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Houston Is On The Right Side Of The Tracks

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Abstract

Houston, Texas has long been plagued by urban and suburban sprawl. Political leadership in Houston has worked hard to improve the economy using several levers available to them. One area the city attempts to improve is that of public transit. The city has developed a large fixed-rail transit system in separate stages since 2004 when the first 7.5 mile stretch of the Harris County Metropolitan Authority fixed light rail, the METRORail, opened. The system has since grown, mostly Eastward, to 22.7 miles and 34 stations, with further expansion planned. I use data on real estate values and property characteristics provided by Harris County Appraisal District and Geographical Information Systems data to determine whether the rail system has had an impact on housing values or urban density.

Evidence in the data supports that the latest generation of transit stations has contributed to increased housing values in the areas surrounding the transit stations as compared to the rest of Houston. There is also evidence in housing data that identifies a broad increase for demand across Houston with a more pronounced increase in demand for density around the transit stations.

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Introduction

Houston, Texas is a large city. The city encompasses 637.4 square miles, making it the eighth-most expansive city in the United States, right behind Oklahoma City, Oklahoma. With a population of over 2.3 million it is the fourth largest city by population in the United States. Houston is the county seat of Harris County, Texas, which has a land mass of 1,777 square miles and is home to an estimated population of 4.7 million people (United States Census Bureau, 2021).

Mostly through the use of Federal infrastructure grants, Harris County has built a total of 22.7 miles of light rail that originally aimed to connect communities with high-trafficked business areas such as the central business district, CBD, and the Texas Medical Center. There has been extraordinary commercial and residential real estate development around the new stations that are in operation. This paper aims to quantify the effect of this new transit program on both nearby housing values and the nature of subsequent development, as measured by building density. Municipalities and governments have many options for contributing to economic development and urban density. One option is to designate zoning for business activity in order to concentrate businesses into one central area to which all workers living in a city could commute. The negative implications for this are increased traffic on highways, congestion within and surrounding central business districts, and both the increased cost of, and incentive to use urban land for, parking.

Vacant land is rare in urban settings. Most real estate has been developed, and if a piece of property is not in use, there is likely a structure on it that cannot be used for whatever reasons, sometimes those reasons are safety related. The most cost-effective option for developers that want to purchase unused real estate, is to demolish whatever structure is on the parcel and pave it into a parking lot. This is the option for those developers that want to use the least amount of money very quickly. The parking lot can even serve a developer’s immediate need to use the property while finalizing details on the project they intend to later develop. Sometimes these details include waiting until more favorable regulatory terms arise. When developers of urban areas are driven to use land for parking rather than productive development such as office buildings, condominiums, the government can step and create incentives that reward such productive developments. The tool that the city of Houston uses most often is the ability to abate property taxes. The government pauses increases to property appraisals for the purposes of delaying the tax liability a new development occurs. The period during which the city is not increasing property values is assigned a value, such as the difference between the existing property value and the market value of the new development, multiplied by the number of years the development goes without a tax liability increase. The resultant value is what the city is seen to have "given" the developer. Although no money changes hands, the two parties are better off. The city receives a brand-new development and increased business activity, and the developer receives a reduced tax liability. Another incentive for developers is added transit options near potential developments. There have been several studies on areas where transit has been introduced to a community, linking neighborhoods with work, school, and play. This so-called "Transit Effect" provides an incentive for developers to use land for developments that contribute to urban density.

Houston, Texas has put to a vote zoning laws three times, in 1948, 1962, and finally in 1993. Each time the population struck down the notion of designating areas in the city for residential or industrial. Perhaps Houston's reluctance to introduce zoning laws is an homage to the "Wild West" image for which Texas is so affectionately known. This means that developers are able to build on their land anything they think will contribute the most to themselves or the economy. The city, in an attempt to position itself as friendly to businesses, leaned heavily into this lack of zoning laws in 2014 with the "City With No Limits" Campaign. Developers have since built apartments, neighborhoods, and mixed-use businesses and the land adjacent to the stations of the METRORail. The implementation of a mass fixed-transit system has brought with it large swaths of development along the corridor the METRORail was built. Since Houston's primary source of revenue is property taxes associated with both residential and commercial real estate, the METRORail has contributed greatly to a rise in property tax revenue for the Houston area.

Anecdotally, one can see the number of cranes accenting the skyline, construction fences around an expanse of real estate developments, and freshly built structures throughout most economic zones in Houston. One indicator that urban density has been popular can be found in the younger generation's desire to reduce commuting times and beautify their city. This desire to reduce commuting times has led realtors to include a "Walk Score" for residential listing. The Walk Score "analyzes hundreds of walking routes to nearby amenities" to award points based on how long of a walk it would take to reach those amenities. Zero points are given to walks greater than 30 minutes (Walk Score, 2021). While not based much on science, it has proven to be an effective marketing tool for realtors. While owning a vehicle may still seem to be a high priority for most of the home buying market, there is enough of a market looking for the conveniences associated with density to include such things as the Walk Score in property listings.

The Houston METRORail has become an effective tool for the municipality both in its intended purpose, connecting people to economic areas, but also indirectly through attracting development along its corridor. There are many reasons for the advancement of Houston's economy over recent years, though one effect of the expansion of Houston's economy has been a pronounced rise in house prices. My hypothesis is that areas that are closer to METRORail stations saw a greater increase in home value than those without access to fixed-rail transit. Further, I believe this greater increase in value is due to an increased demand for urban density in Houston.

Literature Review

Sirmans et al (2005) performed a study on the price characteristics of residential properties. They found that several qualitative factors prevail and attempted to rank them depending on their influence in home prices. The trait found to have the greatest effect on variability of a home price was square footage, with other factors such as number of bathrooms, presence or absence of a basement, age of the home, and lot size, among others also having a sizable impact. The use of these hedonic pricing models provides an estimate of monetary value on different attributes of a piece of property.

Several studies have been performed that compare property values both along transit corridors and within certain distances to transit stations. One study compared activity of residents along new transit stations and found that transit use does increase with more investment into soft measures such as marketing and management of transit facilities rather than hard investment measures such as expansion and better train cars (Hong et al, 2016). A major hurdle for Houston is getting its citizens to use the transit options the municipality provides. There are several reasons the population is reluctant to use mass transit, the street planning has historically been centered around the idea that the majority of the population uses cars, and the population has demanded more and more space in the property they buy. Even with all of the benefits mass transit provides, getting the population to use mass transit may be a challenge for the marketing and management of that system.

In Miami, the implementation of the north end of the Metrorail only had marginal impacts on residential home values. The impact was more pronounced for neighborhoods that were in the lower end of the market as opposed to those homes deemed luxury homes in high-end neighborhoods, where little effect in home values was found to have occurred (Gatzlaff &

Smith, 1993). The implementation of such fixed-rail transit is likely to serve those that live in the lower cost market of houses, so one could argue that the Miami Metrorail was a success even in 1993. Sometimes the promise of new transit projects have been observed to have a leading effect on property values. In Chicago, the Midway line is an expansion of the elevated railways and subways that increases transit access further south from Chicago's loop area down to the Midway airport. Due to speculation, residential property values were found to be seventeen percent higher within one half mile of new stations for the Midway line than they otherwise would have grown due to normal property appreciation for that area of Chicago (Mcdonald & Osuji, 1994). A study performed in 1980 showed that retail properties saw an increase in value around any new capital infrastructure investment made up to that point (Damm et al, 1980). Landis et al (1995) found that the areas around five transit systems in California realized a premium for home prices. Among the counties tested, Alameda and Costa County saw the highest premiums. The study concluded that home prices increased as distance to the train stations decreased, with some counties having a more pronounced transit effect than others. The same effect was not calculated for commercial properties in the California counties.

