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Light Rail Impacts on Property Values:

Analyzing Houston's METRORail

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Light Rail Impacts on Property Values:

Analyzing Houston's METRORail

by

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Report

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SUPERVISOR: Ming Zhang

Light rail transit (LRT) systems are tools to help reduce traffic congestion and air pollution, promote high-density development and more affordable housing, and curtail urban sprawl in metropolitan cities throughout the United States. The impact of transit system services on property values has been studied from various perspectives using many statistical approaches. There are two general categories of effects that proximity to a light rail system can have on the value of residential properties: accessibility benefits (experienced in close proximity to the LRT stations) might increase property values, while nuisance qualities (experienced in both proximity to the LRT line and stations) could have a negative effect on residential property values. Due to the opposing nature of these coexisting effects, results from many empirical studies have been contradictory or inconclusive. This report reviews the spectrum of results found by the growing body of literature focusing on the capitalization effects of rail stations on property values. The economic effect of one particular LRT system, the 7.5 mile long METRORail line located in Houston, Texas, on the value of properties within close proximity to rail stations has not been thoroughly examined, as it only opened for service in 2004. This study utilizes property data acquired from the Harris County Appraisal District (HCAD), Geographic Information System (GIS) techniques, and Hedonic Price Models to analyze the impact of the LRT system in the city of Houston, Texas, on the value of residential properties that lie within close proximity to the line's rail stations.

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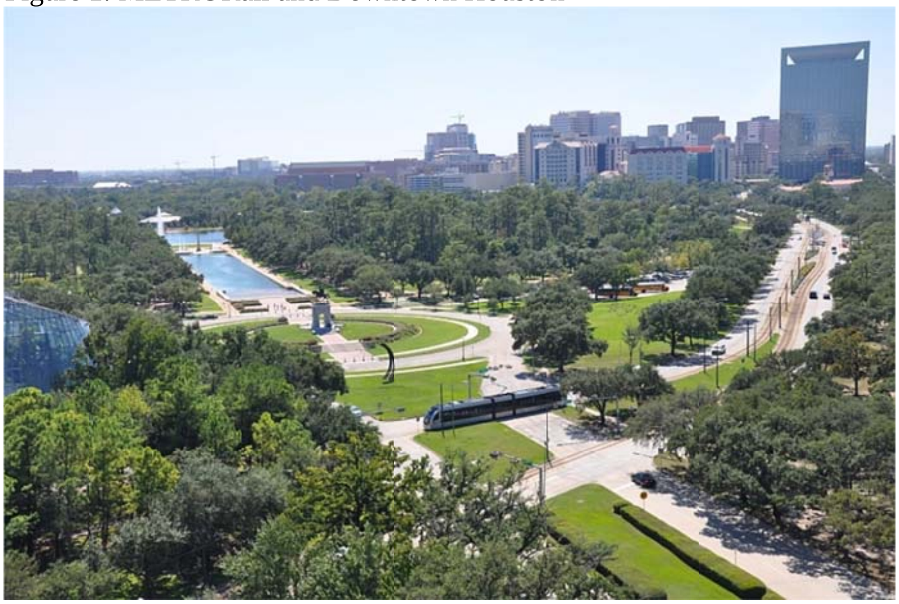

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Chapter One: Introduction

LIGHT RAIL TRANSIT

Transportation is one of the most influential factors on the evolution of urban form. Connecting various nodes located throughout the urban environment, transportation provides people with access to markets, central business districts, and other central locations; such access, in turn, is an important determinant of property value (Gatzlaff and Smith, 1993). Transportation also helped bring about the decentralization of urban places when the personal vehicle grew to be the dominant form of transportation in U.S. cities. This has contributed to the diminishing influence of fixed rail transportation systems on urban property values, as people have been less reliant on public transit to get them to where they need to go. Although more recently, interest in rail systems has seen growth.

In the 1970s, LRT systems emerged as a new, non-exclusive fixed rail system with the aim of achieving “some of the benefits of a rapid transit system, such as heavy rail, but at a low cost” (Arndt, 2009). During the 1970s and 1980s, twelve cities, including major urban centers like San Diego CA, Portland OR, and Buffalo NY, constructed light rail systems (Ryan, 1999). Even more recently, light rail systems have been gaining popularity and growing in numbers. There are between thirty-five to forty LRT systems operating in the United States as of 2011. From 175 million in 1990, the total number of passenger trips on light rail transit systems in the United States grew to 337 million in 2002 (Urbanomics, 2005).

