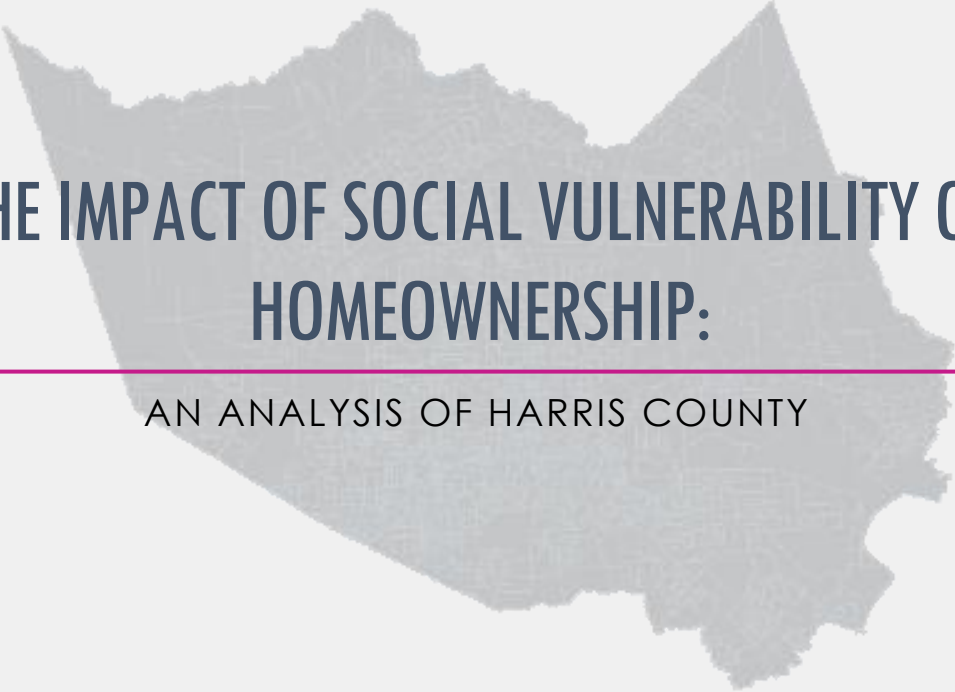


UNIVERSITY OF HOUSTON

GIS FOR URBAN APPLICATIONS TERM PAPER



THE IMPACT OF SOCIAL VULNERABILITY ON HOMEOWNERSHIP:

AN ANALYSIS OF HARRIS COUNTY

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EXECUTIVE SUMMARY

Given the housing instability in America, specifically Harris County, it is important to understand how homeownership is affected by socioeconomic indicators impact in Harris County. Harris County, like other places in America, have disparities amongst racial/ethnic groups in both social vulnerability and homeownership.

This study seeks to analyze these effects through both Ordinary Least Squared and Geographic Weighted Regressions. We regress socioeconomic vulnerability on homeownership across census tracts in Harris County, controlling for several demographic indicators such as race/ethnicity, sex, disability, etc. The goal is to evaluate and predict the changes amongst demographics.

KEY FINDINGS

- Under the OLS model, the SVI is not alone indicative of homeownership rates.
- The GWR model shows that there is less correlation between homeownership and the SVI and between homeownership and minority populations across the census tract.
- There is great spatial correlation between homeownership and socioeconomic vulnerability.
- Census tracts with households containing people over 65 and under 17 are actually more likely to own a home, under the OLS model.

INTRODUCTION

Homeownership in Harris County, TX (Harris County) has been an increasingly salient topic since 2008 with the housing market crash. With the affordable housing crisis and the COVID-19 pandemic causing economic instability for many households, it is important to understand how socioeconomic indicators impact one's ability to own a home in Harris County. We question whether the American Dream of owning property (e.g., homeownership) is really still attainable? Homeownership is the American Dream because it provides many fiscal and social/psychological benefits.¹

The County's population has grown more than 15% over the last 20 years², and each year the housing supply decreases due to poor housing condition from age, deferred housing maintenance, and natural disasters. More recently with the COVID-19 pandemic, according to Kinder Institute, many key housing indicators have shifted dramatically, making housing stability more difficult. In particular, owning a home has become even more difficult due to increased prices.³ According to the Texas A&M Real Estate Center, home sales prices have increased by 108% while income has only increased by 40%.⁴ As a consequence according to research conducted in 2016, researchers predicted that if another economic crash happened homeownership rate could fall by 20 percentage points or more during the next 35 years.⁵

In this paper we will examine demographic indicators such as sex, race, age, and education as they relate to socioeconomic vulnerability and homeownership in hopes of answering the question: "Is the American Dream achievable in Harris County?" This is important to understanding housing patterns and how to appropriately plan for housing needs and how to alleviate housing disparities amongst these demographics.

¹ Roche, William, and Mark Linbald. August 2013. "Reexamining the Social Benefits of Homeownership after the Housing Crisis". Joint Center for Housing Studies (Harvard University). Available at <https://www.jchs.harvard.edu/sites/default/files/hbtl-04.pdf>.

² U.S. Census Bureau (2019) <https://www.census.gov/quickfacts/houstoncitytexas>.

³ Shelton, Kyle. June 23, 2020. "As rents and home prices go up, once-affordable Houston grows less accessible". *Kinder Institute Research*. Available at <https://kinder.rice.edu/urbanedge/2020/06/23/rents-and-home-prices-go-once-affordable-houston-housing-grows-less-accessible>.

⁴ *Housing Activity*, Texas A&M University: Real Estate Center (2020) <https://www.recenter.tamu.edu/>; U.S. Census 2000 and 2019 ACS 1-Year Estimates, U.S. Census Bureau (2020) www.data.census.gov.

⁵ Myers, Dowell and Hyojung Lee. 2016. "Cohort Momentum and Future Homeownership: The Outlook to 2050". US Department of Housing and Urban Development. *Cityscape* 18, No. 1, pp. 131-144.

LITERATURE REVIEW

Many factors impact homeownership (e.g., credit score, income, etc.) Hinderances to homeownership are not only historical but also cyclical.⁶ We concern ourselves with this issue because there are many benefits to being a homeowner; these benefits are both fiscal and psychological. However, there are many disparities amongst demographic groups. Acutely, there is a homeownership divide amongst different groups of income, race/ethnicity, and generational.

Homes, whether owner-occupied or rented, have become unaffordable and incomes are rising at slower rates; however, renter-occupied households have a greater percentage of those who are considered housing cost burdened have also increased.⁷ This is likely to occur because homeowners have more resources to pay for other households needs and “decreases in one's own income lead to less housing consumption and less income left over after paying for housing.”⁸ Housing costs drive how households distribute income to meet other needs like food, clothes, transportation, etc. Therefore, renters are far more likely to be more vulnerable socioeconomically.

Housing Affordability Percentages

Household Income	Less than 20% Spent on Housing Costs			20-29% Spent on Housing Costs			30% or more Spent on Housing Costs (Cost Burdened)		
	Occupied Units	Owner-Occupied Units	Renter-Occupied Units	Occupied Units	Owner-Occupied Units	Renter-Occupied Units	Occupied Units	Owner-Occupied Units	Renter-Occupied Units
< \$20,000	0.7%	1.1%	0.4%	0.8%	1.3%	0.5%	13.0%	6.1%	17.0%
\$20,000 - \$34,999	1.8%	3.9%	0.3%	1.6%	1.6%	1.6%	12.6%	5.0%	17.7%
\$35,000 - \$49,999	2.3%	4.4%	0.8%	4.7%	1.8%	6.7%	6.2%	3.6%	8.0%
\$50,000 - \$75,000	6.3%	8.7%	4.7%	7.4%	4.4%	9.4%	3.8%	3.0%	4.3%
\$75,000 <	6.1%	4.3%	16.6%	1.6%	7.6%	5.0%	2.3%	3.0%	0.6%

Table 1 - Housing Affordability

The possibility of homeownership is even more precarious amongst racial/ethnic groups. Given that Hispanics, 44% of the population, exceed the percentage of whites and Africa Americans make up 19% of the population (shown in Figure 2), equity

⁶ *Not Even Past Redlining: Social Vulnerability and the Legacy of Redlining*, University of Richmond (2016) <https://dsl.richmond.edu/socialvulnerability/map/#loc=10/29.746/-95.329&city=houston-tx>.

⁷ 2019 American Community Survey.

⁸ Janna L. Matlack & Jacob L. Vigdor. 2008. Do Rising Tides Lift All Prices? Income Inequality and Housing Affordability. National Bureau of Economic Research

principles would expect that homeownership rates should reflect similar racial/ethnic groups percentages.⁹

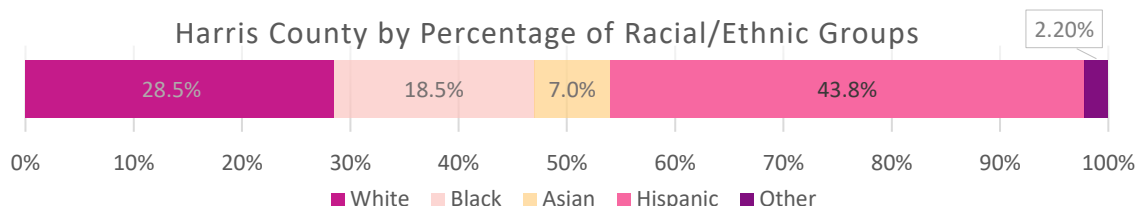


Figure 1 - Harris County by Percentages of Racial/Ethnic Groups

However, Harris County's homeownership rates by racial/ethnic groups are far from reflecting these equity principles. Whites exceed all racial/ethnic groups in homeownership, despite being a minority population in the County.