Kilpatrick et al (2007) find that properties directly adjacent to transit corridors saw a 20% decrease in value likely linked to a certain "stigma" a property carries for being near the noise produced by transit. The decrease in value was found to persist for up to 300 feet beyond the transit corridor, at which point property values were markedly higher. Evidence that the transit effect may not prevail in some communities was found in Buffalo, NY. Hess & Almeida (2007) compare home value premiums for homes located within one quarter mile of a transit station. No premium on home prices were found to be due to factors other than the qualities of the houses in the data. Those qualities, in order of influence, were number of bathrooms, size of the house's lot, and the neighborhood of the house, specifically outside of East Buffalo. The Buffalo study suggests that a big enough economic base must be present in a town in order to optimize transit projects. That is, if Buffalo had a strong enough industry presence, and jobs for people to go to, there may have been a more profound effect of transit projects on home values.

In Houston's early history, between the years 1868 and 1928, the city operated a streetcar system, which can be considered the first iteration of mass fixed transit for the city. By most accounts, and the span of time the system survived, the streetcar system was a successful and popular program. One author even posits that "until the 1920s, virtually every significant land development was located on or near an existing streetcar line" (Baron, 2014). The map of the peak of the streetcar system, portrayed below, draws a lot of corollaries with the existing, and planned, system that operates today. The similarities to the current iteration of fixed rail transit and the original streetcar's popularity can lead one to wonder why the city ripped out the rails and ceased service instead of building upon the existing system much like they would do nearly 80 years later.

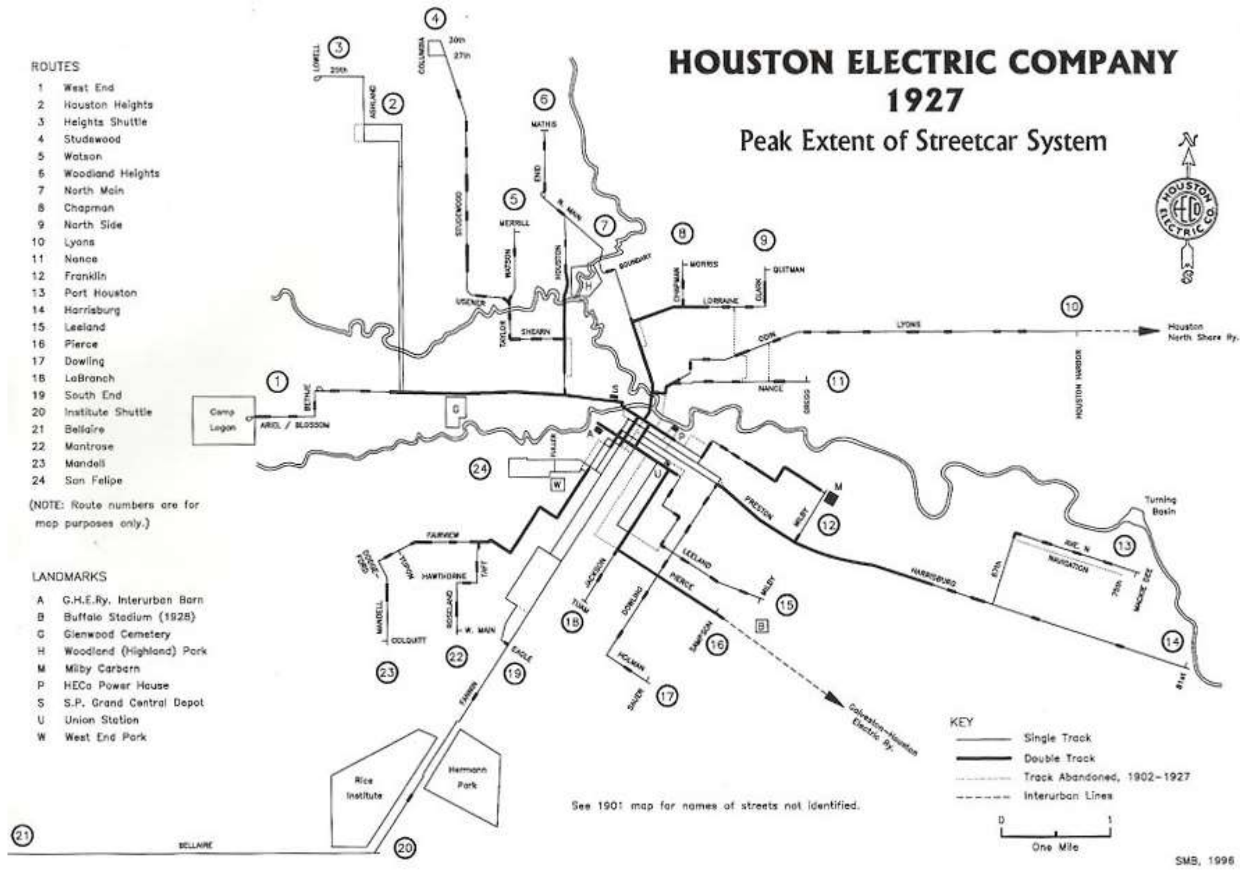

Figure 1 *Peak Extent of Houston Streetcar System*

Note. Adapted from *Should Streetcars and Bus Rapid Transit Be in Houston's Future?* (http://offcite.org/should-streetcars-and-bus-rapid-transit-be-in-houstons-future/). Copyright 2014 by Nick Panzarella.

By most conventional standards, Houston has shown to have a robust and growing economy in recent history. The GDP for the Houston-The Woodlands-Sugar Land metropolitan area was estimated by the Federal Reserve to be $512 billion (2021). The city hosts two major industries regionally, energy and medical. Houston has even successfully hosted a federal government agency, NASA, for decades. There exists a wide range of jobs available to a similarly wide range of education levels, and no construction zoning restrictions. Pan performed two studies of the transit effect associated with the METRORail in 2013 and in 2019. The first study saw proximity to train stations in Houston did have a positive effect on property value, though the qualitative characteristics of homes such as size and number of bedrooms prevailed (2013). A second such study performed in 2019, using residential property values for the six years following the opening of the first 7.5 mile stretch of the METRORail. The study at that time found significant positive effects on residential property values in proximity to the transit stations (2019). These two studies used data associated with real estate sales rather than the valuation data Harris County Appraisal District provides annually. There were also vacant parcels and empty buildings along the completed and proposed lines. Property that saw a significant change in use following the completion of light rail projects in Houston. A 2015 study showed that, between the years 2005 and 2014, land use changed significantly along the transit corridors, with the exception of the years 2005-2008, which saw a slowdown in land use changes, counter to the rate of land use changes in the rest of the city and county. Vacant lots along the corridors were changed to commercial and residential use not only along the completed lines, but along most of the proposed lines that have since been built, with the exception of the future gold line that has not started construction to this day. Though, the authors note that the land use changes may have occurred without the transit projects as the parcels in those areas have historically changed use with some amount of frequency (Lee & Sener, 2017).

The original stretch of 7.5 miles of METRORail was in operation in 2004 as the red line. In 2015, the remainder of the existing length of rail line was put into operation. Construction did not start on the expansion of the red line northbound and the additions of the green and purple lines that travel East and Southeast, respectively, until 2009. Those additional stations, 23 in total, focused more on connecting urban neighborhoods in Houston than the original red line, which runs from economic areas such as the central business district, the Texas Medical Center, and the NRG stadium. The last two stations constructed on the METRORail were finished in January 2017. For the purposes of this paper I chose to identify the initial stretch of the red line as the first generation of stations, while expansion that went into operation in 2015 is represented in this paper as the second generation of stations. The map of all transit stations in operation in Houston is represented below in Figure 1. In the figure below, the original stretch of the red line encompasses the corridor between the UH-Downtown and Fannin South stations. Anecdotally, this corridor is one of the most congested corridors in Houston. All remaining stations comprise the second generation of stations, and instead of connecting more economic areas with the second generation, this group of transit stations is mostly in neighborhoods, with the University of Houston the only additional economic area added to the METRORail corridor.

