half-bathrooms may have an impact on a home's sale price. These two variables were found to be statistically significant only at the 10 percent level of significant and only in the model representing sales in the year 2010. Due to these results, the bathroom variables were not included in the final models.

The income of households in a census block group can possibly impact the sale prices of home within that block group. For this work, a single-family home was assigned the median household income of the block group in which it is located.
In an attempt to account for the large number of University of Oregon students who live in the area, data on students' residences were acquired. If, according to university data, a home had at least one student living there, that home was assigned a value of one for the student dummy variable. All other homes were assigned a zero for this variable. There was no a priori expectation for the sign of this variable. The coefficient could be negative if the presence of students translated to a nuisance factor, for example. The student dummy variable was not statistically significant in any of the models and was not included in the final results.

Dummy variables were also used to indicate if a home had a fireplace (value of one if yes, otherwise zero) or an attached garage (value of one if yes, otherwise zero). While it was hypothesized that these variables might have an impact on sale prices, neither was statistically significant in any of the models.

In Lane County, homes are categorized by a class system, in which Class 1 represents a lower-quality, possibly run-down home. The condition and quality of the home improve as the Class number increases. This variable was used as a proxy for the condition of the home. It was expected that higher-class homes would sell for higher prices than lower-class homes, and these results occurred with statistical significance. The 2005 and 2010 data sets contained single-family homes in Classes 1 through 7. However, the data set for 2016 included homes only in Classes 2, 4, and 5.

Because the EmX service consists of two separate corridors, a dummy variable was constructed to indicate if a home's nearest station was on the Franklin line (east-west), the Gateway line (north-south), or common to both lines. These variables were not found to be statistically significant in any of the models and were not included in the final results.

A home's location in certain school districts can have an impact on sale prices. To account for this, dummy variables were constructed to account for each of the elementary school and high school districts contained within the study area.

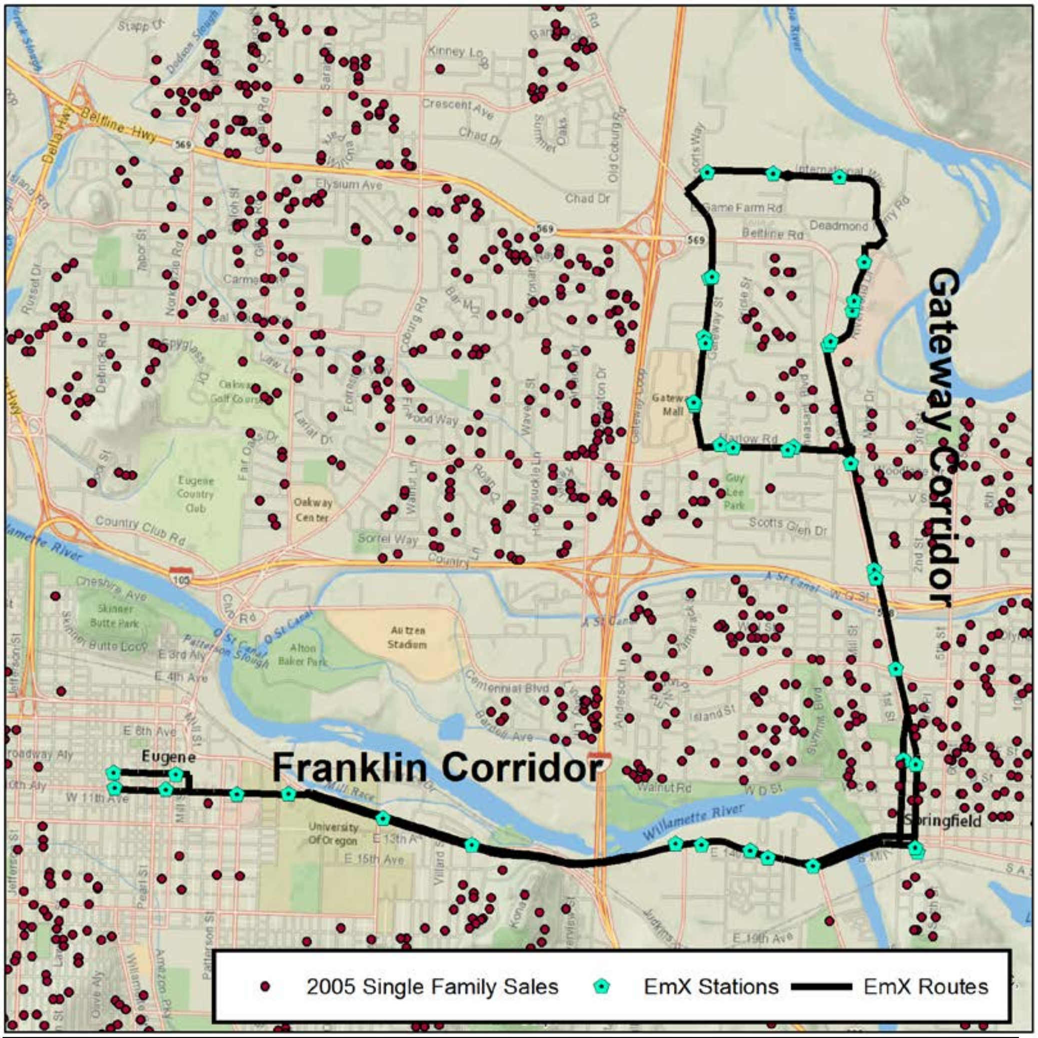
Finally, to consider an alternate way to estimate the impact of distance to a BRT station on sale prices, dummy variables were generated to represent buffers of distance around the corridors. These were constructed in quarter-mile and half-mile increments. However, it was found that these dummy variables were not significant in any of the models and so only the continuous distance variable was used (measured in meters). Still, in some cases they appeared to support the idea that there are positive impacts to sale prices the closer a home is to a BRT station; but that very near the corridor, the trend begins to reverse. This may be because it is considered beneficial to live close to the stations, but not too close.