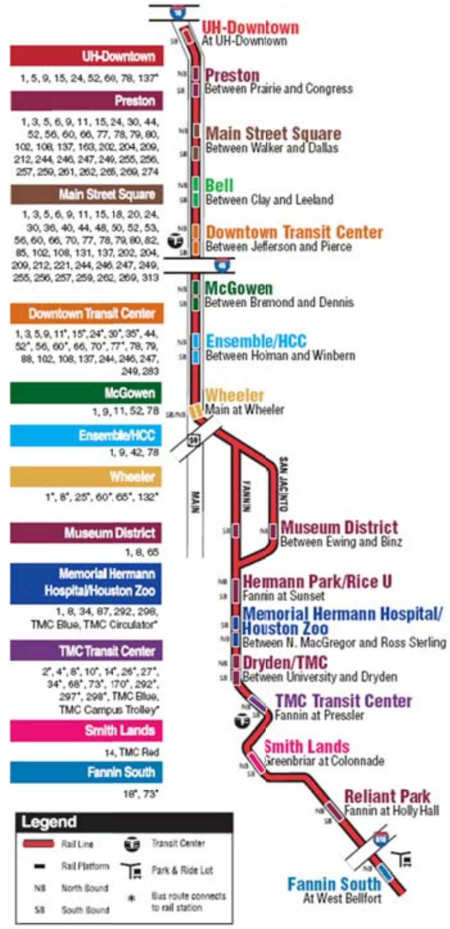
LRT systems are a unique form of rail transit. They enable street-level operation without exclusive rights of way (although some systems do have exclusive rights of way) and they typically receive power from overhead wires. They are also widely adaptable to short or long distances. In busy metropolitan centers, LRT systems tend to operate like bus systems, with stops located every few blocks. Outside of busy city centers, LRT systems are able to travel more quickly with less frequent stops (Arndt, 2009).

HOUSTON’S METRORAIL

Houston’s LRT system, which began operating on the first of January in 2004, penetrates the core of Houston’s inner city. It is identified as the ‘Red Line’ by its operating public entity, the Metropolitan Transit Authority of Harris County (Metro). It is

7.5 miles long and stretches from Downtown to Reliant Park, passing through several of Houston's key places of interest, including the Museum District, Hermann Park, Rice University, the Houston Zoo, and the Texas Medical Center. Figure 2 is part of the METRORail Rider Guide and it identifies the 15 stations and their closest street intersections along the Red Line. Houston's LRT is an at-grade system, generally operating within reserved lanes on existing streets. It serves several multimodal stations, the Federal Transit Administration (FTA) reports, "including the McKinney/Lamar Station Super Stop that integrates with the downtown underground/aerial pedestrian and bus system; the Downtown Transit Center; two stations with the Texas Medical Center Skywalk System; and the Texas Medical Center Transit Center" (FTA, 1999). Based on 1990 census data, the FTA reports, "there were an estimated 1,800 low-income households within a ½ mile radius of the…LRT stations, roughly 21 percent of total households within a ½ mile of proposed stations" (FTA, 1999).

Figure 2: METRORail Rider Guide



www.ridemetro.org

LIGHT RAIL TRANSIT AND PROPERTY VALUES

According to transit economic theory, access to public transportation services is capitalized into property values (Weinstein and Clower, 1999). In the report entitled, *The Initial Economic Impacts of the DART LRT System* (1999), Weinstein and Clower identify the origins of this theory.

> Throughout the 1960s, considerable attention was focused on the comparatively broad issue of how transportation infrastructure influences urban form and, consequently, urban property values (Alonso 1964, Mills 1967, Muth 1969). The impetus of this research was the notion that urban property values are influenced by accessibility, defined commonly as the straight-line distance of a given property from the central business district (CBD) (Kain and Quigley 1970). In other words, any significant improvement in the transportation system that increases accessibility and reduces transportation costs should be capitalized in land values and result in land-use changes.

Indeed, this capitalized value can provide a possible measure of the value of such access (Chen, 1998). It is difficult to evaluate the influence of access on property value, and distance is often used as a proxy. However, distance is not an accurate proxy for access because of other influences on value. To avoid such confusion of factors, this study applies the hedonic modeling method, which has been commonly used by other researchers, e.g. Chen et al. (1998) and Al-Mosaind et al. (1993). In this modeling framework, the distance to the nearest light rail station is used as a measure of the value of access, while also controlling for distance from the rail line itself. This technique is helpful because stations and rail lines also have negative attributes associated with noise and other nuisances, factors that should decline with distance. Including both the distance to the nearest light rail station and the distance to the rail line in the model helps to partially separate the accessibility effect and the nuisance effect.