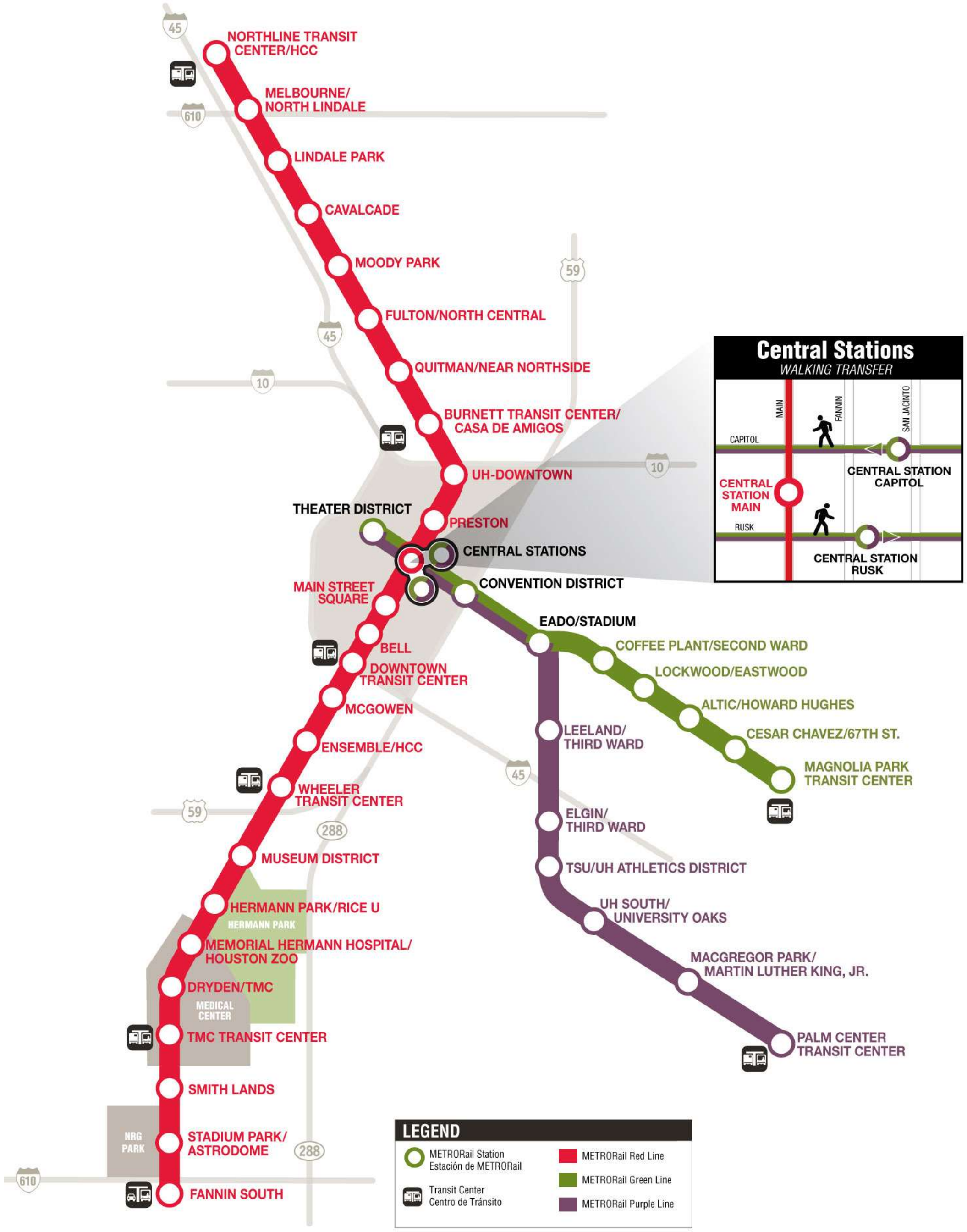

Figure 2 *Map of First- and Second-Generation Transit Stations for Houston METRORail*

Note. Adapted from *How to Ride METRORail*. (https://www.ridemetro.org/). Copyright 2021 by Metropolitan Transit Authority of Harris County

The city has planned a third generation of transit stations that travels west to Missouri City, a popular suburb, and an offshoot of that westbound line that travels north up through the popular Galleria area, a luxury real estate market by most metrics. Though there has been renderings of proposals for a transit line that connects the main airport of Houston, George Bush Intercontinental Airport, to the CBD, no such plans have been formalized by the authorities having jurisdiction over such matters.

To determine whether urban density is a net positive for a region, a meta-analysis examined the effects it has on various factors of society. The study found that there are numerous contributions to welfare of the general public as a region increases its density. The authors concluded that increased density, while met with increased rents, results in increased wages and has a pronounced “amenity effect”. Of particular benefit to increased urban density is that of innovation, as the study found a marked increase in the Technical Factor Productivity of dense urban environments (Ahlfeldt & Pietrostefani, 2017).

Data

Data for property characteristics and values is made publicly available each year by the Harris County Appraisal District, HCAD, for the years 2005 through 2020. HCAD provides the assessed values for each parcel of property within these datasets. The data from HCAD has entries which represent a unique parcel and its characteristics. HCAD assigns an account number to parcels that follows the parcel, rather than the owner, through its life. Land that has been built upon but continues to be a single property retains its account number. When property is created anew on an existing parcel, as is the case for condominiums and office parcels, a new account number is created that follows said property through time. The data for each property also has characteristics for building type that delineates between residential or commercial and use of each parcel. HCAD also provides characteristics for each parcel in Harris County. These characteristics include quantity of bedrooms, stories, bathrooms both half and full, the presence of fireplaces and elevators, and total room count to capture room types that are not “bed” or “bath.” The variable for building area represents the sum of the square feet of living area for residential buildings plus any unfinished portions such as an attic, garage, or porch.

Geographical Informational System mapping was used to create polygons for all properties within the data provided by HCAD. As of the year 2020, Harris County recorded 1,490,819 individual property records that were subject to assessment of their values annually. The summary statistics for the assessed value of the properties spanning the 16 years which data are provided are portrayed in Figure 3 below.

Table 1 *Summary Statistics of Single-Family Homes in Harris County*

Year	Mean	St. Dev.	Minimum	Maximum	Observations
2005	$ 148,704	169,533	$ 1,900	$ 19,162,798	812,391
2006	$ 154,153	176,235	$ 1,900	$ 19,709,624	844,181
2007	$ 172,010	191,697	$ 2,600	$ 19,893,914	872,622
2008	$ 172,010	214,363	$ 2,600	$ 21,870,292	893,677
2009	$ 169,033	220,919	$ 2,600	$ 21,870,292	908,136
2010	$ 165,001	213,122	$ 2,600	$ 21,870,292	919,215
2011	$ 163,954	215,270	$ 2,600	$ 21,870,292	928,759
2012	$ 162,838	223,178	$ 2,600	$ 22,013,185	939,650
2013	$ 168,642	236,115	$ 2,600	$ 18,800,000	953,817
2014	$ 193,739	274,415	$ 2,600	$ 23,760,649	968,205
2015	$ 222,789	313,252	$ 2,600	$ 25,524,473	983,179
2016	$ 232,349	316,862	$ 3,489	$ 25,524,473	997,340
2017	$ 239,484	314,603	$ 3,586	$ 25,524,473	1,011,990
2018	$ 237,801	309,328	$ 2,164	$ 25,524,473	1,024,954
2019	$ 255,079	317,983	$ 407	$ 24,883,399	1,042,441
2020	$ 264,677	319,819	$ 1,290	$ 24,760,584	1,059,447

To capture only single-family homes, the variable state_class provided by HCAD is filtered to include only the results that have an entry of "A1." The data available for single family homes has details such as number of bedrooms, number of bathrooms, the absence or presence of a fireplace. These characteristics are not available for commercial property and is even sometimes not applicable to these types of parcels. In order to perform an analysis using those characteristics, only single-family homes were included. The HCAD data descriptors define A1 as single family homes. The definition for single family homes is broad in this case, and represents detached, and attached homes that are designed to have a single family within them. This removes all buildings used for commercial purposes, including apartments, and condominium buildings. The map of those parcels, where each individual parcel is represented by its own polygon, is depicted in the figure below.