Table 4.1 on the following page provides a statistical summary of the variables considered in this analysis. Each variable's minimum value, maximum value, mean value, and standard deviation are shown. The dummy variables are not included, as they take only the values of zero or one.

Table 4.1: Data Descriptives for Single-Family Homes Sold in 2005, 2010, and 2016

Description	Sold in 2005 (n=1,913)				Sold in 2010 (n=709)				Sold in 2016 (n=755)			
	Min.	Max.	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.
Sale price of home in dollars	$45,000	$599,900	$221,504.57	$89,252.33	$66,000	$595,000	$248,485.04	$90,077.51	$50,000	$599,500	$316,506.75	$107,604,.72
Distance to BRT station in meters	35.97	4,826.94	2,753.22	1,285.68	67.79	4,827.07	2,723.98	1,199.36	277.56	4,819.04	2,885.88	1,262.56
Total square feet of living area	360	5,886	1,539.03	612.47	320	4,180	1,600.87	603.02	432	4,348	1,887.90	638.95
Year home was built	1850	2005	1974.64	18.89	1913	2010	1979.78	17.00	1888	2015	1978.01	21.040
Number of bedrooms in the home	1	7	2.97	0.789	1	7	2.96	0.74	1	7	3.15	0.83
Number of full bathrooms in the home	1	5	1.58	0.63	1	3	1.59	0.58	1	4	1.58	0.63
Number of half-bathrooms in the home	0	2	0.27	0.45	0	2	0.30	0.47	0	2	0.36	0.49
Median household income for census block	$12,288	$126,806	$48,810.11	$20,152.06	$11,409	$126,806	$49,925.57	$20,841.81	$12,288	$126,806	$56,279.03	$22,520.59

Maps in Figures 4.4, 4.5, and 4.6 illustrate the distribution of single-family home sales near the EmX BRT corridors. The maps depict the home sales for 2005, 2010, and 2016, respectively. Due to the scale of the maps, not all of the observations are depicted. In addition, it should be noted that in the 2005 map, the EmX stations were not yet operational. The 2005 data set represents the "before" case. In 2010, only the Franklin Corridor stations were active while the Gateway Corridor stations were still planned. For the 2016 map, all of the EmX stations shown were active.



In 2005, the EmX was not yet operational; the stations shown were planned.