Chapter Two: Literature Review: Theories and Findings

Only one previous study entitled *The Impacts of Urban Light Rail System on Residential Property Values: A Case Study of the Houston METRORail Transit Line* (Pan et al., 2009), has also specifically examined the impact of Houston's LRT system on property values. Using a multi-level regression model with hierarchical data at two levels (individual property level and traffic analysis zone level), the study reports that:

> Proximity to light rail stations and bus stops has significant negative impacts on the properties located within a quarter mile of rail stops and the effects become insignificant between a quarter mile and one-mile distance from rail stops...Overall, accessibility to transit and job centers has much less impacts on property values than home characteristics (Pan et al., 2009).

According to Goetz et al. (2010), various studies have shown that rail transit systems can have either positive or negative impacts on nearby property values. Indeed, there have been mixed results about the extent to which LRT lines impact property values. It is highly contextual as the interplay of many variables determines this relationship (Goetz, 2010). One would think that LRT systems would increase property values if they increase riders' accessibility to work and recreation, and several studies have found this to be true. On the other hand, if light rail lines generate unwanted pollution and crime, they may be found to have a decreasing effect on property values.

The following table presents the findings of several relevant studies that have analyzed the impacts of rail transit systems on property values. Of the eighteen studies reviewed in this report, twelve found only positive impacts of rail systems on property values, five found either mixed or insignificant results, while one found only negative effects.

Table 2.A: Review of Studies: Rail Transit's Effects on Property Values

Authors	Study Area	Transit Rail Type	Effects of Transit Rail Systems on Property Value	Effect (+/-)
Al-Mosaind, Musaad, et al. (1993)	Portland, Oregon	Light Rail	Positive capitalization of proximity to LRT stations	+
Pan et al. (2009)	Houston, Texas	Light Rail	Negative effects within a quarter mile of rail stops. Accessibility to transit and jobs has much less impact on property values than home characteristics	-
Landis et al. (1994)	San Francisco	Heavy Rail, Light Rail, and Commuter Rail	Minor positive capitalization on home sales	+
Ryan (1997)	San Diego, California	Light Rail	Insignificant effect	x
Workman and Brod (1997)	San Francisco, California; Portland, Oregon	Light Rail	Negative effects near transit stations and positive effects further away. Finds attributed to negative environmental effects generated by transit facilities	+/-
Chen, et al. (1998)	Portland, Oregon	Light Rail	Small net positive effect	+
Bowes and Ihlanfeldt (2001)	Atlanta, Georgia	Heavy Rail	Large positive effects in high income neighborhoods between one quarter and three miles of a station, negative direct effects beyond one quarter mile to low income neighborhoods, and negative crime effects in downtown	+/-
Lewis-Workman and Brod (1998)	New York City, New York	Light Rail	Significant positive effects in walking distance to rail station in New York City	+
Hess and Almeida (2007)	Buffalo, New York	Light Rail	Positive in high-income station areas and negative in low-income station areas	+/-
Voith (1991)	New Jersey; Philadelphia, Pennsylvania	Commuter Rail	Minor positive effects	+
Armstrong (1994)	Boston, Massachusetts	Commuter Rail	Significant positive impacts	+

Table 2.A, cont.

Gatzlaff and Smith (1993)	Miami, Florida	Heavy Rail	Weak impact of system. Higher positive effects in high priced neighborhoods	+
Haider and Miller (2000)	Toronto, Canada	Heavy Rail	Positive but not as strong as other factors, like neighborhood characteristics and structural attributes.	+
Cervero (1996)	San Francisco, California	Heavy Rail	Positive effect increased rent within a quarter mile of the stations	+
Nelson and McCleskey (1990)	Atlanta, Georgia	Heavy Rail	Positive effects on low income neighborhood but negative effects on high income communities	+/-
Weinberger (2001)	Santa Clara County, California	Light Rail	Positive effects on properties within 0.25 miles of a station, even more positive effect on properties within 0.25 and 0.5 miles of a station	+
Cervero and Duncan (2002)	Santa Clara County, California	Light Rail and Commuter Rail	Substantial positive effects on commercial properties	+
Armstrong and Rodriguez (2006)	Boston, Massachusetts	Commuter Rail	Positive capitalization of proximity to LRT stations	+

Overall, it appears as though most studies found positive impacts on the value of properties located near rail systems, especially for multi-family, low-income, and commercial properties; more positive impact outside the immediate nuisance zone; but some studies ultimately found negative impacts. It is important to note that the resulting effects vary, as they are highly dependent on each study's particular data set, context, and methodology.