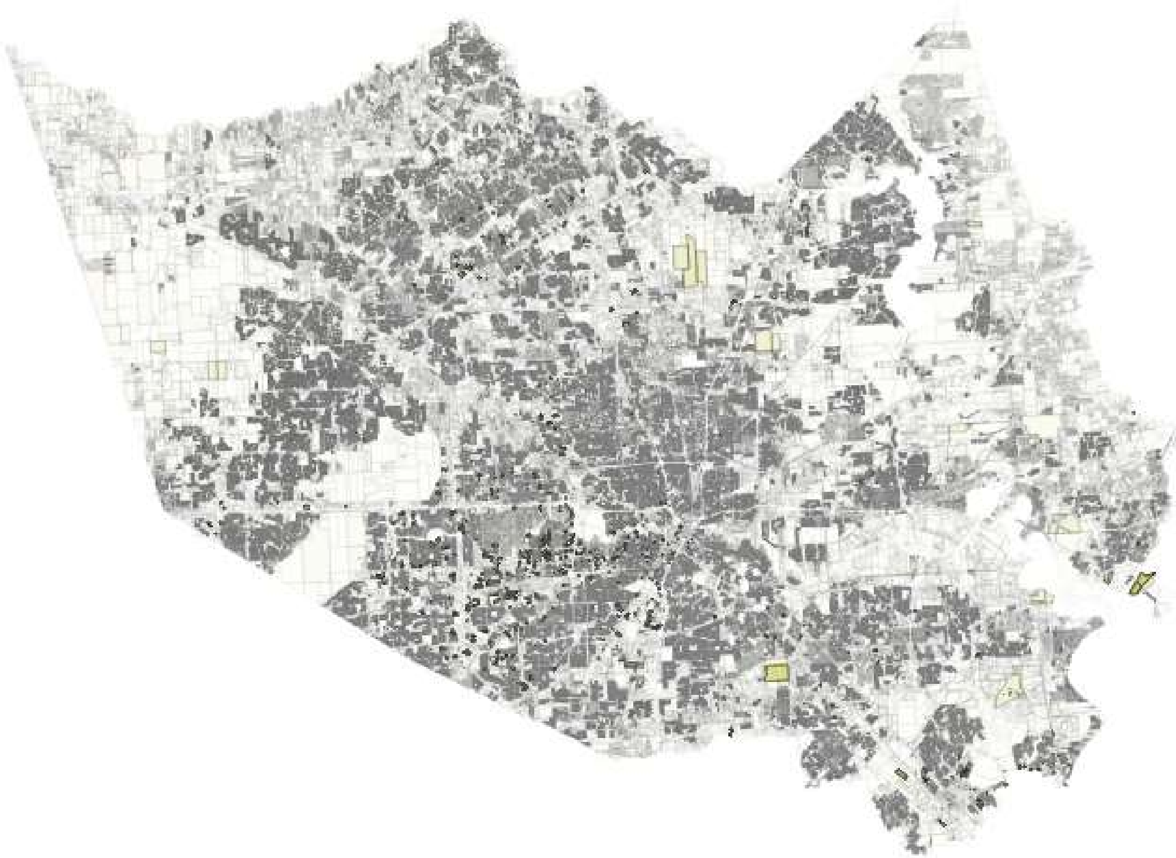

Figure 3 *Map of Real Estate Parcels for Harris County, Texas.*

A layer identifying point location for the second generation of transit stations that travel East and Southeast from the CBD was created in order to identify those parcels within a spatial relationship of the transit stations in question. The second generation are the stations that went into operation in 2015. The idea is to place in buckets each property that is within one quarter mile of a transit station, one half mile of a transit station, and other. The figures below highlight those parcels which are within a half- and quarter-mile radius, respectively.

Figure 4 *Target Parcel Map: ½ Mile Radius of 2nd Generation Transit Station*

Figure 5 *Target Parcel Map: ¼ Mile Radius of 2nd Generation Transit Station*

Empirical Model

Chen et al (1997) developed a general price equation for hedonic pricing models associated with single family homes. That equation, in its simplified form is shown below.

$$Y = a_0 + bX + rZ + \varepsilon$$

Where Y is the sales price, or assessed value, of the property, a is a constant, X is a vector of control variables, Z is a vector of spatial-related variables, e is the random error term, and a, b, and r are parameters estimated in the experiment. I use a similar equation to determine the effect the spatial relationship with the METRORail has on home prices, portrayed below.

$$Y = a_0 + \beta_n x_{it} + +\beta_2 d_t + \beta_3 dist_{it} + \beta_4 dist * op_{it}\ \varepsilon$$

Where Y is the assessed value of the parcel, a is a constant, ε is the error term, d_t is a variable that represents the characteristics of the parcel to include number of total rooms, number of bathrooms, year built, number of stories, and the presence or absence of a fireplace, $dist_{it}$ is the spatial relationship the parcel has with a transit station, the variable $dist*op_{it}$ is an interaction variable indicating the parcel is within a given distance to a transit station and that station is in operation, and β_n, β_2, β_3,and β_4 are parameters to be estimated in the experiment. The spatial relationship in question is a binary variable indicating one when a property is within a certain distance to a transit station, zero when it is not. I estimate this model using both random effects and fixed effects to examine the relationship between assessed value of all parcels over time and including the variable that identifies those parcels within a certain proximity to a transit station. The underlying hypothesis is that property within both a quarter mile and half mile proximities of the METRORail realize an increase in value at a higher rate than those properties not located within one half mile or one quarter of the second generation of transit stations.

Properties in the data that are not single family homes are absent important characteristic data such as total rooms or bathrooms. This includes apartment complexes and commercial properties, therefore only the impact on single family homes could be measured. Other parcels were dropped from the data to include properties with no building on them, properties which were assigned a value of zero by HCAD, and properties that appeared as duplicates due to merging several different datasets.

To produce a population estimate of characteristics, I run a pooled OLS regression on the 15 million observations in the data. The variables identified in the regression are portrayed in Table 2 below.