Figure 4.4: Single-Family Home Sales, 2005

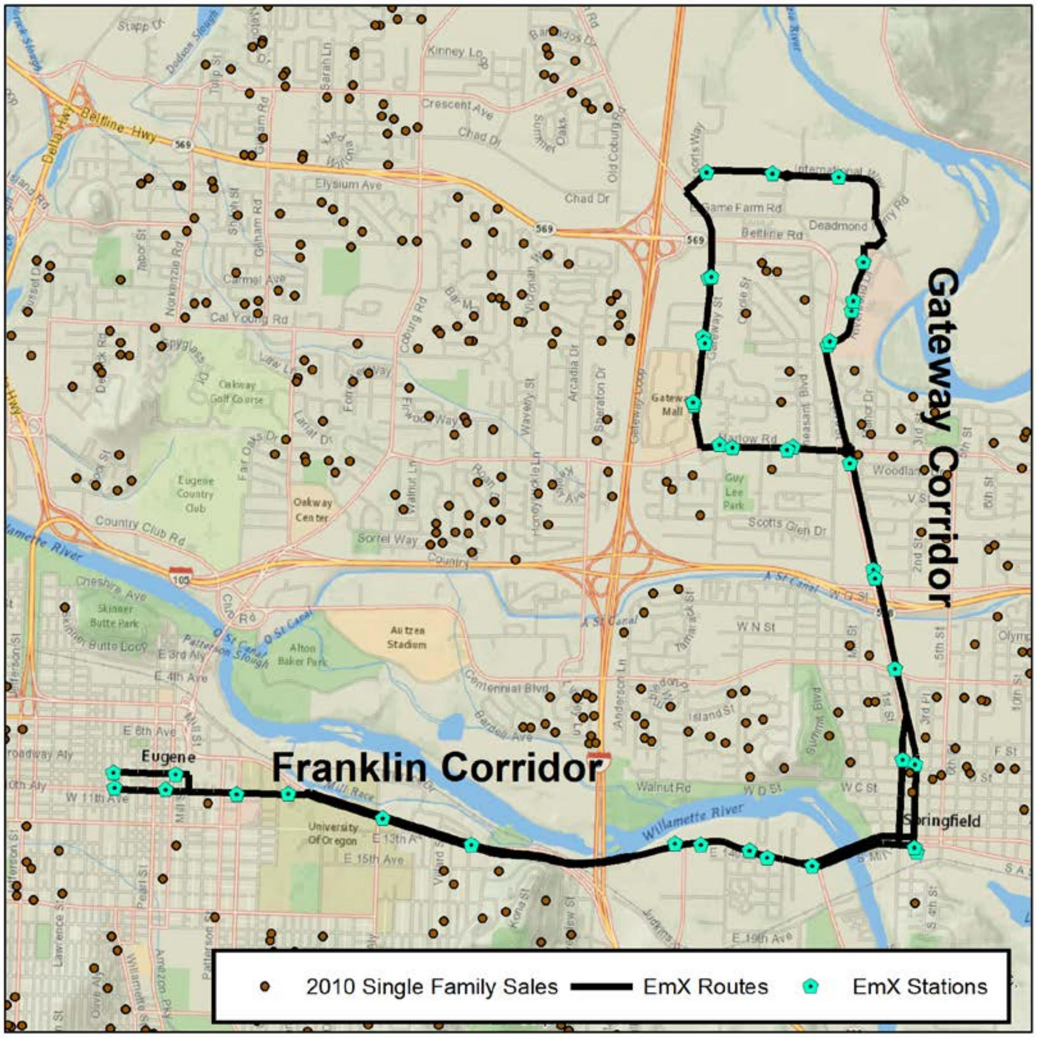


Figure 4.5: Single-Family Home Sales, 2010

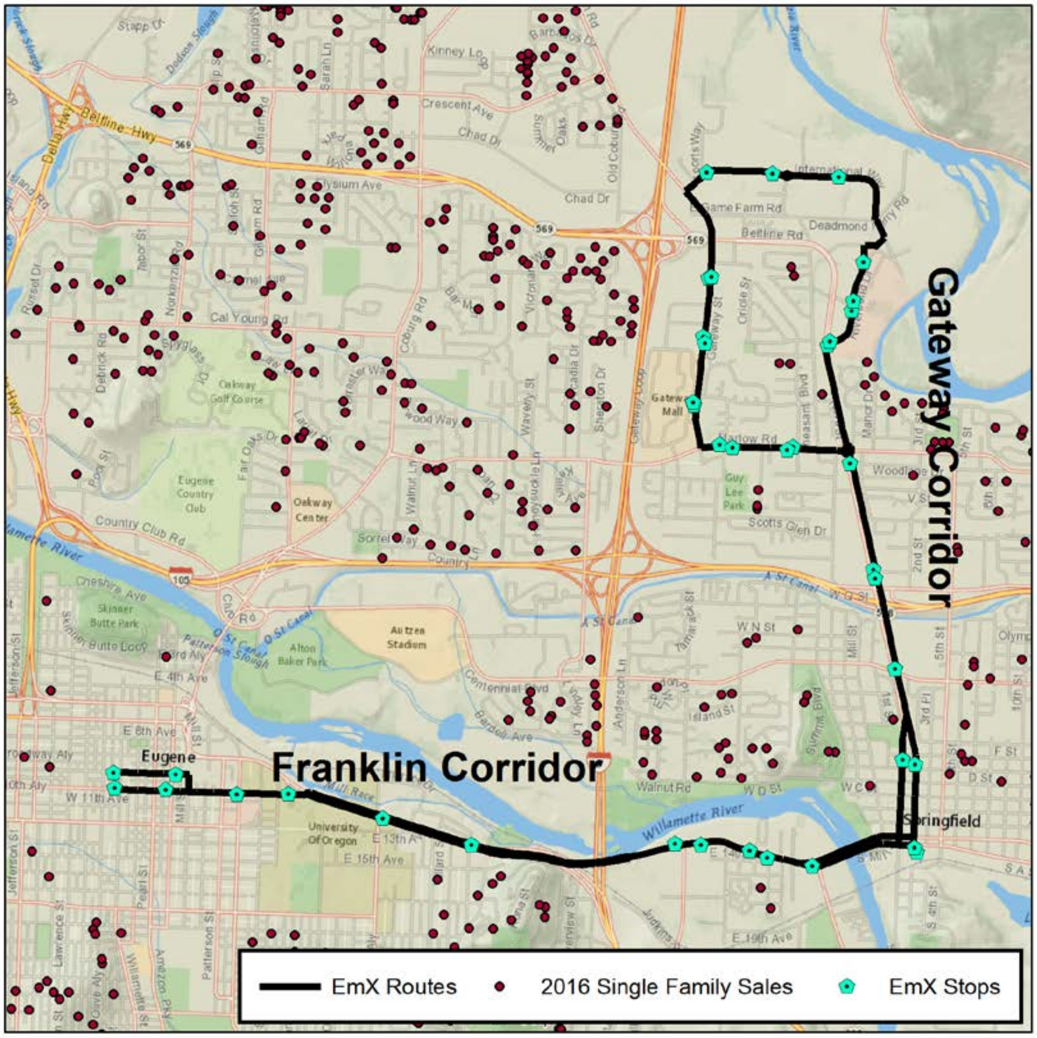


Figure 4.6: Single-Family Home Sales, 2016

5.0 RESULTS OF THE ANALYSIS

The data were analyzed using ordinary least squares (OLS) regression, after ensuring that the relevant assumptions hold. To address any issues regarding heteroskedasticity of unknown origin as well as other potential pitfalls, the models were run using robust regression, which produces White-Huber robust standard errors. The use of robust standard errors is one way to correct OLS estimators in the presence of autocorrelation as well as heteroskedasticity, and makes it more difficult to find statistical significance.

After testing level-level and log-level regression models, it was determined that the level-level models were most robust, so no natural log transformations of the data were used. In addition, the distributions of sale price were all approximately normal, so it was determined that a log transformation of the sale price was not necessary.

Each of the models appears relatively strong, with mostly expected signs on the variable coefficients, and high levels of statistical significance on several of the variables (even with the robust standard errors). All results are included in Table 5.1.