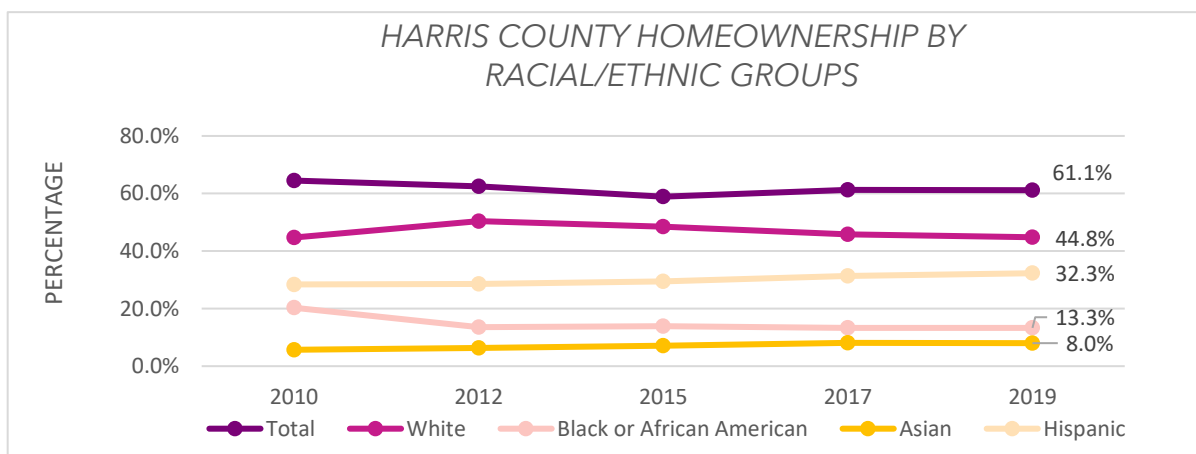


Figure 2 - Harris County by Homeownership Rates

The median household income for all of Houstonians is \$52,450; however, of the largest racial/ethnic groups in Houston, African Americans have the lowest median household income at \$36,814, while White Houstonians have the highest median household income at \$87,208. There is a sharp contrast between the lowest and highest median household incomes by race, White Houstonians make 136% more than African American Houstonians.¹⁰ Households that are low- to moderate-income are most likely housing cost burdened already, and do not have the means to save for a down payments or make the monthly mortgage payments.

⁹ 2019 American Community Survey.

¹⁰ 2019 American Community Survey.

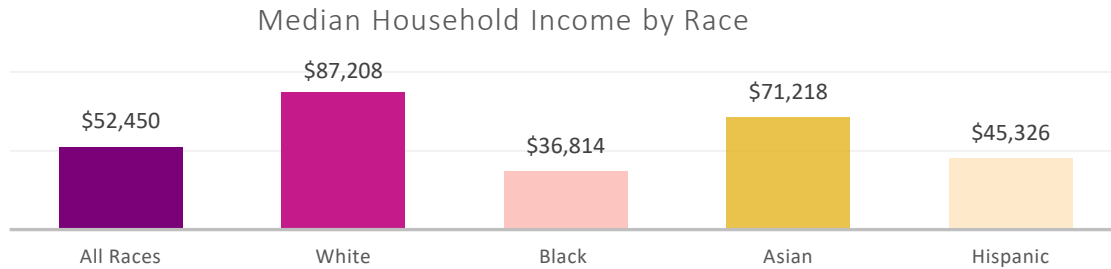


Figure 3 – Median Income by Race

According to Whiting, a home affordable to a white family with a median income would take a black median-income family would take three times the income to purchase, five times more for a Hispanic family, and seven times the income for a female-lead household.¹¹ This means that a white, male-lead household is far more likely to amass wealth compared to females and other racial/ethnic groups. These

Even more telling, homeownership rates have been declining amongst the last three generations. Although many people view homeownership as a means to building wealth and yearn to become homeowners, homeownership has been on the decline with each successive generation since the silent generation born between 1928 and 1945. At age 30, the Silent generation's homeownership rates were much higher than homeownership for Baby Boomers and Generation X when they were 30 years old. Despite the overwhelming majority's desire to own a home, Millennials have the lowest homeownership rate, compared with other generations when they were at the same age. As Millennials grow older, their homeownership rates increase, but it is a "significant lag" compared to preceding generations.¹²

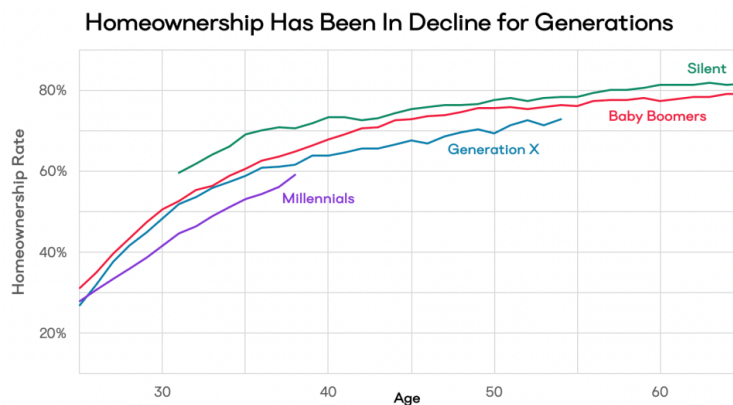


Figure 4 – Homeownership by Generation in Harris County

Education also has a role in homeownership and socioeconomic vulnerability. Data generally shows that homeownership increases as education levels increase. Those with

¹¹ Cathleen Whiting. 2004. Income Inequality, the Income Cost of Housing, and the Myth of Market Efficiency. *American Journal of Economics & Sociology* 63 (4): 851–79. doi:10.1111/j.1536-7150.2004.00319.x.

¹² Apartment List & US Census Bureau, Current Population Surveys, 1976- 2019.

bachelor's degrees in Houston own homes at 37.7 % while those with some college own homes at 24.1% and those with a high school degree or lower at 19.1%. This means that you will be more likely to own a home if you are a college graduate. While this generally holds true, African American homeownership only increases by 4.4% from those who did not attend high school graduates and those who graduated high school. The increase of homeowners for African Americans who attended or graduated college actually decreases, based on 2019 American Housing Survey data. However, as income increases so does homeownership levels, irrespective of race or ethnicity.¹³ On the other hand, some research shows that increasing one's education through the use of student loans can impede homeownership in the long run. Although limited, there is some evidence that suggests that student debt incurred during a college or graduate school tenure correlates with lower homeownership rates for young adults.¹⁴

Redlining Lending Practices

From America's slavery era to the era of Jim Crow regulations post-Civil War, the United States has nonsensically struggled with providing fair, safe, and affordable opportunities in the housing market for African Americans. But during the 1920s, the United States began to institutionalize racially discriminatory practices in federal agencies that "eroded the economic position of African Americans".¹⁵ While these policies have been repealed by the Fair Housing Act of 1968, many lingering effects of these policies still pervade African American and other minority communities.

In 1929, the Great Depression hit, and the United States' housing market crashed. Home values dropped 67% by 1932, and housing values did not improve for the next four years.¹⁶ To assist the economy in recovering, the federal government started implementing several new policies that were inspired by the New Deal proposed by President Roosevelt. In 1934, the Federal Housing Administration (FHA) was a chief federal agency established through the 1934 National Housing Act to help the housing market.¹⁷

The FHA was tasked with reforming the mortgage market. Of the FHA's reformation goals, one was to protect lenders from losses due to homes purchases by insuring them. The FHA would layout mortgage terms and conditions that could be accepted as

¹³ 2019 American Housing Survey, U.S. Census Bureau (2019) <https://www.census.gov/programs-surveys/ahs.html>.

¹⁴ Houle, Jason N. and Lawrence Berger. December 2015. "Is Student Loan Debt Discouraging Homeownership among Young Adults?". The University of Chicago Press. *Social Service Review* 89, No. 4, pp. 589-621.

¹⁵ John Kimble, *Insuring Inequality: The Role of the Federal Housing Administration in the Urban Ghettoization of African Americans*, *Law & Social Inquiry* Vol. 32, No. 2 (Spring, 2007), pp. 399-434.

¹⁶ Tom Nicholas and Anna Scherbina, *Real Estate Prices During the Roaring Twenties and the Great Depression*, *Real Estate Economics* Vol. 41, No. 2 (Summer 2013, pp. 278-309).

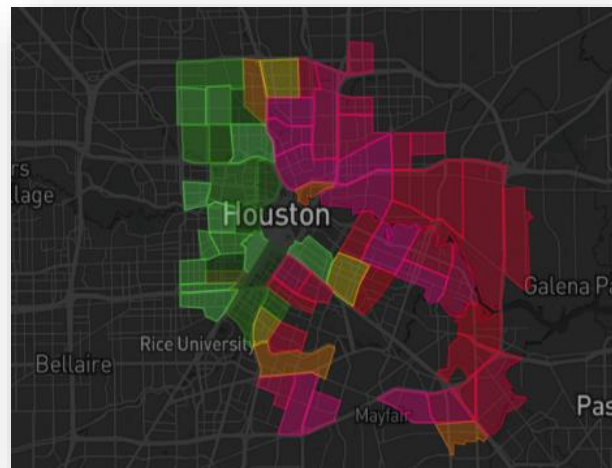
¹⁷ Charles Lane, The New Deal as raw deal for blacks in segregated communities, *Washington Post* (May 25, 2017) https://www.washingtonpost.com/opinions/the-new-deal-as-raw-deal-for-blacks-in-segregated-communities/2017/05/25/07416bba-080a-11e7-a15f-a58d4a988474_story.html.

insurable during the lending process.⁸ The Home Owners' Loan Corporation (HOLC), a government-sponsored agency, then developed maps that showed residential secured areas in every metropolitan city within the United States. These maps were color-coded designating areas that would be insured by the FHA. The FHA adopted the maps and utilized them. Area designations of "Best", "Still Desirable", "Define Declining", and "Hazardous" were decided mainly on the basis of race, which is the greatest issue with this practice. The "Hazardous" areas were outlined in red, which is where the term redlining comes from. Any area where African Americans lived or lived nearby was designated as a "Hazardous" area. Therefore, these areas would be considered too risky to be insured by the FHA. This means that lenders would either not lend to African Americans because their loans would not be insured or that the interest rates would be so high that the potential homeowners would be deterred from making the personal investment.

Redlining occurred when 75% of the Houston population was comprised of non-Hispanic White and about 22% of the population was African American. Although Houston's population has drastically changed since the days of redlining and these kinds of policies have been overturned by Supreme Court rulings and the institution of the Fair Housing Act of 1968, these imprudent practices still shape how Houstonians are living today, particularly African Americans who were most directly affected by these policies. This also promulgated the racial divide not only socially but also within Houston's housing patterns.

Social Vulnerability Index (SVI)

In 20__ the Center for Disease Control (CDC) developed the Social Vulnerability Index (SVI), originally used to determine an area's resiliency after "external stresses on human health, stresses such as natural or human-caused disasters, or disease outbreaks".¹⁸ This index ranks the percentages of 15 factors that cover socioeconomic status, household composition, minority status, commuter type.¹⁹



Recently, the SVI has been used by many researchers to show social vulnerability in connection with other topics like homeownership. For example, the University of

¹⁸ "CDC/ATSDR SVI Fact Sheet". *The Center of Disease Control and Prevention*. Retrieved May 9, 2021. Available at https://www.atsdr.cdc.gov/placeandhealth/svi/fact_sheet/fact_sheet.html.