Table 2 *Variable List and Description*

Variable	Description
dens	Variable for equation bld_ar/land_ar
valpsf	Dependent variable. Assessed value of parcel per square feet of building area
bld_ar	The area of the building attached to the HCAD account number.
land_ar	The area of land attached to the HCAD account number.
totrm	Total rooms of the parcel.
Bthrm	Variable representing number of bathrooms in a home associated with a parcel.
yrbuilt	Year in which the property's improvement (house) was added.
yrbuilt2	Squared value for yrbuilt
Fplc	Dummy variable which is 1 if the building on the parcel has a fireplace.
Stories	Number of stories the building on the parcel has
Stories2	Squared value for Stories
sgqmile	Binary variable which is 1 if the parcel in question is within one quarter mile of a transit station.
sgqmileop	Binary variable which is 1 if the transit station nearest the parcel is in operation.
sghmile	Binary variable which is 1 if the parcel in question is within one half mile of a transit station.
sghmileop	Binary variable which is 1 if the transit station nearest the parcel is in operation.
yr	Time series estimate for year coefficient

The variable yr represents all time dummies for years, beginning with 2005 as the first year for which values are provided. The variables sghmile and sgqmile represent a binary variable that equals one if the parcel, i, is within x miles of a transit station, and zero otherwise. The interaction variable, sgqmileop and sghmileop, equal one if the parcel is within x miles of a train station and that station is in operation, zero if the parcel is not within range, and zero if the transit station is not in operation. Fixed effects transformation regression analyses are preferred when using panel data, such as this case, and to control for unobserved heterogeneity. The use of pooled OLS regressions is necessary in order to estimate the effects different characteristics, β_2, have on single-family property. This is also used to evaluate whether or not the houses within a half mile of a transit station is not active were valued lower or higher than other property prior to those stations being active. Only when the stations are active is the sghmileop variable equal to one, therefore the interaction of those two variables indicates that the parcel in question may benefit from the amenity effects the newly operating transit stations provide. Pooled OLS will recover the coefficient, indicating whether these transit stations are being built in generally higher, or lower, market areas.

Results

This section details the analysis I performed to determine whether the second generation of transit stations contributed to house prices or urban density.

Price

The results for the pooled OLS regression using sgqmileop as a binary variable to indicate a parcel is within a quarter mile of a transit station and that station is in operation are represented in Table 3 below.

Table 3 *Pooled OLS Regression Results for Price (Quarter Mile Proximity)*

Variable	Coef.	Std. Error	P>|t|
bld_ar	0.011	0.000	0.000
totrm	-2.567	0.012	0.000
Bthrm	27.899	0.028	0.000
Fplc	6.531	0.030	0.000
stories	-80.307	0.132	0.000
stories2	22.070	0.038	0.000
yrbuilt	-72.968	0.093	0.000
yrbuilt2	0.018	0.000	0.000
sgqmile	-72.968	0.267	0.000
sgqmileop	18.204	0.427	0.000
yr2006	2.031	0.079	0.000
yr2007	6.066	0.078	0.000
yr2008	8.500	0.078	0.000
yr2009	5.702	0.078	0.000
yr2010	3.406	0.078	0.000
yr2011	2.103	0.077	0.000
yr2012	0.365	0.077	0.000
yr2013	1.674	0.077	0.000
yr2014	11.214	0.076	0.000
yr2015	22.658	0.076	0.000
yr2016	26.508	0.076	0.000
yr2017	29.695	0.076	0.000
yr2018	28.797	0.076	0.000
yr2019	39.907	0.075	0.000
yr2020	41.238	0.075	0.000
constant	72697.86	91.447	0.000

The regression for quarter mile proximity to a train station provided an adjusted r-squared of 0.29, lower than expected. Given the p-values for all variables read zero to three decimal places, I assume the variables contribute to variability with some unobserved heterogeneity within the population model. The coefficient for the interaction variable sgqmile is negative, indicating the homes within a quarter mile of a second-generation transit station realized lower values until the transit stations went into operation. The coefficient for interaction variable, sgqmileop, is positive, indicating the houses within a quarter mile of transit stations rose in value at a greater rate than the rest of the homes in the HCAD data.

To control for unobserved heterogeneity and because I am working with panel data, I perform a fixed effects transformation regression, using all parcels in the data where HCAD provides an assessed value. The results are provided in Table 4 below.

Table 4 *Fixed Effects Regression Results for Price (Quarter Mile Proximity)*

Variable	Coef.	Std. Error	P>|t|
yrbuilt	-0.781	0.005	0.000
yrbuilt2	0.0004	0.000	0.000
sgqmileop	16.742	0.238	0.000
yr2006	2.622	0.044	0.000
yr2007	6.711	0.043	0.000
yr2008	9.104	0.043	0.000
yr2009	6.48	0.043	0.000
yr2010	4.286	0.043	0.000
yr2011	3.075	0.043	0.000
yr2012	1.446	0.043	0.000
yr2013	2.856	0.043	0.000
yr2014	12.239	0.043	0.000
yr2015	23.461	0.043	0.000
yr2016	27.443	0.042	0.000
yr2017	30.849	0.042	0.000
yr2018	30.056	0.042	0.000
yr2019	37.809	0.042	0.000
yr2020	42.181	0.042	0.000
constant	69.328	4.816	0.000

The characteristic variables totrm, Bthrm, Fplc, stories, and stories2 were omitted in the fixed effects regression due to collinearity. In this regression, the coefficient for sgqmileop is positive, indicating parcels within a quarter mile of a transit station realize greater price increases than those not located near a transit station. Table 5 below portrays the results of a random effects regression on the data for all parcels using the interaction variable for quarter mile proximity.

Table 5 *Random Effects Regression for Price (Quarter Mile Proximity)*

Variable	Coef.	Std. Error	P>|t|
yrbuilt	-0.781	0.005	0.000
yrbuilt2	0.0004	0.000	0.000
sgqmile	29.8410	0.961	0.000
sgqmileop	16.742	0.238	0.000
yr2006	2.622	0.044	0.000
yr2007	6.711	0.043	0.000
yr2008	9.104	0.043	0.000
yr2009	6.48	0.043	0.000
yr2010	4.286	0.043	0.000
yr2011	3.075	0.043	0.000
yr2012	1.446	0.043	0.000
yr2013	2.856	0.043	0.000
yr2014	12.239	0.043	0.000
yr2015	23.461	0.043	0.000
yr2016	27.443	0.042	0.000
yr2017	30.849	0.042	0.000
yr2018	30.056	0.042	0.000
yr2019	37.809	0.042	0.000
yr2020	42.181	0.042	0.000
constant	69.328	4.816	0.000

A Hausman test results in a Prob>chi2 value of zero to three decimal places, therefore I consider the fixed effects regression the more appropriate model for this experiment.

I perform a similar regression for single family houses with a redefined proximity interaction variable for houses within a half mile radius of second-generation transit stations. The variables are the same with the exception of sghmile and sghmileop substituting for sgqmile and sgqmileop. The results of that regression are outlined in the table below.

Table 6 *Pooled OLS Regression Results for Price (Half Mile Proximity)*

Variable	Coef.	Std. Error	P>|t|
bld_ar	0.011	0.000	0.000
totrm	-2.577	0.012	0.000
Bthrm	27.856	0.028	0.000
Fplc	6.557	0.030	0.000
stories	-80.371	0.132	0.000
stories2	22.109	0.038	0.000
yrbuilt	-74.037	0.093	0.000
yrbuilt2	0.019	0.000	0.000
sghmile	-20.171	0.153	0.000
sghmileop	17.011	0.239	0.000
yr2006	2.032	0.074	0.000
yr2007	6.065	0.073	0.000
yr2008	8.501	0.073	0.000
yr2009	5.702	0.073	0.000
yr2010	3.405	0.072	0.000
yr2011	2.103	0.072	0.000
yr2012	0.363	0.072	0.000
yr2013	1.671	0.072	0.000
yr2014	11.211	0.072	0.000
yr2015	22.532	0.071	0.000
yr2016	26.382	0.071	0.000
yr2017	29.567	0.071	0.000
yr2018	28.668	0.071	0.000
yr2019	36.777	0.071	0.000
yr2020	41.106	0.07	0.000
constant	73759.18	92.132	0.000

The adjusted r-squared measured 0.29 for the regression and all variable P-values read zero to three decimal places, supporting the assumption that they contribute to variability in the population model. The coefficient sghmileop of 17.011 can be interpreted as the additional dollar amount per square foot of house provided by being within a half mile of an operating second generation train station. In other words, a 2,000 square foot house would experience an increase in value of $34,022 if it is located within a half mile of a second-generation transit station. The lower coefficient associated with shgmileop, when compared to that of sgqmileop, while someone minimal, can be interpreted as the Transit Effect diminishing as the property gets further away from the transit stations in question.