The key variable of interest in this study, the distance of a home to its nearest BRT station, has the expected negative sign and is statistically significant at the 95 percent level for all three models: 2005, 2010, and 2016. Further, the magnitude of the coefficient increases from 2005 to 2010 and again from 2010 to 2016. This indicates that the effect of the distance to the BRT station on sale price is increasing over time, as the EmX service continues to mature.

For the 2005 model, the coefficient on distance indicates that a 100-meter decrease in distance to a station (i.e., getting closer to the station) increases sale price by $823, on average and holding all other factors constant. This result occurs even prior to the EmX service's starting, and may be capturing a premium for being near the corridors. However, it may also be capturing a speculative premium from home-buyers who knew the upgraded transit service would be opening in the next couple of years.

In the 2010 model, only observations along the Franklin Corridor were used because it was the only line open at the time. Interestingly, in the 2010 model, a 100-meter decrease in distance to a station increases average sale price by $1,056, all else constant. This increase in the magnitude of the coefficient indicates that being closer to the corridor/stations, at least along the Franklin Corridor, is somewhat more favorable in 2010 than in 2005, perhaps due to the implementation of the BRT service. In 2016, with both corridors having several years of operation, the magnitude of the coefficient increases yet again, with a 100-meter decrease in distance being associated with an increase in the average sale price by $1,128.

While this study is most concerned with the key distance variable, it is important to be sure that all variable coefficients in the models have expected signs and reasonable magnitudes. Total square feet of living area is a strong predictor of sale price, both in theory and in the models presented herein. The coefficient has the expected positive sign and is statistically significant at the 5 percent level of significant in all but the 2010 model. However, in the 2010 model, it is significant at the 10 percent level of significance. For the 2005 model, an increase of 100 square feet of living space is associated with a $7,007 increase in the average selling price. This value is only $2,981 in 2010, but increases again to $7,966 in 2016.

The year a home was built has a positive, statistically significant impact on sale price. The newer the home, the higher the sale price, all else constant. In the 2005 model, a home that is newer by one year can expect an average increase of $377.72 in the sale price. This value is estimated at $313.11 for the 2010 model and $451.87 for the 2016 model.

The number of bedrooms in a home was statistically significant only in the 2010 model, at the 10 percent level of significance. For the 2010 model, it is interpreted along with the related interaction term between bedrooms and living area. It can be estimated that, at the means of the data, an additional bedroom, holding living area constant, reduces the property value by $2,754.40. This value is computed by taking the derivative of the sale price with respect to the number of bedrooms (= –21,948.83 + 11.99(1,600.87)), where the mean living area is 1,600.87 square feet. It was expected that, by allowing the number of bedrooms to vary with square feet of living area, property value would increase with additional bedrooms. However, there are many smaller homes in the data set, in which additional rooms will tend to be relatively small. Even when controlling for the other factors, the result persists.

Table 5.1. 2005, 2010, and 2016 Cross-Sections – Single-Family Homes

Variable	Description	2005 (n=1,810) Coefficient *Robust Std Error*	2010 (n=411) Coefficient *Robust Std Error*	2016 (n=711) Coefficient *Robust Std Error*
Constant	Constant term in regression equation	–650,650.90 * *(136,546.70)*	–437,871.40 *(314,848.30)*	–608,374.20 * *(294,859.10)*
Distance	**Distance (meters) from home to nearest BRT station, active or planned**	**–8.232*** ***(1.762)***	**–10.557 *** ***(3.640)***	**–11.278 *** ***(2.797)***
Living Area	Size of home's living area in square feet	70.07 * *(9.991)*	29.81 ** *(18.056)*	79.66 * *(13.417)*
Year Built	Year the home was built	377.72 * *(69.778)*	313.11 ** *(159.654)*	451.87 * *(147.608)*
Bedrooms	Number of bedrooms	-3,288.58 *(4,296.274)*	–21,948.83 * *(9,628.759)*	-14,970.85 *(8,545.121)*
Bedrooms x Living Area	Interaction term between bedrooms and living area	-0.543 *(2.588)*	11.99 * *(4.832)*	4.110 *(3.575)*
Income	Median household income for census block group that includes the property	0.1482 ** *(0.090)*	0.4725 * *(0.1731)*	0.1950 *(0.1414)*
Class 1 Single Family	Dummy variables based on the Class category of single-family homes: Take value of 1 if property is categorized in the stated class; 0 otherwise (base case in 2005 and 2010 is Class 3 homes; in 2016, it's Class 5 homes)	–29,191.05 * *(9,887.094)*	–122,269.40 * *(13,958.800)*	n/a
Class 2 Single Family		–10,406.04 * *(3,515.827)*	–35,305.57 * *(12,519.450)*	–118,345.70 * *(14,344.640)*
Class 3 Single Family		n/a	n/a	n/a
Class 4 Single Family		38,215.82 * *(3,482.169)*	40,166.73 * *(9,088.425)*	-56,378.82 * *(7,827.440)*
Class 5 Single Family		103,687.30 * *(8,658.293)*	77,996.11 * *(17,969.72)*	n/a
Class 6–7 Single Family		171,151.70 * *(37,273.56)*	215,738.20 * *(16,176.350)*	n/a