¹⁹ See Appendix for further breakdown on the CDC's Social Vulnerability Index.

Richmond has developed a mapping-tool that shows how areas where redlining occurred still experience residual effects of the racially-discriminatory practices today. These areas have disproportionately:

- Higher Social Vulnerability Indices (SVI);
- Larger Minority Populations;
- Lower Life Expectancies and Less Individuals over 65;
- Greater Poverty Levels; and
- More negative health Impacts.

These negative impacts include asthma, cancer, diabetes, high blood pressure, kidney disease, mental health problems, obesity, and pulmonary disease. Areas that were originally designated as “Best ” or “Still Desirable” have lower SVIs and other negative impacts which are shown in green and yellow. On the other hand, neighborhoods that were designated as “Define Declining” and “Hazardous” are primarily areas with high SVIs. When comparing the differences between the areas that received an A (“Best”) and D (“Hazardous”) HOLC grades in 1936, the data shows historical patterns still existing today. Great social vulnerability disparities are still present in areas where they were graded as having the best financial security and those being graded as having hazardous security. The A graded areas are still comprised of predominately White households, and the D graded areas have a high concentration of African American populations.²⁰

Not only are there homeownership gaps among socially vulnerable groups and racial/ethnic groups,²¹ black homeowners have a much greater risk of losing their homes and becoming renters than white homeowners even after controlling for “life-course, socioeconomic, and housing characteristics”, and these risks and gaps have continued to increase over time.²²

Homeownership is economically preferable for most households; however, it provides many “positive spillover” effects for society because it is a vehicle for “wealth accumulation, better social outcomes for children,” civic participation, greater success in labor markets, and more.²³ Much of the research surrounding homeownership

²⁰ See Appendix for SVI comparisons of A and D HOLC grades; *Not Even Past Redlining: Social Vulnerability and the Legacy of Redlining*, University of Richmond (2016)

<https://dsl.richmond.edu/socialvulnerability/map/#loc=10/29.746/-95.329&city=houston-tx>.

²¹ Seah, Kiat Ying, Eric Fesselmeyer and Kien Le. January 2017. “Estimating and decomposing changes in the White–Black homeownership gap from 2005 to 2011. Sage Publications”. *Urban Studies* 54, No. 1, pp. 119-136.

²² Sharp, Gregory and Matthew Hall. August 2014. “Emerging Forms of Racial Inequality in Homeownership Exit, 1968–2009”. [Oxford University Press](#). *Social Problems* 61, No. 3, pp. 427-447.

²³ [Causa](#), Orsetta and [Nicolas Woloszko](#). 2020. [Policy Considerations on Housing, Wealth, and Inequality: The Moving to Work Retrospective Evaluation](#). US Department of Housing and Urban Development. *Cityscape* 22, No. 3, pp. 339-364; Christopher E. Herbert and Eric S. Belsky. 2008. The Homeownership Experience of Low-Income and Minority Households: A Review and Synthesis of the Literature. [US Department of Housing and Urban Development](#). *Cityscape* 10, No. 2, pp. 5-59.

articulates that homeownership benefits low-income and minority groups.²⁴ However, homeownership demand factors for these groups include, race/ethnicity, sex, occupation, education, age, family type, past credit, and family/peer housing history will determine a family's ability to attain homeownership.²⁵ Therefore, we will study similar demand factors for homeownership and incorporating a socioeconomic vulnerability index.

²⁴ Christopher E. Herbert and Eric S. Belsky. 2008. The Homeownership Experience of Low-Income and Minority Households: A Review and Synthesis of the Literature. [US Department of Housing and Urban Development](#). *Cityscape* 10, No. 2, pp. 5-59.

²⁵ Christopher E. Herbert and Eric S. Belsky. 2008. The Homeownership Experience of Low-Income and Minority Households: A Review and Synthesis of the Literature. [US Department of Housing and Urban Development](#). *Cityscape* 10, No. 2, pp. 5-59.

METHODOLOGY

RESEARCH QUESTION & THEORETICAL ARGUMENT

Given that the American Dream seems to be hard to find, largely due to economic disparities, this study seeks to determine the effects of social vulnerability on homeownership in Harris County across Census Tracts. Based precedent research, not only do we expect socioeconomic vulnerability to negatively impact homeownership in Harris County across Census Tracts, but we also expect that other social factors like current housing cost burdens, car ownership, sex, race, age, etc. will have a negative correlation with homeownership.

DATA, VARIABLES, & MODEL SPECIFICATIONS

Description of Data

For this study, we will study census tracts across Harris County. Three data sources were amalgamated to create the dataset for this research. The sources included the 2018 American Community Survey, the Centers for Disease Control and Prevention ("CDC") 2018 Social Vulnerability Index ("SVI") and the U.S. Department of Housing and Urban Development's 2018 Comprehensive Housing Affordability Strategy (CHAS) data. We used 12 Variables to evaluate, which include homeownership rates, socioeconomic vulnerability index, and percentage of population that are:

- commuters with no vehicles
- with limited English proficiency,
- minority households
- female
- over 65
- under 17
- single parent
- living with a disability

The socioeconomic vulnerability index includes for factors: (1) poverty level, (2) unemployment, (3) income, and (4) educational attainment. Although there are 784 census tracts in Harris County, we were only able to observe 782 instances across Harris County with these combine datasets due to a lack of information for some tracts.

VARIABLE DESCRIPTIONS

Var	Var Description	Var Type
Housing Tenure	Percentage of owner-occupied homesteads	Dependent; numerical
Socioeconomic Vulnerability	Percentile rank of households who are socioeconomically vulnerable.	Independent; numerical
Housing Cost Burdened	Percentage of homeowners and renters spending 30% or more of household income on housing costs.	Control; numerical
Minority Population	Percentage of population that is minority.	Control; numerical
Female Population	Percentage of population who is female	Control; numerical
No Vehicles	Percentage of population who do not own a vehicle.	Control; numerical
Limited English Proficiency	Percentage of population who does not speak English well.	Control; numerical
Population over 65	Percentage of population that is over 65 years old.	Control; numerical
Population under 17	Percentage of population that is under 17 years old.	Control; numerical
Single Parent	Percentage of population that is a single parent.	Control; numerical
Disability	Percentage of population who is living with a disability.	Control; numerical

Table 2 – Variable Descriptions

To better understand the relationship between socioeconomic vulnerability and homeownership rates, we must control for other factors in this model. The several variables included in this model that we will be controlling for are those of populations over 65 and under 17, race, sex, and unemployment. In general, those of an older age are less likely to be in poverty, which can be partially attributed to social security programs that supplement incomes during older age. In fact, children comprise the largest chunk of those in poverty, with young adults following close behind. We hypothesize that there is a negative relationship between age and poverty, as one's likelihood of being in poverty decreases for older age groups.

Descriptive Statistics

DESCRIPTIVE STATISTICS OF VARIABLES

Variable	Obs.	Mean	Std. Dev.	Min	Max
Homeownership	784	.5406732	.2495561	0	.992891
Socioeconomic Vulnerability	786	-3.282261	61.67341	-999	.9964
Housing Cost Burdened	784	.3333613	.1125951	.0730731	1
Minority Population	786	69.69975	25.62557	0	100
Female Population	784	.4931493	.0820262	.0019075	.9083969
No Vehicles	786	4.127608	51.12945	-999	52.9
Limited English Proficiency	786	12.28333	11.5514	0	55.5
Population over 65	786	10.63486	5.185225	0	39
Population under 17	786	25.76679	7.061003	0	41.9
Single Parent	786	11.58919	7.056164	0	46.5
Disability	786	9.766539	5.39555	1.1	100

Table 3 - Descriptive Statistics of Variables

Appendix A: Maps captures the spatial distribution for dependent variables and all of the control variables. However, the maps below show that the highest percentages of homeownership (75% or more) are not in the areas where the greatest populations of socioeconomic vulnerability are located. We will spatially evaluate these disparities.

POPULATION WITH HOMEOWNERSHIP

POPULATION WITH SOCIOECONOMIC VULNERABILITY

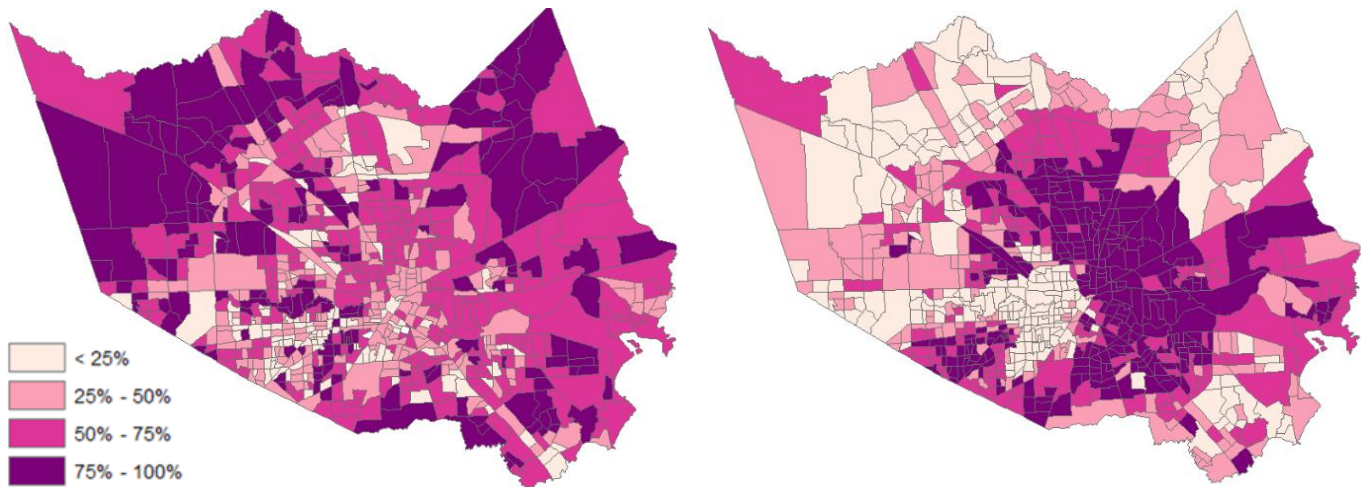


Figure 5 - Comparison of Homeownership and Socioeconomic Vulnerability

Model Specification

Ordinary Least Squares (OLS) Regression

We will regress a Socioeconomic Vulnerability index on homeownership and control for the remaining variables listed in Table 3. The equation below shows the OLS regression.