Chapter Three: Data and Methodology

DATA

Assessed values of residential properties from 2004 and 2010 are used for this study. Data was retrieved from the Real and Personal Property Database of the Harris County Appraisal District (HCAD). In addition, the 2000 Census is used to provide neighborhood information for each census tract, including data for the median house value, the median income, the percentage of people over 65 years old, and the percentage of minorities in the population. Geographic Information System (GIS) is also employed to calculate four spatial-related variables using the straight-line distance from the centroid of each parcel: the distance to the nearest METRORail station, the shortest distance to the LRT line, the distance to the Central Business District (City of Houston City Hall), and the distance to the Texas Medical Center (Methodist Hospital). As its name implies, the straight-line distance is the length of the straightest line possible that joins the two points of interest. Table 3.A, located on the following page, identifies and describes the nine independent variables used in this study.

The GIS buffer tool was also utilized to isolate the residential properties located within a mile of the METRORail line. But first, land-use data was necessary in order to identify the parcels with residential uses. This data was retrieved from a GIS specialist with Houston-Galveston Area Council (HGAC), who kindly granted the author access to a shape file containing the 2008 Land-Use data for all parcels in Harris County.

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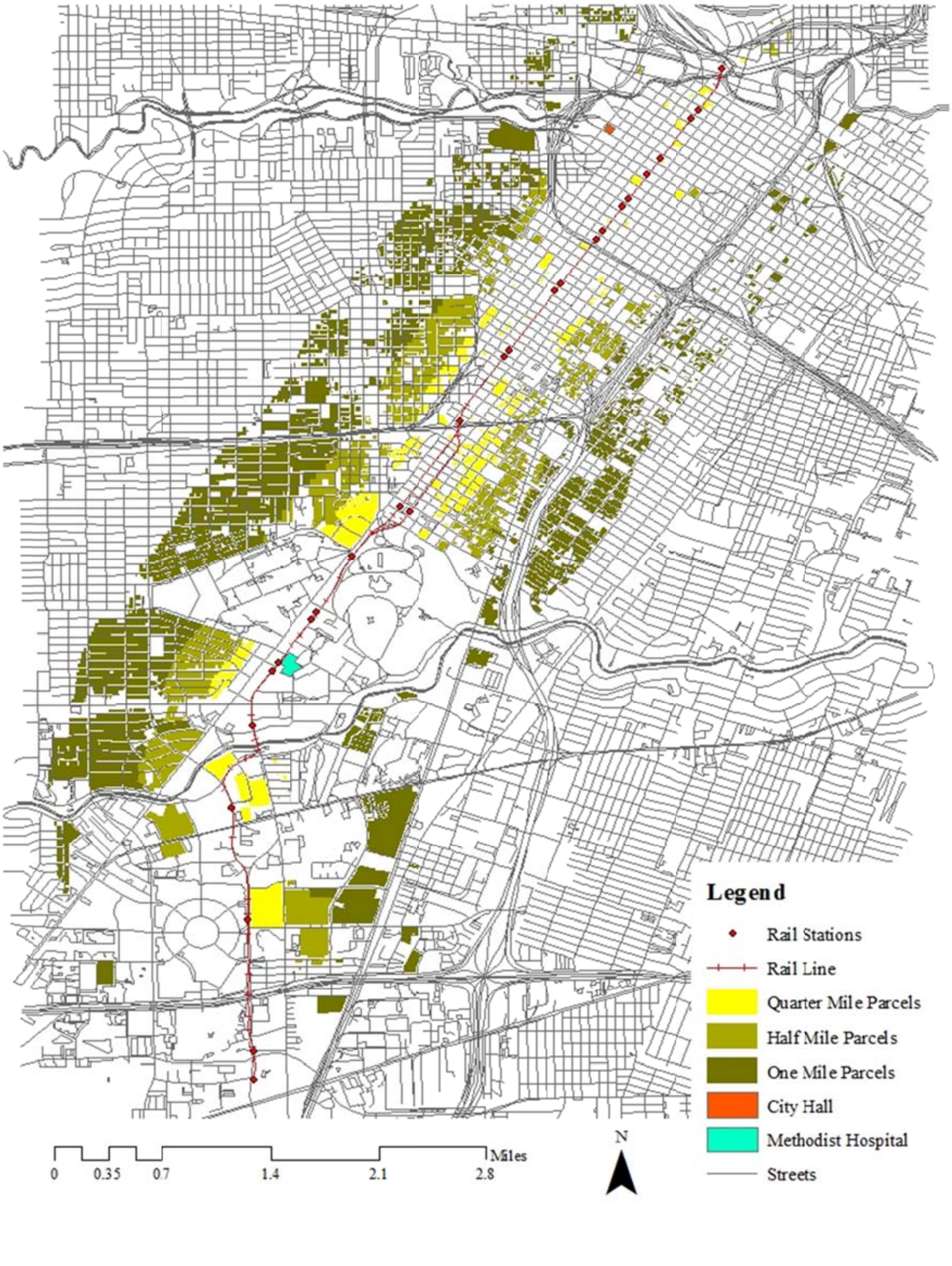
Legend
Rail Stations
Rail Line
Quarter Mile Parcels
Half Mile Parcels
One Mile Parcels
City Hall
Methodist Hospital
Streets
0 0.35 0.7 1.4 2.1 2.8
Miles
N