To control for unobserved heterogeneity, a fixed effects transformation regression was performed using variables that vary with time, rather than fixed variables that would portray collinearity through time. The time invariant variables totrm, Fplc, stories, stories2, and sghmile are omitted from the fixed effects regression. The results for the regression using the interaction variable sghmileop to portray both the parcel is within a half mile of a train station and that station is in operation are portrayed in Table 6 below.

Table 7 *Fixed Effects Regression Results for Price (Half Mile Proximity)*

Variable	Coef.	Std. Error	P>|t|
yrbuilt	-0.780	0.005	0.000
yrbuilt2	0.0004	0.000	0.000
sghmileop	13.851	0.141	0.000
yr2006	2.621	0.044	0.000
yr2007	6.710	0.044	0.000
yr2008	9.102	0.043	0.000
yr2009	6.478	0.043	0.000
yr2010	4.283	0.043	0.000
yr2011	3.073	0.043	0.000
yr2012	1.443	0.043	0.000
yr2013	2.854	0.043	0.000
yr2014	12.237	0.043	0.000
yr2015	23.367	0.043	0.000
yr2016	27.349	0.043	0.000
yr2017	30.755	0.042	0.000
yr2018	29.932	0.042	0.000
yr2019	37.715	0.042	0.000
yr2020	42.087	0.042	0.000
constant	69.310	4.815	0.000

The characteristic variables totrm, Bthrm, Fplc, stories, and stories2 are omitted in the fixed effects regression due to collinearity. In this regression, the coefficient for sghmileop is positive, indicating parcels within a quarter mile of a transit station realize greater price increases than those not located near a transit station. Table 8 below portrays the results of a random effects regression on the data for all parcels using the interaction variable for half mile proximity.

Table 8 *Random Effects Regression Results for Price (Half Mile Proximity)*

Variable	Coef.	Std. Error	P>|t|
yrbuilt	-0.454	0.005	0.000
yrbuilt2	0.0002	0.000	0.000
sghmile	21.825	0.558	0.000
sghmileop	14.165	0.141	0.000
yr2006	2.612	0.044	0.000
yr2007	6.719	0.044	0.000
yr2008	9.137	0.044	0.000
yr2009	6.531	0.043	0.000
yr2010	4.347	0.043	0.000
yr2011	3.147	0.043	0.000
yr2012	1.531	0.043	0.000
yr2013	2.96	0.043	0.000
yr2014	12.363	0.043	0.000
yr2015	23.514	0.043	0.000
yr2016	27.516	0.043	0.000
yr2017	30.936	0.043	0.000
yr2018	30.156	0.042	0.000
yr2019	37.922	0.042	0.000
yr2020	42.26	0.042	0.000
constant	68.815	4.796	0.000

The characteristic variables totrm, Bthrm, Fplc, stories, and stories2 were omitted in the fixed effects regression due to collinearity. A Hausman test results in a Prob>chi2 value of zero to three decimal places, therefore I consider the fixed effects regression the more appropriate model for this experiment.

Density

To measure the impact, if any, the METRORail has had on density of residential buildings in Houston, I chose to compare the total square feet of building per total square feet of land for each structure. The notion being that as demand for housing in certain areas increases, developers will attempt to place more usable structure on the same, or smaller lot, choosing to use more of a residential lot for structure, or increasing the number of stories a structure has per square feet of land. The data, as it stands, has over 17 million observations that span 16 years. I first remove any parcels that do not have a recorded assessed value, which includes most government buildings such as schools, military bases, etc. There may not be a reliable manner with which to value such properties while they are in use. The GIS model indicated that 165,687 observations within the data correlated with entries in the existing data from HCAD. The number of single-family homes that existed within a half mile of the now-operating transit stations was 9,397 in 2005. By 2020, that number had increased to 11,513. Without increasing the amount of land, the density of the parcels themselves increased from landowners dividing existing parcels into new ones throughout that period.

To measure the variability of density over the sixteen years measured, I calculate each parcel's density by first producing the dens variable. This variable is produced by dividing the area of the structure on the parcel by the area of the land the parcel has. This results in a number that, intuitively would be greater than one should the structure have more than one floor. This number also indicates whether the parcel owners are using more of the land to develop. The implied assumption is that, as land in an urban setting becomes more and more valuable, the projects the owners are incented to undertake are ones that make more and more use of that urban land. The options are usually offices, homes, and retail or commercial in an urban setting and with each of those options, the more structure a developer can place on the same amount, or less, land, the more of that sweet, sweet, revenue-producing square feet you will achieve. In contrast to urban settings, industrial settings strive for the most efficient use of the machinery on the land, therefore there is less incentive to place more structure on the same amount of land. Suburban developers also have the same incentive to put more structure on the same amount of land to produce more units in aggregate, but the competing incentive of the customer demanding more land area will often keep a suburban developer from maximizing square feet of structure per land area.

The first regression I produced for density used the independent variables totrm, Bthrm, Fplc, stories, stories2, yrbuilt, yrbuilt2, sghmile, and sghmileop to perform a time series pooled OLS regression to determine the variability of *dens*. The results for the regression performed are portrayed in Table 9 below.

Table 9 *Pooled OLS Regression Results for Density (Half Mile Proximity)*

Variable	Coef.	Std. Error	P>|t|
bld_ar	0.000	0.000	0.000
totrm	-0.026	0.000	0.000
Bthrm	0.016	0.000	0.000
Fplc	0.012	0.000	0.000
stories	-0.377	0.000	0.000
stories2	0.183	0.000	0.000
yrbuilt	-0.096	0.000	0.000
yrbuilt2	0.000	0.000	0.000
sghmile	0.047	0.000	0.000
sghmileop	0.011	0.001	0.000
yr2006	0.001	0.000	0.000
yr2007	0.002	0.000	0.000
yr2008	0.002	0.000	0.000
yr2009	0.003	0.000	0.000
yr2010	0.003	0.000	0.000
yr2011	0.003	0.000	0.000
yr2012	0.004	0.000	0.000
yr2013	0.005	0.000	0.000
yr2014	0.006	0.000	0.000
yr2015	0.007	0.000	0.000
yr2016	0.007	0.000	0.000
yr2017	0.007	0.000	0.000
yr2018	0.007	0.000	0.000
yr2019	0.007	0.000	0.000
yr2020	0.007	0.000	0.000
constant	93.488	0.285	0.000

There were 15,015,274 observations of single-family homes over a 16-year period in the regression. The r-squared for the regression measured 0.54. The variable in which I am interested is the sghmileop interaction variable and its positive correlation to density as I measure it. The p-value for the variable is zero to three decimal places, indicating the variable's significance to the variability of the dens variable. This supports the assumption that demand for density is rising for those parcels located near a transit station at a greater rate than those not located within a half mile of a transit station. The positive coefficient associated with sghmileop indicates support that parcels within a half mile of a transit station while the station is in operation, correlate with a heightened demand for density as measured through the square feet of building per square feet of land in a parcel.

To control for unobserved heterogeneity, a fixed effects transformation regression is performed using variables that vary with time, rather than fixed variables that would portray collinearity through time. The time invariant variables totrm, Bthrm, Fplc, stories, and stories2 were omitted due to collinearity. This regression includes only single-family homes as the scale for commercial real estate density is greater than the scale for single-family homes. The results for the fixed effects regression are portrayed in Table 10 below.