% of Homeowners

$$\begin{aligned} &= \beta_0 + \beta_1 \text{SocioeconomicVulnerability} + \beta_2 \% \text{HousingCostBurden} \\ &+ \beta_3 \% \text{Minority Population} + \beta_4 \% \text{Female} + \beta_5 \% \text{No Vehicles} \\ &+ \beta_6 \text{English Proficiency} + \beta_7 \text{Age} + \beta_8 \text{Familial Status} + \beta_9 \text{Disability} \\ &+ \beta_{10} \text{Education} \end{aligned}$$

Geographic Weighted Regression Analysis Based on ArcGIS

A spatial analysis technique that takes non-stationary variables into consideration (e.g., climate; demographic factors; physical environment characteristics) and models the local relationships between these predictors and an outcome of interest.

$$y = b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n + e$$

EMPIRICAL RESULTS

Variable w/Label	OLS Model	OLS Model 2	OLS Model 3 with Logged Independent Variable	OLS Model 4 with Logged Independent Variable
Socioeconomic Vulnerability	0.0022121 (.0429)		.1940376	
Housing Cost Burdened	-1.209408*** (0.064)		-3.399407***	
Minority Population	0.0008225** (0.000)	.0003955***	.0046078**	.0046076
Female Population	0.0862594 (0.061)	.0684991*	.5532575**	.483686
No Vehicles	-0.0101459*** (0.001)	-.0172492***	-.0313118***	-.0503797***
Limited English Proficiency	-0.0005619 (0.001)	-.0028769***	-.0046359	-.0098588***
Population over 65	0.0132875*** (0.001)	.0156683***	.043261***	.0491252***
Population under 17	0.0124862*** (0.001)	.0161528***	.0251805 ***	.0371065 ***
Single Parent	-0.0050363*** (0.001)	- .0120288***	-.0114725*	-.0306641***
Disability	0.0030561* (0.002)	.0061253***	.0128245**	.0237395***
Coefficient	0.4817658 (0.046)	.1269465***	-1.198353***	-2.248466**
Observations	782	782	775	775
Adjusted R ²	0.7226	0.5899	0.5717	0.4654

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4 - Empirical Results

In the original OLS model, the most significant variables are housing cost burden, minority population, no vehicle for community, populations over 65 and under 17, single parent households, and persons living with a disability. Housing cost burden is significant at the 0.01 alpha-level and holding all other variables constant, and one percent increase in housing cost burden will yield a 1.2% decrease in the likelihood of

attaining homeownership. However, the inverse is true for populations over 65 and under 17, meaning that holding all other variable constant, we see an increase in ability to own a home. The most successful model is the OLS Model 2 shows that all of the variables are incredibly significant to understanding one's ability to attain homeownership. Populations with no vehicle and limited English proficiency negatively impact homeownership status while populations of minorities, those with disabilities, and single parents have a very low probability of attaining homeownership.

SPATIAL ANALYSIS

Spatial Autocorrelation

We ran the Spatial Autocorrelation Moran's I to see if the results yield a random spatial pattern, meaning that there is no spatial correlation between the dependent and independent variable. The results of this inferential statistic are shown in Figure 5 below.

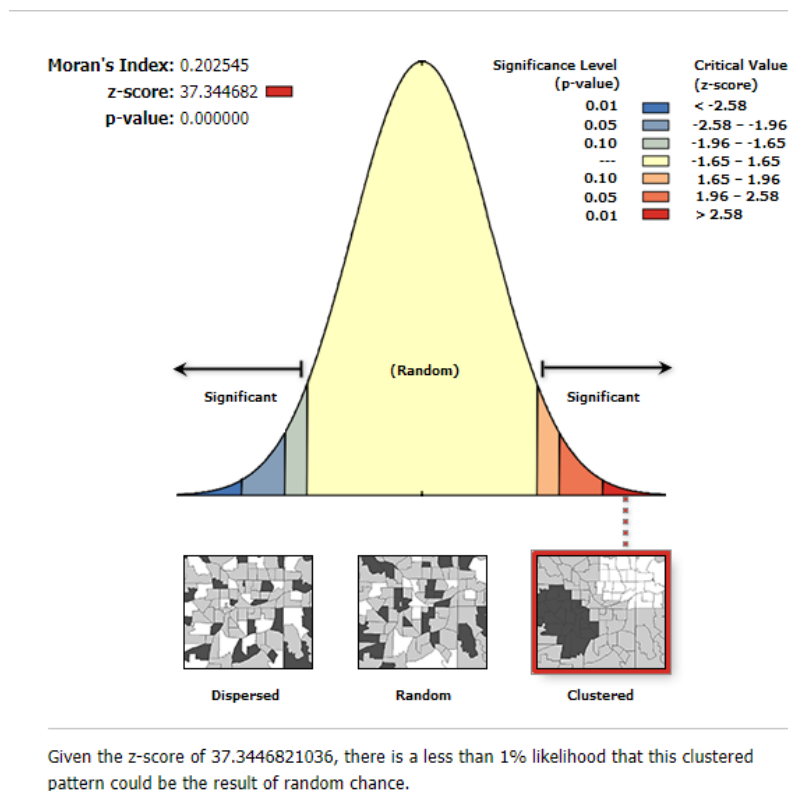


Figure 6 – Spatial Autocorrelation Moran's I Results

Based on the results from the Moran's statistic results, the z-score is 37.34, which is extremely high, and the p-value is 0.000 so we reject the null hypothesis that the correlation is randomly distributed amongst the census tracts. This means that there is high spatial clustering. To account for this, we take another step to perform a geographic weighted regression.

Geographic Weighted Regression

The maps below show the geographically weighted regressions of homeownership regressed by the Socioeconomic Vulnerability Index and the percentage of minority populations. Initially is regress the SVI to show the spatial relationship with homeownership, and after further inspection of causes for homeownership disparities, we modified the GWR to regress Minority Populations on homeownership as well. Both geographically weighted regressions have an adjusted r^2 of 0.35, meaning that these models only explain about 35% of the reason for homeownership.

The maps below show both GWR models.

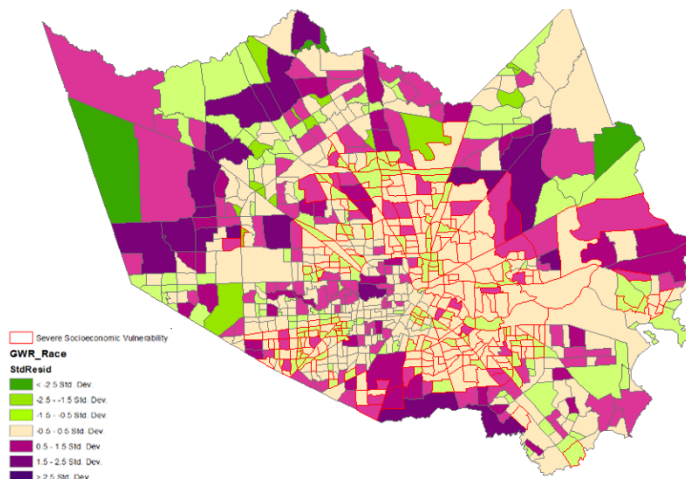


Figure 7 – Geographically Weighted Regression with SVI

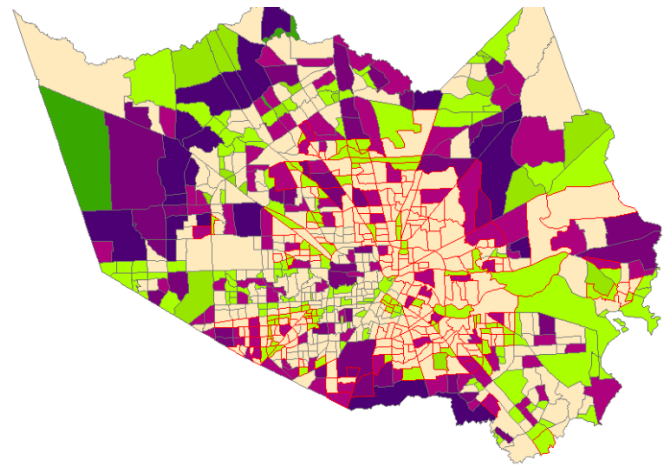


Figure 8 – GWR with Minority Populations

The areas that are purple have overpredictions of the clustered areas whereas the green areas show that there is an underprediction of the clustered areas. Either way, we find that homeownership is particularly affected in areas where the greatest socioeconomic vulnerability.

When juxtaposed against the areas with severe socioeconomic vulnerability, these models show that there is some correlations with the lack of homeownership and the location of minority populations and those who are severely socioeconomically vulnerable.

POST ESTIMATION ANALYSIS

Multicollinearity

We also ran the multicollinearity test to assess whether there is high multicollinearity between variables. Variables with a VIF score between 1 and 5 do not have high correlation. Generally, scores between 5-10 have less desirable multicollinearity, and a VIF score that exceeds 10 means the variable has a high multicollinearity and should be removed from the model.

MULTICOLLINEARITY TEST (VIF)

Variable	VIF	1/VIF
Socioeconomic Vulnerability	7.98	0.125383
Housing Cost Burdened	5.11	0.195858
Minority Population	2.88	0.347045
Female Population	2.79	0.358192
No Vehicles	2.24	0.445455
Limited English Proficiency	2.22	0.450345
Population over 65	1.98	0.504799
Population under 17	1.91	0.522663
Single Parent	1.85	0.541199
Disability	1.14	0.880523
Mean VIF	4.14	

Table 5 - Multicollinearity Test (VIF)

Here all of the variables have VIF scores that are less than 10; however, the SVI and housing cost burdened scores were above so we maintained there is low multicollinearity amongst all of the variables. Nevertheless, we ran a model that excludes the variables with a VIF score above 5. The results show that the model is slightly more significant for a logged y value, but less so when the y vlaue is not logged.