Table 3.A: Independent Variables

Variable Label	Variable Description
Avg. Household Size	Average Household Size, by Census Tract (number of people)
Median House Value	Median House Value, by Census Tract ($)
Median Household Income	Median Household Income, by Census Tract ($)
% Over 65	Percentage of residents over 65 years old, by Census Tract (%)
% Non White	Minorities as a percentage of the population, by Census Tract (%)
Distance to Rail Line	The straight-line distance from the parcel centroid to the METRORail line (Feet)
Distance to Station	The straight-line distance from the parcel centroid to the closest METRORail Station (Feet)
Distance to Hospital	The straight-line distance from the parcel centroid to the Methodist Hospital (Feet)
Distance to City Hall	The straight-line distance from the parcel centroid to Houston's City Hall (Feet)

Table 3.B: Descriptive Statistics of the Sample

	Min.	Max.	Mean	Std. Deviation
Avg. Household Size (# ppl)	1.3	3.5	2.1	0.5
Median House Value ($)	12,500.0	438,500.0	151,409.6	81,625.9
Median Household Income ($)	13,750.0	127,746.0	37,780.3	15,749.4
% Over 65 (%)	0.4	26.6	7.5	5.0
% Non White (%)	3.6	95.2	42.1	20.3
Distance to Rail Line (ft)	42.3	5,236.7	2,929.0	1,178.6
Distance to Station (ft)	96.8	5,622.2	3,069.3	1,153.3
Distance to Hospital (ft)	1,069.9	24,306.4	12,401.0	4,618.7
Distance to City Hall (ft)	1,453.4	28,814.6	10,405.2	7,750.5

VALUE MEASUREMENT

Based on existing literature, including Chen (1998), Miller (1982), Freeman (1979), and Ridker et al. (1967), four categories of housing attributes that effect housing prices should be controlled for when possible:

1. Physical attributes of the house itself, including housing quality and quantity: frequently included variables are lot size, house size, number of bedrooms, number of bathrooms, presence of basement or not, and age of building;
2. Neighborhood attributes, such as median household income, occupation structure, white/minority ratio, school quality, and crime rate;
3. Locational attributes: distance to Central Business District (CBD) and other major business or employment centers are included as proxies for locational attributes to measure accessibility; and
4. Fiscal and economic externalities: property tax, public facilities, zoning, air quality, proximity to a power plant, shoreline, and traffic externalities.

This study examines the effects of proximity to transit on residential property values. Due to data limitations, the individual physical housing attributes mentioned above are not a part of this study, as they were not included in the property data sets for 2004 and 1010 purchased from the Harris County Appraisal District. Not having the individual attributes of the property buildings as part of the analysis is not ideal, but the study is able to use another variable instead, for which there is data available. This variable is the assessed value of physical improvements made to each property. Although we are unable to control for the individual physical attributes of the house itself, having the overall value of the structure allows us to calculate the total value of each property (land value + improvements value). With these dependent variable data sets, we are able to test the effects of proximity to transit on the value of the land and on the total value of properties.

HEDONIC PRICE MODEL APPROACH

Multiple regression models are the statistical tools most frequently used to test a hypothesis in the social sciences.

> [They] infer causal relationships between a dependent variable…and various explanatory variables, including the existence of a transit investment, and transit service levels. Two of the most commonly used types of regression analysis in transit economic impact analyses are 1) hedonic price models; and 2) logistic regression (Cervero, 1998).

This study chose to use hedonic price modeling because it helps separate the effects of transit's presence from the influences of other possible explanatory factors. The name 'hedonic price modeling' refers to the regression technique used to give different property attributes monetary value (Cervero, 1998). The estimations resulting from hedonic price functions can be fraught with uncertainties, including potentially omitted variable biases, the choice of function form for the price function, and spatial autocorrelation (Armstrong et al., 2006).

In general, for measuring property value effects, hedonic price models take the following form, similar to models used in the studies by Chen (1998) and Cervero and Duncan (2002):

$P_i = f\,(T, N, L, C)$

Where: P is the assessed price of parcel *i*;

T is a vector that gauges proximity to LRT station/line;

N is a vector of neighborhood characteristics;

L is a vector of spatially related variables;

C is a vector of controls.