Table 10 *Fixed Effects Regression Results for Density (Half Mile Proximity)*

Variable	Coef.	Std. Error	P>|t|
yrbuilt	0.106	0.000	0.000
yrbuilt2	0.0000	0.000	0.000
sghmileop	0.004	0.000	0.000
yr2006	0.000	0.000	0.244
yr2007	0.000	0.000	0.011
yr2008	0.000	0.000	0.698
yr2009	0.000	0.000	0.350
yr2010	0.000	0.000	0.008
yr2011	0.000	0.000	0.000
yr2012	0.000	0.000	0.000
yr2013	0.000	0.000	0.000
yr2014	0.000	0.000	0.000
yr2015	0.001	0.000	0.000
yr2016	0.001	0.000	0.000
yr2017	0.001	0.000	0.000
yr2018	0.001	0.000	0.000
yr2019	0.001	0.000	0.000
yr2020	0.001	0.000	0.000
constant	-106.303	0.265	0.000

The coefficient for sghmileop is positive, the p-value of .000, which indicates that the single-family properties within a half mile of a transit station positively correlate with an increased demand for urban density.

Table 11 *Random Effects Regression Results for Density (Half Mile Proximity)*

Variable	Coef.	Std. Error	P>|t|
yrbuilt	0.095	0.000	0.000
yrbuilt2	-0.002	0.000	0.000
sghmile	0.080	0.001	0.000
sghmileop	0.003	0.000	0.000
yr2006	0.000	0.000	0.131
yr2007	0.000	0.000	0.003
yr2008	0.000	0.000	0.809
yr2009	0.000	0.000	0.095
yr2010	0.000	0.000	0.001
yr2011	0.000	0.000	0.000
yr2012	0.000	0.000	0.000
yr2013	0.000	0.000	0.000
yr2014	0.001	0.000	0.000
yr2015	0.001	0.000	0.000
yr2016	0.001	0.000	0.000
yr2017	0.001	0.000	0.000
yr2018	0.001	0.000	0.000
yr2019	0.001	0.000	0.000
yr2020	0.001	0.000	0.000
constant	-94.85	0.258	0.000

The coefficient for sghmileop is positive in both the fixed and random effects, which supports the hypothesis that the second generation of transit stations contributed to population density along the transit corridor. A Hausman test results in a Prob>chi2 value of zero to three decimal places, therefore I consider the fixed effects regression the more appropriate model for this experiment.

Conclusion

In Houston's case, the METRORail has been a broad success in development, operation, and ridership numbers. The contribution to economic growth that the system has realized may be part of a broader history of economic success for the region, with the medical and energy industries supplying an enviable number of jobs that can now be filled with people that do not have cars, or choose not to use those cars to commute. Though the regression associated with density did not support a broad contribution to density due to the METRORail, the evidence does support an increasing demand for density. Given the positive association with well-being density has, this can provide a positive outlook for the city.

Municipalities that depend mostly on property tax as revenue can use the data presented in determining where to best invest in infrastructure in their cities and states. Because Texas has no state income tax, like many other states do, property tax is the single greatest source of revenue for cities like Houston. The rate at which single family homes whose owner lives in and only owns one house in Houston is taxed was about 2.4% in 2020. Owning and living in one home in Texas qualifies a person for the Homestead Exemption for taxes that limits increases to a home's value and reduces the property tax burden. The sum for all square feet of living area of the properties that are within a quarter mile of a train station was 5,361,362. Given the result for value contribution per square feet for being within a quarter mile of a train station is $18.20, the annual amount of value provided by the train station to those properties within a quarter mile equates to $97.6 million. Based on the prevailing tax rate Houston and Harris County charge, the municipalities are realizing a benefit to tax revenue of at least $2.3 million annually due to the transit effect. The same calculation for parcels within a half mile, with about 18.2 million square feet of livable area and a value benefit of $17.01, equates to a tax revenue benefit for Houston and

Harris County of more than \$7.4 million per year. Municipalities can take these numbers into account as they gauge their own returns to infrastructure spending and where best to direct capital improvement funding when deciding how to make their city great again.

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Appendix 1

Harris County Metropolitan Authority Ridership Numbers – Feb 2016

February 2016 (Fiscal Year 2016) Ridership Summary

Monthly Total Ridership

Monthly Total Ridership	Local Network			Commuter Network	Entire Network
February	Local Bus	Light Rail	Total	Park & Ride	Grand Total
2016	4,908,117	1,571,549	6,479,666	718,664	7,198,330
2015	4,510,923	1,116,742	5,627,665	666,408	6,294,073
Change	397,194	454,807	852,001	52,256	904,257
Percent	9%	41%	15%	8%	14%

Average Daily Ridership

Average Weekday	Local Network			Commuter Network	Entire Network
February	Local Bus	Light Rail	Total	Park & Ride	Grand Total
2016	196,718	61,125	257,843	34,390	292,233
2015	191,355	46,630	237,985	33,736	271,721
Change	5,363	14,495	19,858	654	20,512
Percent	3%	31%	8%	2%	8%

Average Saturday	Local Network			Commuter Network	Entire Network
February	Local Bus	Light Rail	Total	Park & Ride	Grand Total
2016	122,569	31,516	154,085	N/A	154,085
2015	109,638	20,468	130,106		130,106
Change	12,931	11,048	23,979		23,979
Percent	12%	54%	18%		18%

Average Sunday	Local Network			Commuter Network	Entire Network
February	Local Bus	Light Rail	Total	Park & Ride	Grand Total
2016	93,521	23,034	116,555	N/A	116,555
2015	71,938	14,659	86,597		86,597
Change	21,583	8,375	29,958		29,958
Percent	30%	57%	35%		35%

This report reflects ridership results as of April 12, 2016

Note. Adapted from *Ridership Results*. (https://www.ridemetro.org/). Copyright 2021 by Metropolitan Transit Authority of Harris County

Appendix 2

Harris County Metropolitan Authority Ridership Numbers – Feb 2020

February 2020 (Fiscal Year 2020) Ridership Summary

Monthly Total Ridership

Monthly Total Ridership	Local Network			Commuter Network	Entire Network
February	Local Bus	Light Rail	**Total**	**Park & Ride**	**Grand Total**
2020	4,801,715	1,528,789	**6,330,504**	**658,713**	**6,989,217**
2019	4,645,463	1,499,109	**6,144,572**	**645,676**	**6,790,248**
Change	156,252	29,680	**185,932**	**13,037**	**198,969**
Percent	3%	2%	**3%**	**2%**	**3%**

Average Daily Ridership

Average Weekday	Local Network			Commuter Network	Entire Network
February	Local Bus	Light Rail	**Total**	**Park & Ride**	**Grand Total**
2020	189,832	62,567	**252,399**	**33,846**	**286,245**
2019	190,874	60,831	**251,705**	**33,034**	**284,740**
Change	-1,042	1,735	**694**	**812**	**1,505**
Percent	-1%	3%	**0%**	**2%**	**1%**

Average Saturday	Local Network			Commuter Network	Entire Network
February	Local Bus	Light Rail	**Total**	**Park & Ride**	**Grand Total**
2020	126,499	29,693	**156,192**	**N/A**	**156,192**
2019	123,189	29,133	**152,321**		**152,321**
Change	3,310	560	**3,871**		**3,871**
Percent	3%	2%	**3%**		**3%**

Average Sunday	Local Network			Commuter Network	Entire Network
February	Local Bus	Light Rail	**Total**	**Park & Ride**	**Grand Total**
2020	101,926	24,334	**126,259**	**N/A**	**126,259**
2019	97,370	23,604	**120,974**		**120,974**
Change	4,556	729	**5,285**		**5,285**
Percent	5%	3%	**4%**		**4%**