Dependent variable: market sale price of home.

*Significant at a minimum of 5% level of significance. **Significant at a minimum of 10% level of significance.

2005 model: adjusted R^2 = 0.749, F (Wald statistic) = 141.66 (prob > F = 0.0000).

Class dummies are jointly significant using the heteroskedastic-robust F statistic, F = 42.30 (prob > F = 0.000).

2010 model: adjusted R^2 = 0.692, F (Wald statistic) = 32.82 (prob > F = 0.0000).

Class dummies are jointly significant using the heteroskedastic-robust F statistic, F = 66.50 (prob > F = 0.000).

2016: adjusted R^2 = 0.714, F (Wald statistic) = 105.87 (prob > F = 0.0000).

Class dummies are jointly significant using the heteroskedastic-robust F statistic, F = 35.95 (prob > F = 0.0000).

Table 5.1. 2005, 2010, and 2016 Cross-Sections – Single-Family Homes (continued)

Variable	Description	2005 (n=1,810)	2010 (n=411)	2016 (n=711)
		Coefficient *Robust Std Error*	Coefficient *Robust Std Error*	Coefficient *Robust Std Error*
Edison	Dummy variables based on the boundaries of the local elementary school districts for the Eugene and Springfield areas: Take value of 1 if property is located in the stated district; 0 otherwise (Adams Elementary district in Eugene is used as the base case)	16,965.87 ** *(9,740.409)*	41,128.56 * *(14,519.550)*	18,260.21 *(15,517.240)*
Gilham		48,175.44 * *(9,134.296)*	n/a	n/a
McCornack		356.08 *(9,083.961)*	2,184.34 *(15,133.310)*	-5,449.53 *(20,585.640)*
River Road		35,491.02 * *(9,197.460)*	55,105.76 * *(15,276.680)*	-9,590.70 *(14,255.400)*
Willagillespie		43,086.68 * *(9,578.174)*	62,704.41 * *(15,985.020)*	22,290.64 * *(8,011.586)*
Centennial		-1,982.46 *(7,418.047)*	9,003.31 *(17,447.090)*	-5,822.68 *(9,201.578)*
Douglas Gardens		24,540.60 * *(9,835.876)*	9,489.40 *(14,587.550)*	14,507.89 *(11,502.200)*
Page		19,474.27 * *(8,276.948)*	n/a	n/a
Maple		-1,336.39 *(7,690.379)*	-13,540.06 *(14,259.020)*	-5,471.57 *(11,571.210)*
Yolanda		9,105.72 *(8,775.582)*	n/a	n/a
Riverbend		12,221.23 *(10,565.310)*	12,182.24 *(14,718.620)*	–32,387.54 *(24,035.570)*
Edgewood		437.26 *(8,353.734)*	7,981.44 *(13,876.756)*	-24,774.74 ** *(15.059.410)*
Cesar Chavez		7,965.72 *(6,307.824)*	-7,858.23 *(8,804.756)*	23,315.64 ** *(12,447.730)*
Bertha Holt		30,294.18 * *(9,378.160)*	21,526.19 *(19,088.120)*	-1,834.98 *(7,873.569)*
Camas Ridge		-17,317.70 * *(6,593.312)*	12,997.85 *(10,821.130)*	-40,182.73 * *(14,101.890)*
Two Rivers		-604.58 *(7,123.694)*	n/a	n/a
South Eugene	Dummy variables based on the boundaries of the local high school districts for the Eugene and Springfield areas: Take value of 1 if property is located in the stated district; 0 otherwise (Sheldon High district in Eugene is used as the base case)	57,994.65 * *(9,578.018)*	77,010.91 * *(17,103.630)*	52,210.91 * *(10,854.560)*
Churchill		31,697.40 * *(9,370.529)*	54,360.64 * *(16,030.740)*	-11,001.58 *(8,805.868)*
Springfield		-10,624.50 *(12,182.540))*	7,592.02 *(20,763.530)*	-44,841.55 * *(9,864.518)*
Thurston		5,285.95 *(12,447.290)*	n/a	n/a