In this study, the hypothesis predicts that the accessibility effect, represented by the distance to LRT stations, will cause a higher percent increase in property values between 2004 and 2010 as the distance to stations decreases, and that the nuisance effect, represented by the distance to the LRT line, will cause a lower percent increase in property values between 2004 and 2010 as the distance to the line increases.

Chapter Four: Analysis and Results

Analyses were performed on 2,310 residential parcels located within a mile radius around the METRORail LRT line (see Figure 3). Parcels without data values for all variables were excluded from the study. Data for the selected parcels was processed using IBM's SPSS Statistics 19 desktop program (IBM), a statistical software.

Several statistical values measure the ability of a model to predict property value. One of these statistics is the R-squared (R^2) value, also known as the goodness-of-fit index. This statistic varies from 0-1 and represents the proportion of the total variability in the dependent variable Y that is accounted for by the set of explanatory variables. Higher R-squared values indicate that the variables selected for a hedonic price model do a good job of predicting property value.

Statistical significances are also investigated to ensure there is a relationship between explanatory and dependent variables and that the relationship is significantly different from zero. Several measurements of statistical significance are used in this study to measure the statistical significance of each of the independent variables and the overall significance of each model. The statistical significances of the independent variables are investigated using t-tests. The overall significance of each hedonic price model is measured using an F-test.

In order to build the most appropriate regression models for this study, the dependent variable data was transformed into eleven possible forms (see Table 4.A). Intermediate regression models tested the eleven variations to determine which forms of the dependent variable would produce the most statistically significant and comparable results as a function of the nine independent variables.

Table 4.A: Dependent Variables

Variable Label	Variable Description
2004 Land Value	2004 Land Value Only
2010 Land Value	2010 Land Value Only
2004 Improvements Value	2004 Improvements Value Only
2010 Improvements Value	2010 Improvements Value Only
2004 Total Value	(2004 Land Value) + (2004 Improvements Value)
2010 Total Value	(2010 Land Value) + (2010 Improvements Value)
2004 Unit Price	2004 Land Value / parcel sq ft
2010 Unit Price	2010 Land Value / parcel sq ft
Percent Land Value Growth	[(2010 Land Value) – (2004 Land Value)] / (2004 Land Value)
Percent Improvements Value Growth	[(2010 Improvements Value) – (2004 Improvements Value)] / (2004 Improvements Value)
Percent Total Value Growth	[(2010 Total Value) – (2004 Total Value)] / (2004 Total Value)

The results from the intermediate testing models (not shown) suggested that two forms of the dependent variable produced the most statistically comparable results: the percent land value growth and the percent total value growth. Results from the multiple regression analyses using both of these dependent variables are presented below. The results from the regression model using the growth percentage of land value dependent variable are shown in Table 4.B and the results from the regression model using the growth percentage of total value dependent variable are shown in Table 4.C.

All nine independent variables were included in both regression models. Both analyses use the ‘distance to the station’ independent variable to represent accessibility and the ‘distance to the line’ independent variable to represent nuisance qualities.

Table 4.B: Regression Model I

Model I	Coefficients		t	p	95% Confidence Interval	
	B	Std. Error				
Avg. Household Size	-0.0986007	0.0523826	-1.88	0.060	-0.2013228	0.0041215
Median House Value	7.13E-06	5.40E-07	13.22	0.000	6.08E-06	8.19E-06
Median Household Income	2.16E-06	2.01E-06	1.07	0.284	-1.79E-06	6.11E-06
% Over 65	0.05555	0.0044109	12.59	0.000	0.0469002	0.0641999
% Non White	0.0211361	0.0017034	12.41	0.000	0.0177958	0.0244764
Distance to Rail Line	0.000099	0.0001235	0.8	0.423	-0.0001433	0.0003412
Distance to Station	-0.0003218	0.0001308	-2.46	0.014	-0.0005784	-0.0000652
Distance to Hospital	0.0002593	0.0000129	20.03	0.000	0.0002339	0.0002846
Distance to City Hall	0.0001543	7.32E-06	21.08	0.000	0.0001399	0.0001686
Constant	-5.754078	0.3157315	-18.22	0.000	-6.373226	-5.134929

Dependent Variable: % Land Value Growth
Total Cases: 2,310
R Squared: 0.2297
F Value: 76.21