This report reflects ridership results as of ***March 6, 2020***

Note. Adapted from *Ridership Results*. (https://www.ridemetro.org/). Copyright 2021 by Metropolitan Transit Authority of Harris County

Appendix 3

Harris County Appraisal District Property Valuation Example

HARRIS COUNTY APPRAISAL DISTRICT
REAL PROPERTY ACCOUNT INFORMATION
0601290000011

Tax Year: 2020

Print

Owner and Property Information			
Owner Name & Mailing Address:	**FLORES JAMES C & CHERIE H 1620 RIVER OAKS BLVD HOUSTON TX 77019-1202**	Legal Description: Property Address:	**LTS 10 & 11 BLK 1 RIVER OAKS COUNTRY CLUB ESTATE** **3330 INWOOD DR HOUSTON TX 77019**

State Class Code	Land Use Code	Land Area	Total Living Area	Neighborhood	Neighborhood Group	Market Area	Map Facet	Key Mapï¿½
A1 -- Real, Residential, Single-Family	1001 -- Residential Improved	260,924 SF	30,119 SF	8324	1695	164 -- 1F River Oaks Area	5257D	492P

Value Status Information

Value Status	Notice Date	Shared CAD
Noticed	03/31/2020	No

Exemptions and Jurisdictions

Exemption Type	Districts	Jurisdictions	Exemption Value	ARB Status	2019 Rate	2020 Rate
Residential Homestead	001	HOUSTON ISD	4,545,000	Supplemental: 09/18/2020	1.136700	1.133100
	040	HARRIS COUNTY	4,520,000	Supplemental: 09/18/2020	0.407130	0.391160
	041	HARRIS CO FLOOD CNTRL	4,520,000	Supplemental: 09/18/2020	0.027920	0.031420
	042	PORT OF HOUSTON AUTHY	4,520,000	Supplemental: 09/18/2020	0.010740	0.009910
	043	HARRIS CO HOSP DIST	4,520,000	Supplemental: 09/18/2020	0.165910	0.166710
	044	HARRIS CO EDUC DEPT	4,520,000	Supplemental: 09/18/2020	0.005000	0.004993
	048	HOU COMMUNITY COLLEGE	3,390,000	Supplemental: 09/18/2020	0.100263	0.100263
	061	CITY OF HOUSTON	4,520,000	Supplemental: 09/18/2020	0.567920	0.561840

Texas law prohibits us from displaying residential photographs, sketches, floor plans, or information indicating the age of a property owner on our website. You can inspect this information or get a copy at **HCAD's information center at 13013 NW Freeway.**

Valuations

Value as of January 1, 2019			Value as of January 1, 2020		
	Market	Appraised		Market	Appraised
Land	15,783,557		Land	15,783,557	
Improvement	9,099,842		Improvement	8,977,027	
Total	24,883,399	24,883,399	Total	24,760,584	24,760,584

Land

Market Value Land												
Line	Description	Site Code	Unit Type	Units	Size Factor	Site Factor	Appr O/R Factor	Appr O/R Reason	Total Adj	Unit Price	Adj Unit Price	Value
1	1001 -- Res Improved Table Value	SF1	SF	65,000	1.00	1.00	0.85	--	0.85	95.00	80.75	5,248,750.00
2	1001 -- Res Improved Table Value	SF2	SF	65,000	1.00	1.00	0.85	--	0.85	95.00	80.75	5,248,750.00
3	1001 -- Res Improved Table Value	SF3	SF	130,924	1.00	0.50	0.85	--	0.43	95.00	40.38	5,286,057.00

Building

Building	Year Built	Remodeled	Type	Style	Quality	Impr Sq Ft	Building Details
1	1990	2002	Residential Single Family	Residential 1 Family	Superior	24,428 *	Displayed
2	1933	2002	Residential Single Family	Residential 1 Family	Excellent	1,440 *	View
3	1960	2002	Residential Single Family	Residential 1 Family	Excellent	4,251 *	View

* All HCAD residential building measurements are done from the exterior, with individual measurements rounded to the closest foot. This measurement includes all closet space, hallways, and interior staircases. Attached garages are not included in the square footage of living area, but valued separately. Living area above attached garages is included in the square footage living area of the dwelling. Living area above detached garages is not included in the

Note. Adapted from *Search by Account Number*. (https://hcad.org/property-search/real-property/real-property-search-by-account-number/). Copyright 2021 by Harris County Appraisal District.

Appendix 4

Harris County Tax Assessment Statement Example

ANN HARRIS BENNETT
TAX ASSESSOR-COLLECTOR
P.O. BOX 3547
HOUSTON, TEXAS 77253-3547
TEL: 713-274-8000

* 0 0 2 2 6 2 0 0 0 0 0 0 8 *

SANDERS SUMMER D
1209 SAMPSON ST
HOUSTON TX 77003-3903

HARRIS COUNTY TEXAS

2020 Property Tax Statement

Web Statement

Statement Date:	May 8, 2021
Account Number	
002-262-000-0008	

Our records indicate that your statement has been requested by a mortgage company.

Taxing Jurisdiction	Exemptions	Taxable Value	Rate per $100	Taxes
Houston ISD	90,824	238,296	1.133100	$2,700.13
Harris County	65,824	263,296	0.391160	$1,029.91
Harris County Flood Control Dist	65,824	263,296	0.031420	$82.73
Port of Houston Authority	65,824	263,296	0.009910	$26.09
Harris County Hospital District	65,824	263,296	0.166710	$438.94
Harris County Dept. of Education	65,824	263,296	0.004993	$13.15
Houston Community College System	49,368	279,752	0.100263	$280.49
City of Houston	65,824	263,296	0.561840	$1,479.30

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Total 2020 Taxes Due By January 31, 2021:	$6,050.74
Payments Applied To 2020 Taxes	$6,050.74
Total Current Taxes Due (Including Penalties)	$0.00
Prior Year(s) Delinquent Taxes Due (If Any)	$0.00
Total Amount Due For May 2021	**$0.00**

Penalties for Paying Late	Rate	Current Taxes	Delinquent Taxes	Total
By Febuary 28, 2021	7%	$0.00	$0.00	$0.00
By March 31, 2021	9%	$0.00	$0.00	$0.00
By April 30, 2021	11%	$0.00	$0.00	$0.00
By May 31, 2021	13%	$0.00	$0.00	$0.00
By June 30, 2021	15%	$0.00	$0.00	$0.00

Property Description

1209 SAMPSON 77003
LT 8 BLK 542 SSBB .1148 AC

Appraised Values	
Land - Market Value	200,000
Impr - Market Value	174,333
Total Market Value	374,333
Less Capped Mkt Value	45,213
Appraised Value	329,120

Exemptions/Deferrals

Homestead Exemption

Tax Bill Increase (Decrease) from 2015 to 2020: Appraised Value 21%, Taxable Value 14%, Tax Rate -5%, Tax Bill 15%.

Note. Adapted from *Ann Harris Bennett Tax Assessor-Collector*.

(https://www.hctax.net/Property/TaxStatement?source=nav2&Account=0022620000008).

Curriculum Vitae

Andrew Ryle was born on June 12, 1986 in Spring, Texas. He graduated from Spring High School in 2004. He then served in the United States Air Force from 2004 until 2008 spending three years stationed in Aviano, Italy. After being honorably discharged, Andrew attended the University of Houston, graduating in the fall of 2013 with a Bachelor of Science in Construction Management Technology. A career in construction project management followed, allowing Andrew to gain experience in several industries including energy, heavy transit, infrastructure, and high tech. After obtaining a Bachelor of Business Administration in Finance at the University of Houston-Downtown in 2018, Andrew completed a Master of Business Administration in the fall of 2020 at the University of Texas at El Paso.