Dependent variable: market sale price of home.

*Significant at a minimum of 5% level of significance. **Significant at a minimum of 10% level of significance.

2005 model: Elementary school dummies are jointly significant using the heteroskedastic-robust F statistic, F = 6.00 (prob > F = 0.000). High school dummies are jointly significant using the heteroskedastic-robust F statistic, F = 22.88 (prob > F = 0.000).

2010 model: Elementary school dummies are jointly significant using the heteroskedastic-robust F statistic, F = 3.84 (prob > F = 0.000). High school dummies are jointly significant using the heteroskedastic-robust F statistic, F = 17.36 (prob > F = 0.000).

2016 model: Elementary school dummies are jointly significant using the heteroskedastic-robust F statistic, F = 3.49 (prob > F = 0.001). High school dummies are jointly significant using the heteroskedastic-robust F statistic, F = 26.08 (prob > F = 0.0000).

The variable representing the median household income of the census block group containing the home was significant at the 10 percent level of significant in the 2005 model, significant at the 5 percent level of significance in the 2010 model, and not significant in the 2016 model. For those data, a $100 increase in the median household income is associated with a $14.82 increase in the average sale price in 2005 and a $47.25 increase in the average sale price in 2010.

A set of dummy variables represents the class categorizations of the single-family homes. The classes relate to the condition and/or quality of the home, with Class 1 being the lowest condition or quality and Class 7 being the highest condition or quality (Class 7 is the highest in the data sets used in this study). Each of the variable coefficients has the expected sign and is statistically significant. All of the Class dummies were found to be jointly significant using the heteroskedastic-robust F statistic.

For the 2005 and 2010 data, the coefficients are compared to the Class 3 category, which is used as the base case. Class 1 homes have, on average, estimated sale prices $29,191.05 less than Class 3 homes in 2005, and estimated sale prices $122,269.40 less than Class 3 homes in 2010. Also, Class 2 homes are associated with a $10,406.04 lower average sale price than Class 3 homes in 2005 and a $35,305.57 lower average sale price in 2010.

As expected, Class 4 homes have estimated sale prices higher than Class 3 homes: $38,215.82 higher in 2005 and $40,166.73 higher in 2010. Similarly, estimated sale prices for Class 5 homes are on average $103,687.30 higher than Class 3 homes in 2005 and $77,996.11 higher than Class 3 homes in 2010. Lastly, Class 6 and 7 homes (combined due to the low number of Class 7 homes in the data set) have estimated sale prices on average $171,151.70 higher than Class 3 homes in 2005 and $215,738.20 higher than Class 3 homes in 2010.

In the 2016 data, there were only Class 2, Class 4, and Class 5 single-family homes. For this model, Class 5 was used as the base case. As such, the expected signs on the coefficients for the Class 2 and Class 4 dummies was negative (average sale prices should be lower than Class 5). As seen in Table 5.1, these coefficients have the expected signs and are statistically significant. On average, Class 2 homes have estimated sale prices $118,345.70 less than Class 5 homes, while Class 4 homes are associated with estimated sale prices $56,378.82 lower than Class 5 homes.

Finally, sets of dummy variables were used to account for variations in sale prices related to local elementary and high school districts. Both sets of dummy variables, for elementary schools and high schools, were found to be jointly significant using the heteroskedastic-robust F statistic. All results for these variables are shown in Table 5.1.