Heteroskedasticity

Following the regression, we ran the Breusch-Pagan test to see if the OLS model had any heteroskedasticity. We created predicted values for both the y value, in this case homeownership, and the error terms. We, then, squared the error term and regress the squared error term on all of the dependent and control variables and created a scatter plot of the predicted y values and the squared error terms (shown in Figure 6)

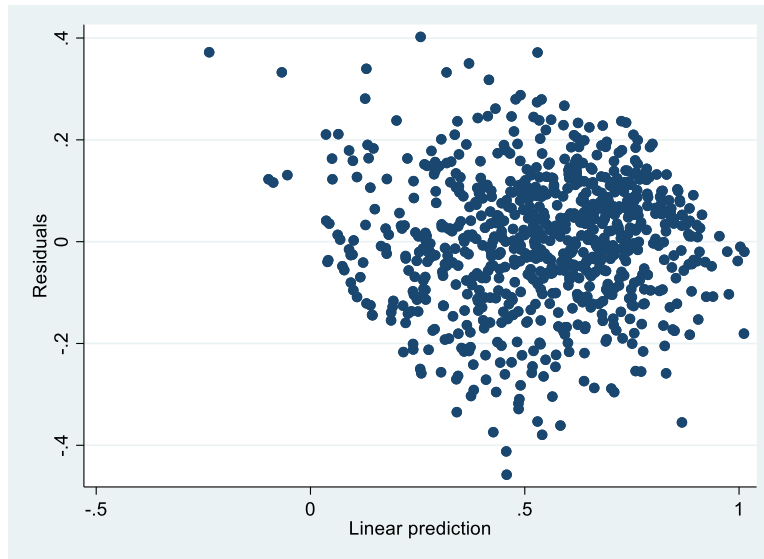


Figure 9 – Scatter Plot for Predicted y and squared residuals

Looking at the scatter plot, there seems to be some heteroskedasticity in the model. However, the Breusch-Pagan test sheds more light on this issue. The results show the probability value is 0.000. Since it was less than 0.05, we are 95% confident that we can reject the null hypothesis that the r^2 equals 0 and can conclude that the test is significant. Therefore, there is heteroskedasticity in this model to correct for this we used the log of the independent variable. The results of that model are shown in Table 5.

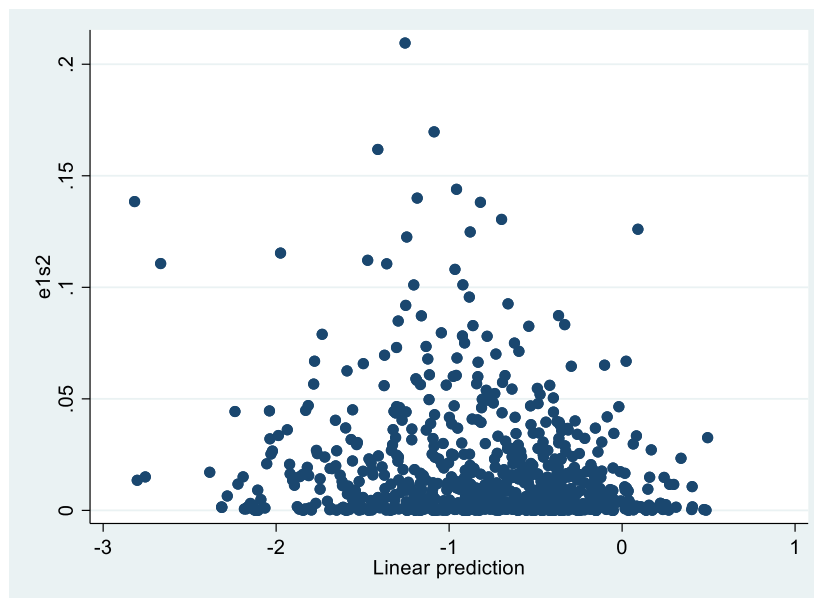


Figure 10 – Scatter Plot for Predicted $\log$ of y and squared residuals

Although the new model has reduced the heteroskedasticity, this model seems to explain less of the correlation between the variables, as the adjusted r^2 has decreased to 0.5717. Nevertheless, this model should lend to the idea that perhaps the OLS model is even

less significant than it initially appears. Therefore, the variables included do not thoroughly explain the correlation between homeownership and socioeconomic index due to omitted variable bias and additional variables are necessary to explain the model.

Omitted Variables

To test for bias, we ran the Ramsey RESET test using powers of the fitted values of homeownership variable to test whether there were omitted variables. The p-value was 0.000. This means that we reject the null hypothesis that there were no omitted variables. Therefore, we conclude there are some variables missing from this model to explain the correlation between homeownership and the socioeconomic index.

FINDINGS, RECOMMENDATIONS, & LIMITATIONS,

MAIN FINDINGS

Under the OLS model, the SVI is not alone indicative of homeownership rates. However, many other social factors play a large role in Harris County home ownership rates. However, the GWR model shows that there is less correlation between the variables across the census tract. The model should be re-specified to see if a relationship exists between these predictors and an outcome of homeownerships.

The model should be adjusted to include the omitted variables and correct for heteroskedasticity. However, the models show that households that have young children or elderly persons are more likely to be homeowners. Housing cost burden is also a large determinant in whether someone will be a homeowner.

POLICY RECOMMENDATIONS

What does this Mean? Harris County might seek regional coordination to alleviate high social vulnerability. Incentives for developers or property managers could be given to build affordable single-family homes or to improve the current housing stock. Houston should also consider more densified homeownership options like condos, duplexes, triplexes, and townhomes. This would allow new ways of homeownership that promote environmentally, sustainable living and increase the housing stock on a greater scale than traditional single-family homes. Government agencies should also consider one or more of the following programs coupled with on-going financial counseling and monitoring:

- down payment assistance;
- monthly payment assistance; and/or
- mortgage lending to “less” credit-worthy people.

RESEARCH LIMITATIONS & FUTURE RESEARCH

This research is limited because this data is not available at the individual level. This would have been the best study because we could analyze each person within a given area rather than generalized data through percentages and percentile rankings. Additionally, the study might have benefited from viewing this information at the census block level; however, much of the information was not available for at this geographic level. If it were available, the study could also include a geographic analysis by super neighborhoods, giving a better understanding of homeownership variances among neighborhoods.

This research was also conducted at only one point in time rather than taking a look at panel data. It would be more prudent to study the effects of social vulnerability over time. However, the SVI is a relatively index of study. Perhaps overtime, a time series analysis would be more feasible.

Future research might include an amended OLS model to show the CDC SVI using different control variables. This may have an effect on the predicted homeownership rates; however, new control variables would need to be selected. Additionally, times series analysis of data can provide a deeper look at what has caused the decline in homeownership rates overtime. Further research should also include examination of how housing market interventions, such as subsidized rental assistance, homebuyer assistance, and supply expansions, improve upon homeownership for groups who have been previously socially vulnerable.

CONCLUSION

Not only was homeownership a critical public policy goal in the 1990s and early 200s, but homeownership continues to be a strong goal for most Americans because it is a primary vehicle for building the American Dream. It also proves to be beneficial for social, psychological, and financial gain for households. However, many barriers like income, reduced housing stock, increased housing prices, systematic racism, and historical discrimination, impede many Americans from attaining this goal.

The model specified shows some correlations between homeownership and socioeconomic vulnerability. The modified regressions also show that there is some correlation between homeownership and minority populations. We should make sure that we craft policies that help to alleviate gaps between racial/ethnic groups and assist those who are socioeconomically vulnerable to purchase low-cost homes because homeownership provides so many ancillary benefits to society.



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APPENDIX A

ORIGINAL 1936 HOLC MAP

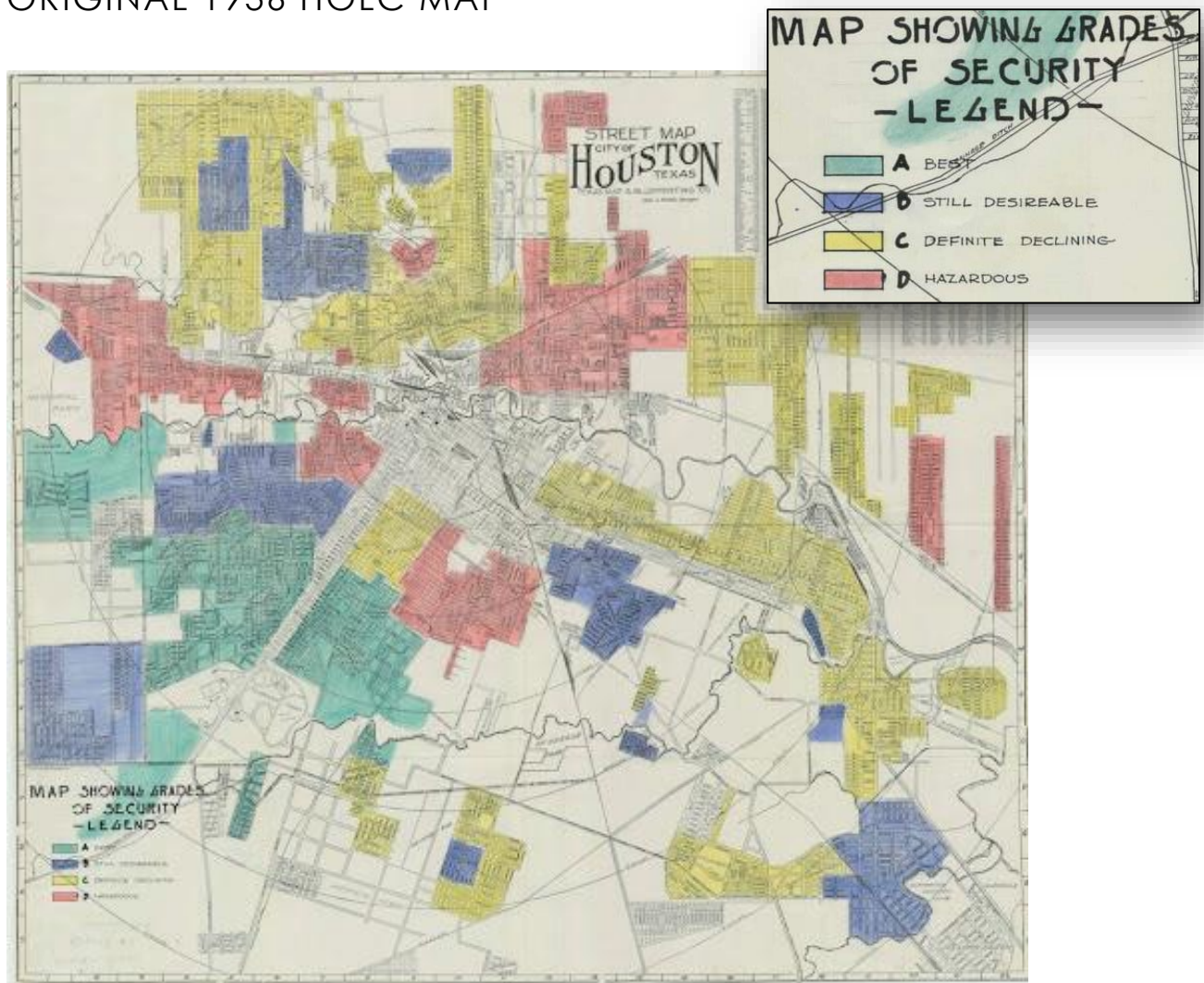


Figure 11 - Original 1936 HOLC Map

CDC SOCIAL VULNERABILITY INDEX (SVI) FACTORS

Socioeconomic status

- Below poverty
- Unemployed
- Income
- No high school diploma)