Table 4.C: Regression Model II

Model II	Coefficients		t	p	95% Confidence Interval	
	B	Std. Error				
Avg. Household Size	-1.282061	0.2492603	-5.14	0.000	-1.77086	-0.7932626
Median House Value	0.0000211	2.57E-06	8.24	0.000	0.0000161	0.0000262
Median Household Income	-0.000027	9.58E-06	-2.82	0.005	-0.0000458	-8.22E-06
% Over 65	0.1519421	0.0209892	7.24	0.000	0.1107823	0.1931019
% Non White	0.0646403	0.0081055	7.97	0.000	0.0487455	0.080535
Distance to Rail Line	0.0019658	0.0005878	3.34	0.001	0.0008131	0.0031184
Distance to Station	-0.0026984	0.0006226	-4.33	0.000	-0.0039194	-0.0014774
Distance to Hospital	0.0010047	0.000616	16.31	0.000	0.0008839	0.0011255
Distance to City Hall	0.0006259	0.0000348	17.97	0.000	0.0005576	0.0006941
Constant	-18.68863	1.502394	-12.44	0.000	-21.63482	-15.74245

Dependent Variable: Percent Total Value Growth
Total Cases: 2,310
R Squared: 0.1398
F Value: 41.53

The estimations of the coefficients for variables representing physical accessibility are of primary interest here. We may conclude from the modeling results that the growth percentages for land values and the growth percentages for total values of residential properties between 2004 and 2010 increased as the distance to the nearest stations decreased. This suggests that accessibility to Houston's METRORail currently is capitalized into property values.

The partial regression coefficient (B) represents the strength and type of relationship that exists between each individual independent variable and the dependent variable. The coefficients are the slope between the dependent variable and each of the independent variables. The negative B coefficients for the independent variable 'distance to the station' were found to exist in both models I and II. The negative sign of the coefficient suggests that the variable has an inverse relationship with the dependent variables. This can be interpreted to mean that as the distance from the rail station increases, the growth percentages in land values and the growth percentages in total values decrease. In other words, properties closer to an LRT station experienced a greater percent increase in value from 2004 until 2010 than properties located further away.

Interpretation of the B coefficients found in the regression results for the focus variable 'distance to the station' suggest several conclusions. In Model I, a B coefficient of -0.0003218 for the variable 'distance to the rail station,' suggests that for every one hundred feet closer to the station, the land value increase from 2004 to 2010 was 3.218% higher. In Model II, a B coefficient of -0.0026984 for the variable 'distance to the rail station' suggests that for every one hundred feet closer to the station, the total value increase from 2004 to 2010 was 26.984% higher. The estimated change in value from 2004 to 2010 was found to be much higher for total values than for land values when looking at the measured distance to the rail station.

Also, the results suggest that the growth percentages for land values and total values are lower for properties closer to the rail line. The positive sign of the B coefficients for the independent variable ‘distance to the line’ in both models suggests that the variable has a direct (or positive) relationship with the two dependent variables. This means that as the distance away from the line increases, the percent growth in land values and the percent growth in total values increase. In other words, properties closer to the LRT line experienced lower percent increases in value from 2004 until 2010 than properties located further away.

Further interpretation of the B coefficients found in the regression results for the focus variable ‘distance to the rail line’ suggests several points. In Model I, a B coefficient of 0.000099 for the variable ‘distance to the rail line’ suggests that for every one hundred feet further from the rail line, the land value increase from 2004 to 2010 was 0.99% higher. In Model II, a B coefficient of 0.0019658 for the variable ‘distance to the rail line’ suggests that for every one hundred feet further away from the rail line, the total value increase from 2004 to 2010 was 19.658% higher. The estimated change in value from 2004 to 2010 was found to be much higher for total values than for land values when looking at the measured distance to the rail line.

The R-squared value reported for Model I was 0.2297. This suggests that twenty-three percent of the variation in the percentage change in land values is explained by the included independent variables. The R-squared value found for Model II, 0.1398, suggests that about fourteen percent of the variation in the percentage change in total values is explained by the included independent variables. The low R-squared values indicate that there are other important variables which impact the change in assessed valuation. Roughly 77% (Model 1) and 86% (Model 2) of the variation in the change in assessed valuation is unexplained. The low R-squared values do not, however, diminish the statistical significance of the separate independent variables.

A desirable feature of a regression model is a high F-value; it represents the statistical significance of the entire model. Both regression models show statistical significance: Model I has an F-value of 76.21 and Model II has an F-Value of 41.53.

T-values represent the statistical significance of each individual independent variable in a model. Generally, when the absolute value of a variable's t-value is greater than two, it is considered statistically significant. Of our focus variables, 'distance to the rail line' in Model I has the lowest t-value of 0.8. The t-value for 'distance to the station' is slightly better (-2.46), and it is the fourth lowest t-value of Model I. In Model II, the t-value for 'distance to the line' is the second lowest (3.34), while the study's other focus variable, 'distance to the station,' has the third lowest t-value in Model II (-4.33). The t-value results for the focus variables are rather low. In fact, the Model I t-value for the 'distance to the rail line' variable is too low to be conventionally considered statistically significant. The Model II t-values for the focus variables are also low, but they are high enough to be able to consider the focus variables to be statistically significant.