Overall, each of the three models appears relatively robust. F statistics indicate a strong fit, and the R-square values, while not the most essential statistic, do indicate that the models explain a majority of the variation in sale prices. For example, approximately 75 percent of the variation in sale price is explained by the variables used in the 2005 model. In 2010, approximately 69 percent of this variation is explained. For the final model, using 2016 data, approximately 71 percent is explained.

The results described herein do seem to support the hypothesis that proximity to EmX BRT stations does have a positive, statistically significant impact on the sale prices of single-family homes surrounding the BRT corridors.

6.0 CONCLUSION

As described in the previous section, the results of the estimated models appear relatively strong, with statistically significant coefficients using heteroskedastic-robust standard errors. Algebraic signs and overall magnitudes of the estimated coefficients conform to expectations, as well. It was mentioned in Section 1.1 that the hypothesis of this work is that the marginal effect on residential property values of proximity to the BRT stations is statistically positive. Put another way, as the distance from a residence to a BRT stations decreases, the marginal effect on its estimated average sale price increases. The results of this effort indicate that this hypothesis is confirmed, thus reflecting a premium for the access provided by the EmX BRT service to various origins and destinations in the community.

One of the more interesting aspects of the findings as they relate to the impacts of BRT is that the absolute magnitude of the distance coefficient increases from 2005 to 2010 and again from 2010 to 2016 (as shown in Table 5.1). This provides evidence to suggest that the impact of the distance to the BRT station on the average estimated sale prices of single-family homes is increasing over time, as the EmX service matures. Further, it should be noted that the results were not adjusted for inflation; however, the changes in the estimated value of the distance coefficient are at a rate much higher than inflation from 2005 to 2010 (in absolute terms, the coefficient increased 28 percent from 2005 to 2010). From 2010 to 2016, the coefficient increased 8 percent in absolute terms.

In addition, the distance coefficient was negative and statistically significant even in the 2005 model, prior to the opening of the Franklin corridor. This may be due to an already-existing premium for proximity to the major corridor, but it may also be capturing a speculative effect from buyers who were aware of the forthcoming BRT services.

Perhaps, then, the increase in the distance coefficient in the 2010 model might be due to the additional premium associated with increased access to the high-quality EmX BRT service along the Franklin Corridor. By 2016, both corridors had been in operation for several years, and the magnitude of the coefficient increased again.

Overall, these findings suggest that proximity to the EmX BRT stations contributes to a small (but increasing), statistically significant positive impact on the actual market sale prices of single-family homes. To be certain, the impact would be expected to be relatively small in magnitude when all of the numerous factors that influence home sale prices are considered.

While the EmX BRT is only one case study, the contribution is expected to be significant on a national scale because it is only the third U.S. study within the past ten years on this topic for the BRT mode. As such, there is still a need for even more research on this topic. The cities currently operating BRT in the U.S. such as Pittsburgh, Boston, Los Angeles, and Cleveland, etc., vary in size, density, and other characteristics which could lead to different results regarding the impacts of the transit services on land values. Eugene is one of the relatively smaller cities operating full-featured BRT and it is characterized as a lower density, university town. Future research ideas include applying this or a similar methodology to other BRT systems in the U.S., as well as to other types of properties (apartments, condominiums, commercial), and also refining the method by using increasingly advanced econometric and/or geo-spatial techniques.

This work contributes to the still relatively small body of literature on the residential property value impacts of BRT in the U.S. The research questions presented in Section 1.2 have been answered with the results of this study. First, these findings show that residential property values increase with increasing proximity to the Eugene EmX BRT stations. Further, the results from the EmX BRT are comparable in magnitude to those obtained by the other recent studies on BRT in the U.S., and are even comparable, although in some cases somewhat lower than, the results of research on BRT outside the U.S. and research results from other modes such as light rail. Finally, the findings of this work provide additional insight into how BRT services can play a measurable role in livability and economic development in a community. For example, additional tax revenue from increases in assessed values (related to higher sale prices) can be used by cities to further promote economic development and projects that contribute to livability. The results from this study will provide policymakers and those in the U.S. transit industry with the best, most recent information to assist in making informed transit investment and development decisions.

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8.0 APPENDIX A – PHOTO CREDITS

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