Household composition & disability

- Aged 65 or older
- Aged 17 or younger
- Older than age 5 with a disability
- Single-parent households

Minority status & language

- Minority
- Speak English “less than well”

Housing type & transportation

- Multi-unit structures
- Mobile homes
- Crowding
- No vehicle
- Group quarters

SVI COMPARISONS OF A AND D HOLC GRADES

Super Neighborhood		Houston Ranges	Neartown Montrose	Museum District	University Place	Greater Third Ward	Greater Fifth Ward	Clinton Park Tri-Community
1940 HOLC Grade		--	A	A	A	D	D	D
Current Conditions								
Social Vulnerability Index (SVI)		0-1	0.097	0.242	0.354	0.84	0.991	0.899
Minority Population		6.3% - 94.4%	19%	42.4%	22.4%	85.6%	78.6%	58.1%
Median Age		27 - 46	33	34	80	72.9	69.9	71
Life Expectancies		68.4 - 83.6	76.9	82.6%	36%	42%	35%	36%
Population over 65		0.8% - 21.6%	34.0%	11.5%	9.8%	11.2%	7.7%	8.5%
Poverty Level		1.9% - 44.5%	12.4%	16.6%	11.8%	41.2%	38.3%	44.5%
Health Impacts	Asthma	6.3% - 11.1%	6.7%	7.3%	6.9%	11.1%	10.9%	10.9%
	Cancer	2.1% - 7.5%	4.2%	4.8%	49%	5.6%	5.5%	5.7%
	Diabetes	3.8% - 22.5%	5.4%	8.0%	6.4%	21.2%	22.5%	21.2%
	High Blood Pressure	15.6% - 50.6%	19.6%	26.0%	22.9%	48.3%	48.5%	48%
	Kidney Disease	1.3% - 5.8%	1.7%	2.2%	1.9%	5.2%	5.66%	5.3%
	Mental Health Problems	8% - 19.1%	9.4%	9.8%	9.5%	17.8%	18.8%	17.4%
	Obesity	21.7% - 48.3%	25.0%	27.6%	25.9%	46.9%	48.3%	46.9%
	Pulmonary Disease	1.7% - 10.3%	2.7%	3.3%	3.2%	9.6%	10.3%	9.4%
	Pulmonary Disease	1.7% - 10.3%	2.7%	3.3%	3.2%	9.6%	10.3%	9.4%

Source: University of Richmond²⁶

²⁶ *Not Even Past Redlining: Social Vulnerability and the Legacy of Redlining*, University of Richmond (2016)
<https://dsl.richmond.edu/socialvulnerability/map/#loc=10/29.746/-95.329&city=houston-tx>.