For the two particular focus variables, the overall results from Regression Model II may be considered more statistically significant and reliable than those of Model I because of the t-values and p-values. The p-value represents the probability of getting the calculated value if the coefficient were equal to zero (the null hypothesis). Conventionally, when a p-value is less than 0.05, the coefficient is considered statistically significant. In Model I, the p-value for 'distance to the line' is 0.423 and the p-value for 'distance to the station' is 0.014. The p-value for the 'distance to the line' variable is too high for its coefficient to be considered statistically significant. In Model II, the p-value for 'distance to the line' is 0.001 and the p-value for 'distance to the station' is 0.000. The low p-values for both of the variables suggest statistical significance.

Overall, the modeling results found in this study can be considered robust due to the large number of observations (2,310) included in the analysis. The results suggest that the growth percentage for land and total values between 2004 and 2010 for properties closer to the rail stations increased faster than for those further away, with larger value changes found for the total values examined in Model II. On the other hand, it is important to note that the focus variables appear to have coefficients of lower statistical significance than several of the other independent variables included in the study.

Chapter Five: Discussion and Conclusions

Many cities have experienced the possible socio-economic benefits that light rail transit can bring. However, "it has also been criticized for high costs in construction and operations, low ridership and revenue, noises, crimes and numerous safety problems" (Pan, 2009). Also, studies have shown the capitalization effects of rail transit to be extremely modest and highly variable (Weinstein and Clower 1999, Cervero and Landis 1995).

It is difficult for transit rail systems to have significant impacts on urban development, land use, population, and employment without supportive policies and efforts, like incentive zoning, citizen support and more (Pan, 2009). Houston's transit planning agencies, including METRO Houston and the Metropolitan Planning Organization in Houston (the Houston-Galveston Area Council) have limited governmental powers and "lack the means to offer financial incentive to complement urban planning interventions, such as zoning or land use in the vicinities of a rail line" (Pan, 2009). Also, it can take many years for land values to feel the capitalization effects of transportation improvements (Weinstein and Clower, 1999).

This study utilizes a hedonic price model to analyze the impacts of the light rail transit line on the values of adjacent residential properties. Ultimately, the modeling results confirm the hypothesis that that the accessibility effect, represented by the distance to LRT stations, causes a higher percent increase in property values between 2004 and 2010 as the distance to the nearest rail station decreases. In addition to the influence of increased access, this relationship may also be attributed to improvements made around the station areas during the same time period, including the addition of landscaping and other services and amenities.

The modeling results also confirm that the nuisance effect, represented by the distance to the LRT line, causes a lower percent increase in property values during the 2004 to 2010 time period as the distance to the line increases. This finding suggests that nuisance effects such as increased noise and congestion caused by LRT systems can cause problems that transportation planners and policymakers should address in the future.

According to the results, many of the other independent variables, including several neighborhood qualities and the distances to downtown and to the Texas Medical Center, have stronger statistical relationships with the dependent variables than the focus variables have with them. This suggests that these other independent variables, including the distance to the Texas Medical Center, the distance to downtown, and several neighborhood attributes, including median house value, the percentage of people over the age of 65, and minorities as a percentage of the population, have more significant influences on the value of residential properties located within a mile of Houston's LRT system than the study's focus variables.

There exist several possible explanations for the weak results found in this study regarding the relationship between rail transit and property values. For one, this study may not have given the METRORail line sufficient time to impact adjacent properties, as it has only been six years since it first opened in 2004.

A second possibility concerns the data and measurement technique. Indeed, a likely issue with this study is that it lacked complete data on housing attributes needed for a thorough use of a hedonic price model. Also, further analyses performed on other types of land uses may see different results.

Thirdly, Weinstein and Clower (1999) discuss the possibility that rail transit systems should not be expected to increase accessibility.

> Some studies, in fact, have claimed that rail systems do not impact accessibility because they tend to serve few origins and destinations, and they carry a very small share of the total number of trips in an area (Weinstein and Clower 1999, Hamer 1976, Meyer & Gomez-Ibanez 1981).

A related fourth possibility concerns the limited size of Houston's METRORail. The line is currently only 7.5 miles long, stretching between downtown and the Reliant Park. A majority of the land uses surrounding the current line are not residential and the line only hits a limited number of destinations within a small portion of a large city; two facts that may limit the level of perceived benefits from the line as it stands currently.

Several expansions to the line are currently under construction and will connect the METRORail to additional portions of this auto-dominated city. The expansions should encourage additional ridership and further support Houstonians' valuing of transit systems.

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