APPENDIX B: SPATIAL DISTRIBUTION OF VARIABLES

CPERCENTAGE OF HOMEOWNERSHIP RATES

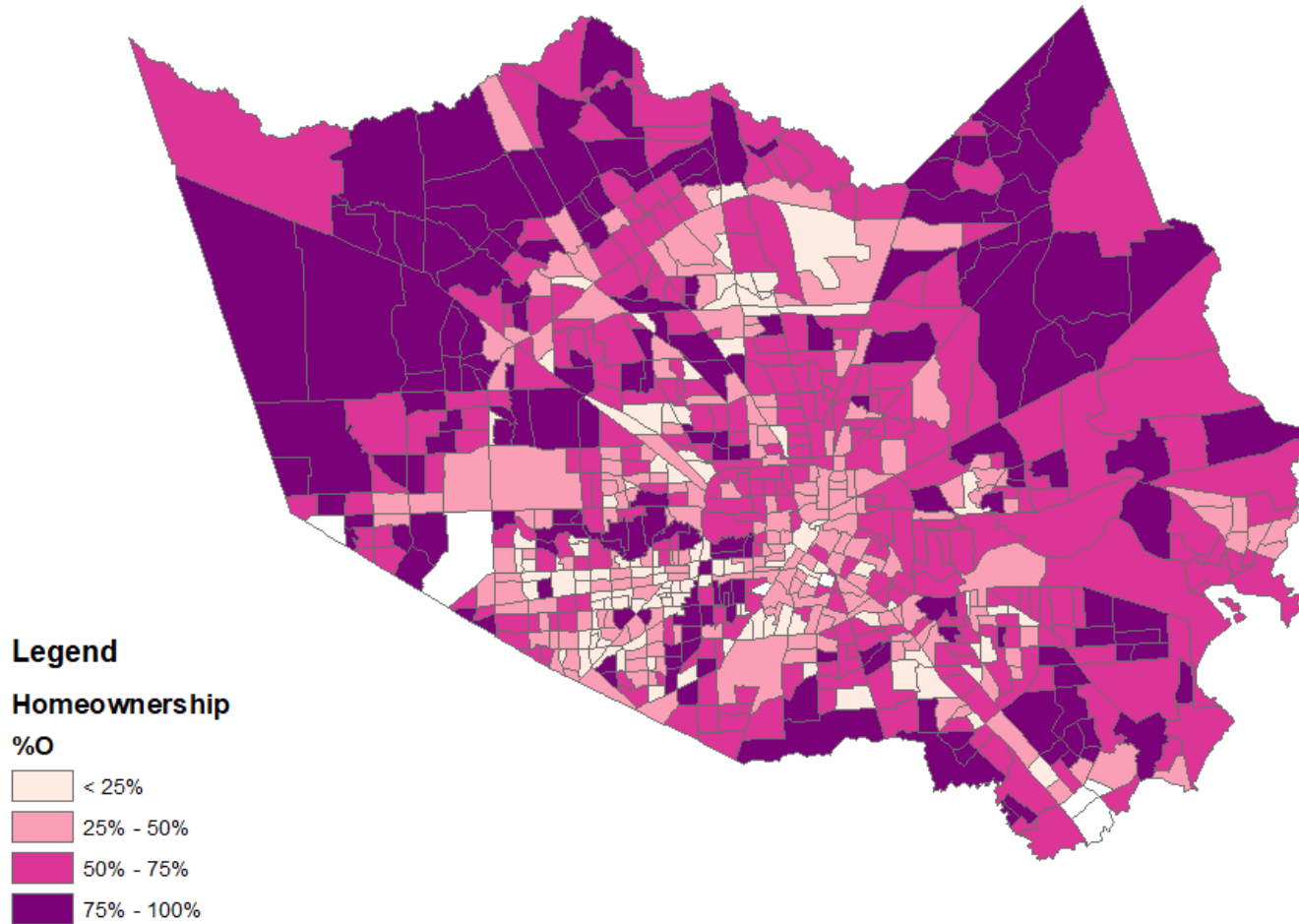


Figure 12 - Percentage of Homeownership

HARRIS COUNTY AREAS WITH SOCIOECONOMIC VULNERABILITY

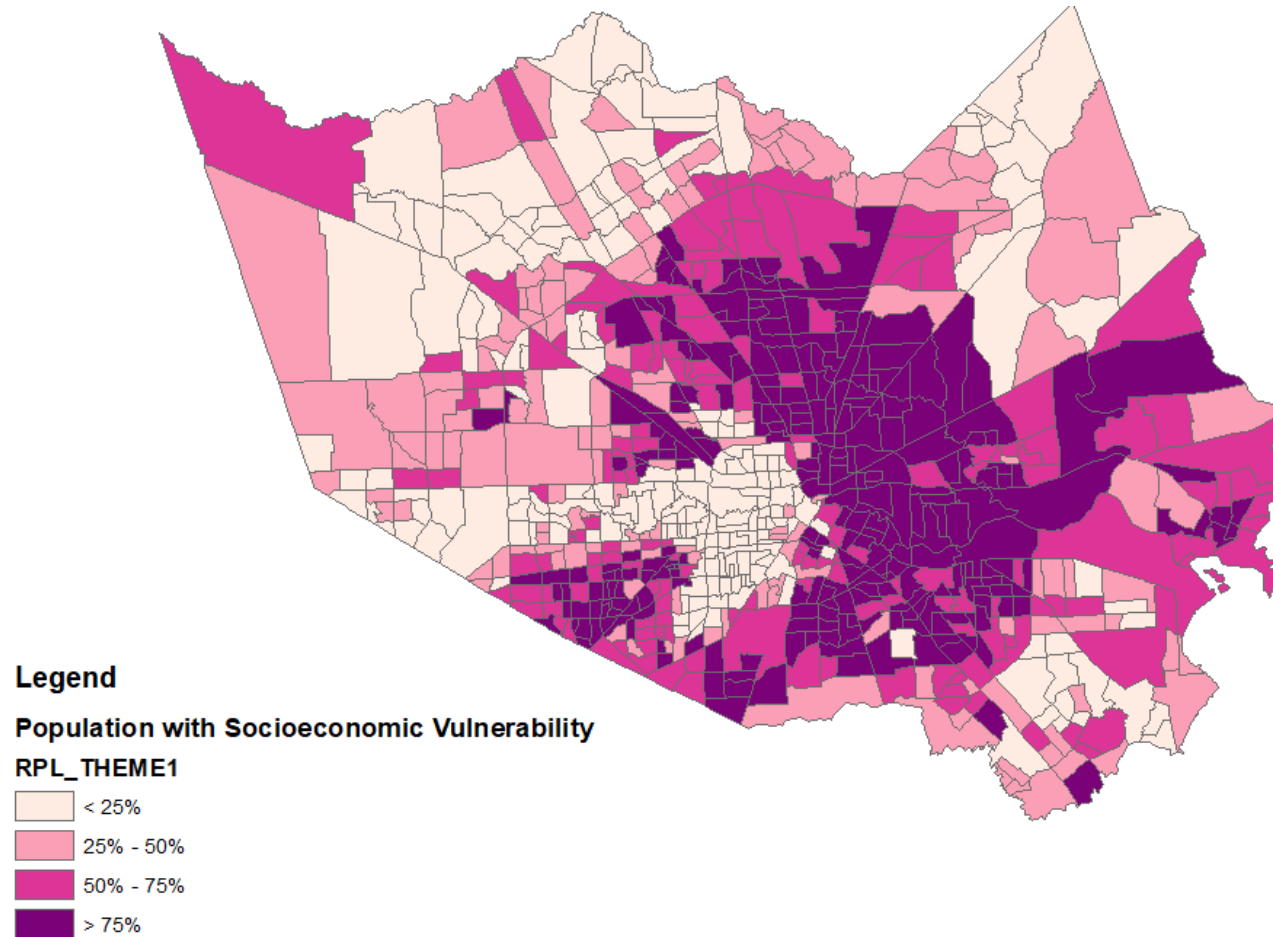


Figure 13 - Population with Socioeconomic Vulnerability

HARRIS COUNTY POPULATION OF SINGLE PARENTS

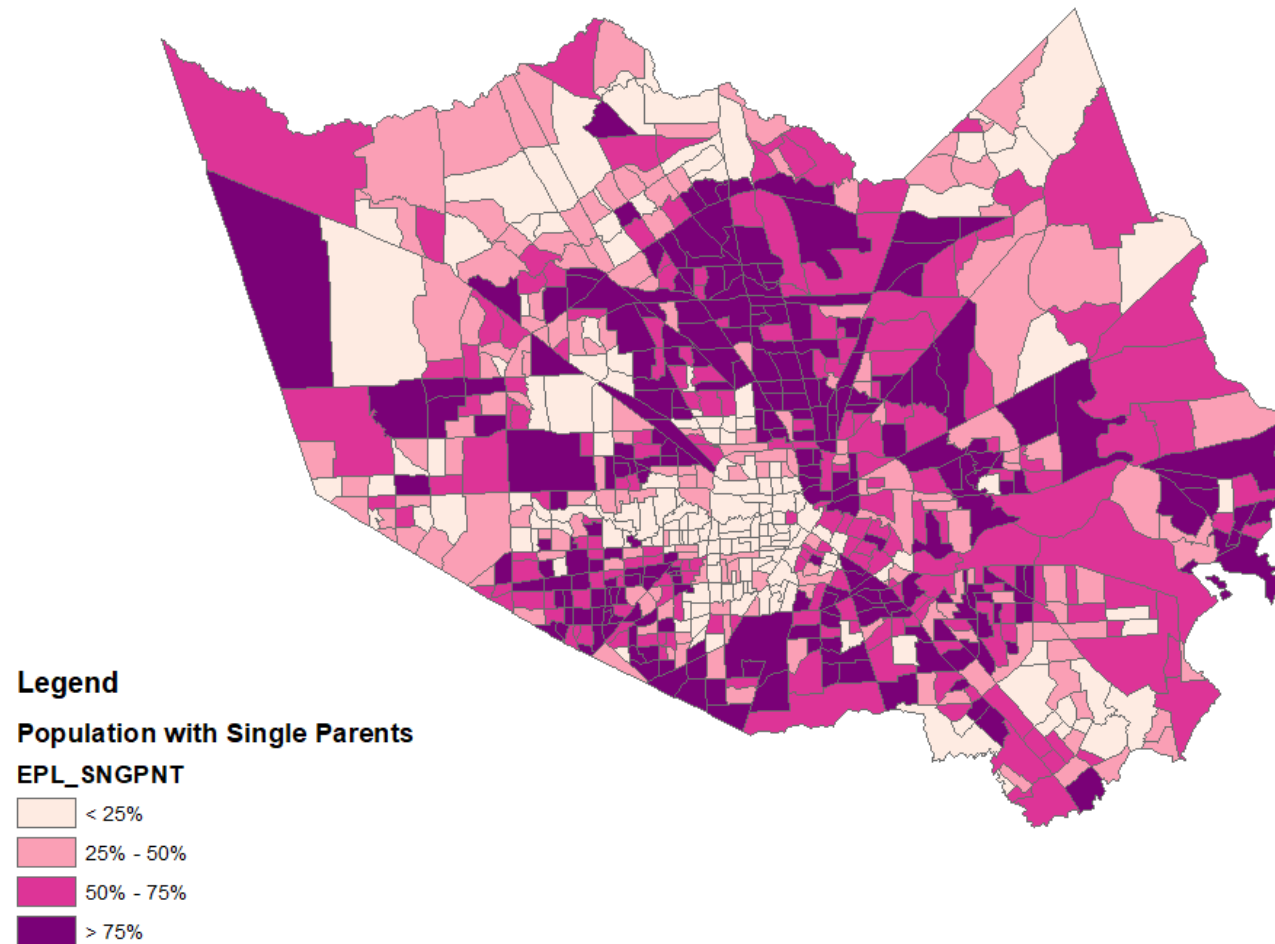


Figure 14 - Population with Single Parents

HARRIS COUNTY POPULATION OVER 65

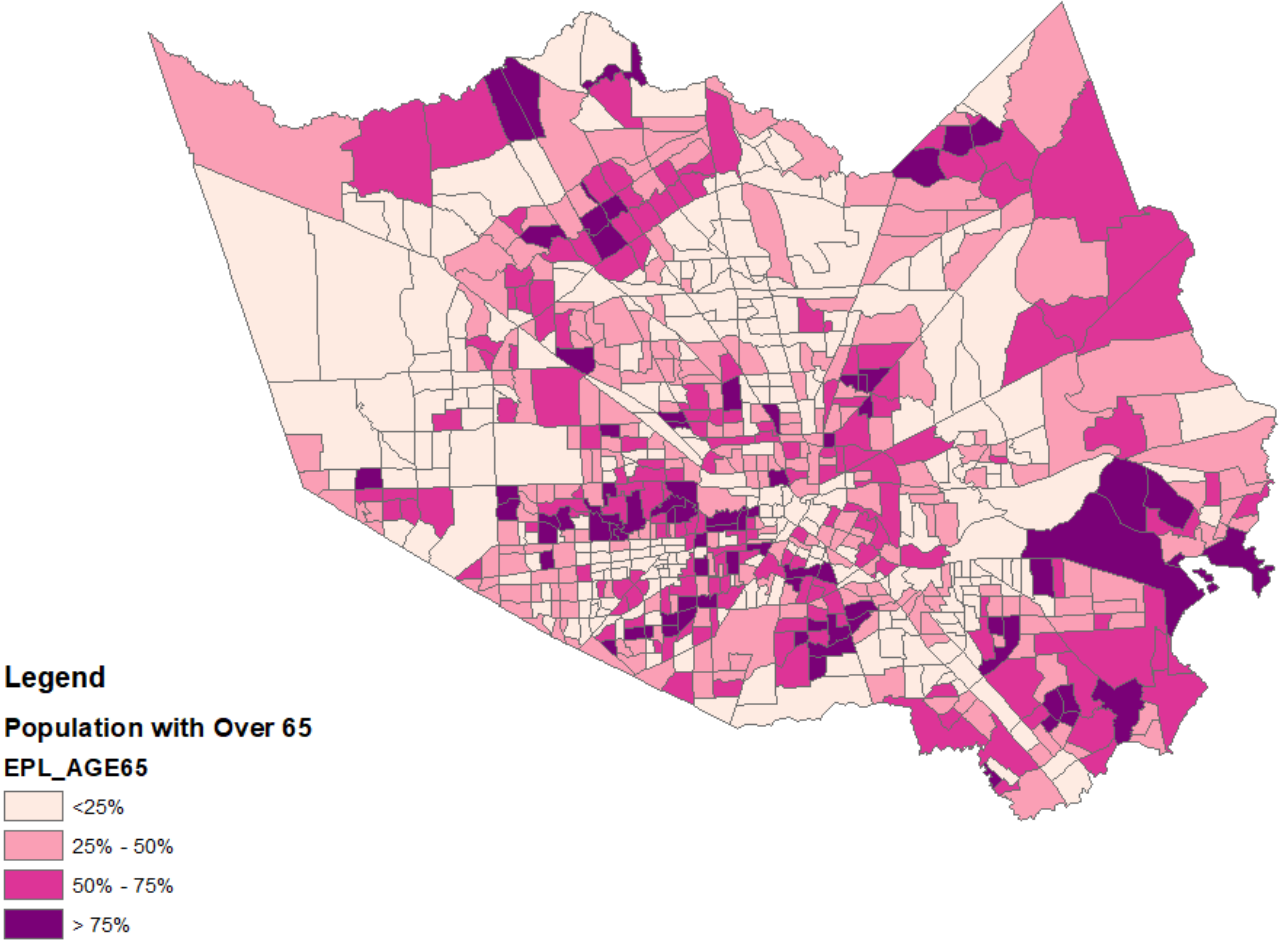


Figure 15 - Population over 65

HARRIS COUNTY POPULATION UNDER 17

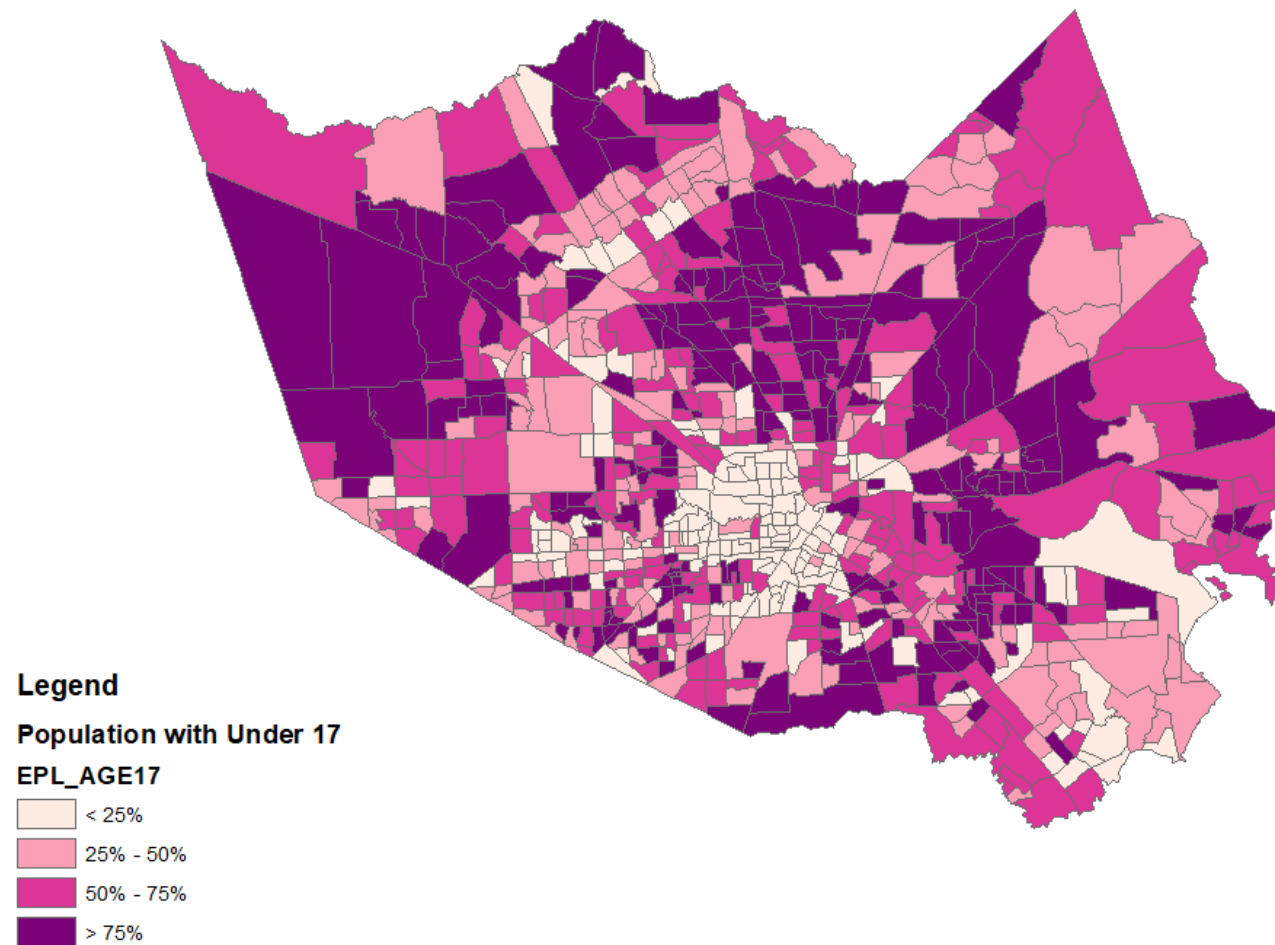


Figure 16 - Population under 17

HARRIS COUNTY POPULATION LIVING WITH A DISABILITY

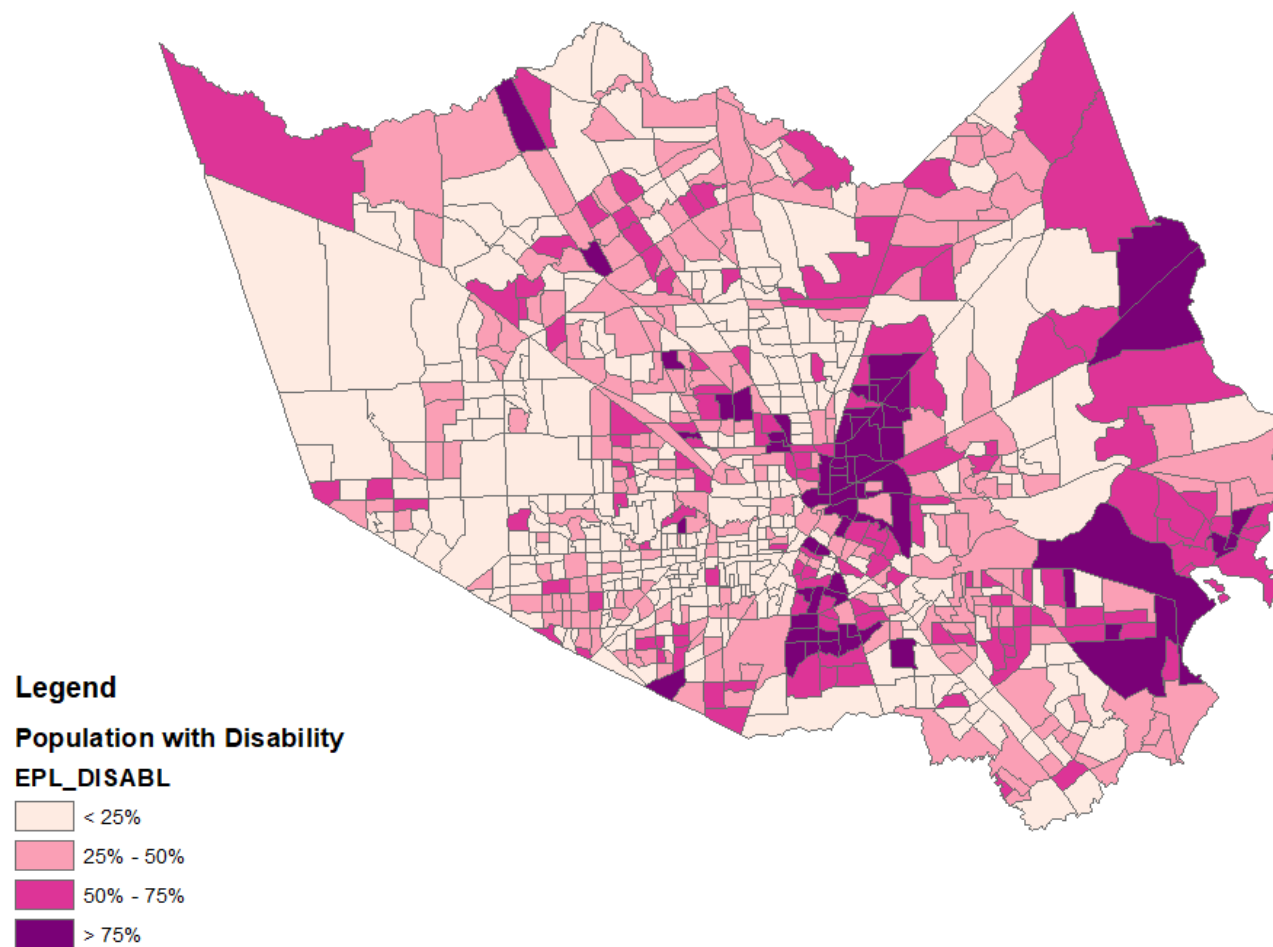


Figure 17 - Population with a Disability

HARRIS COUNTY POPULATION WITH MINORITY POPULATIONS

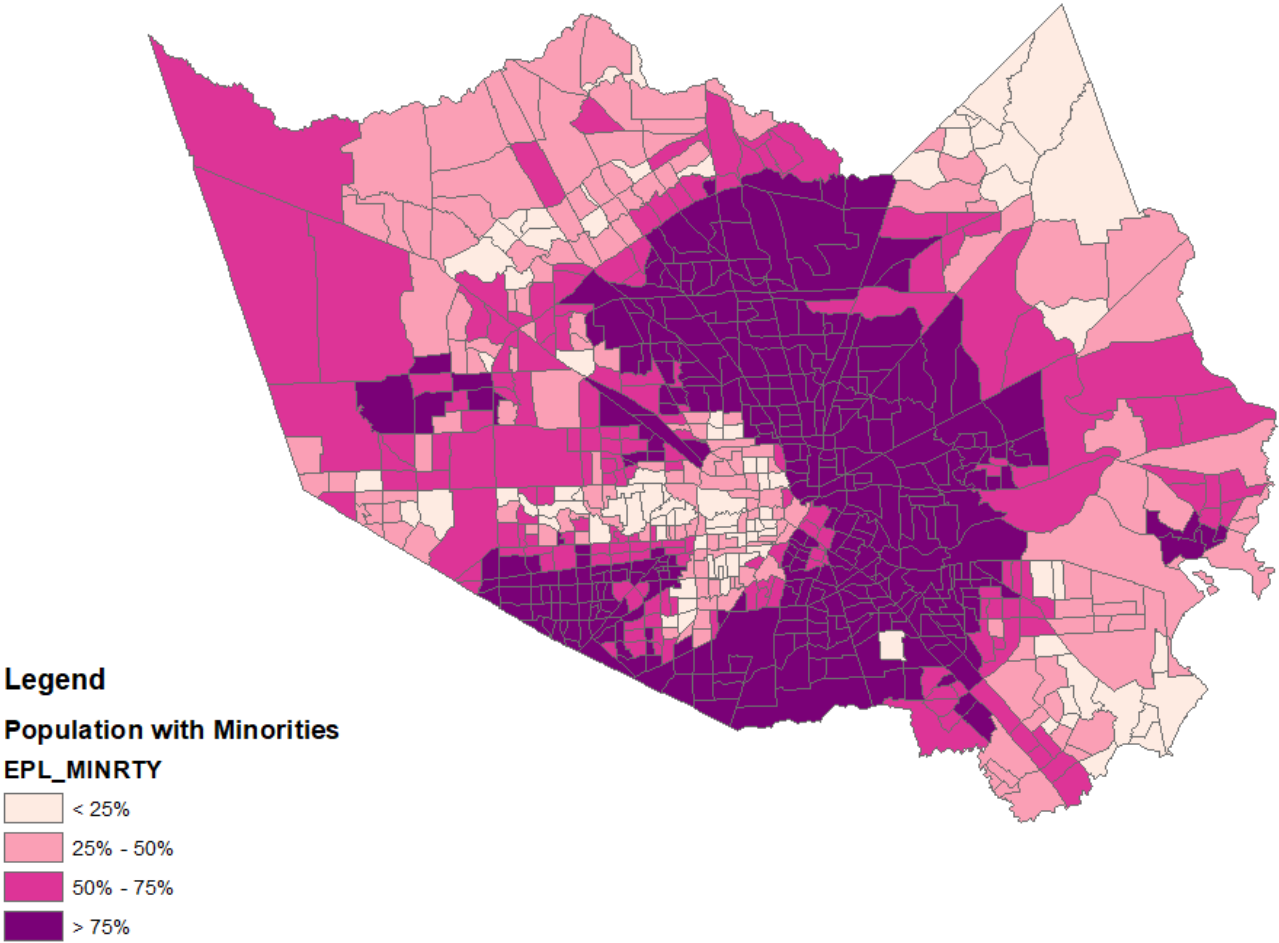


Figure 18 - Population of Minorities

HARRIS COUNTY POPULATION WITH LIMITED ENGLISH PROFICIENCY

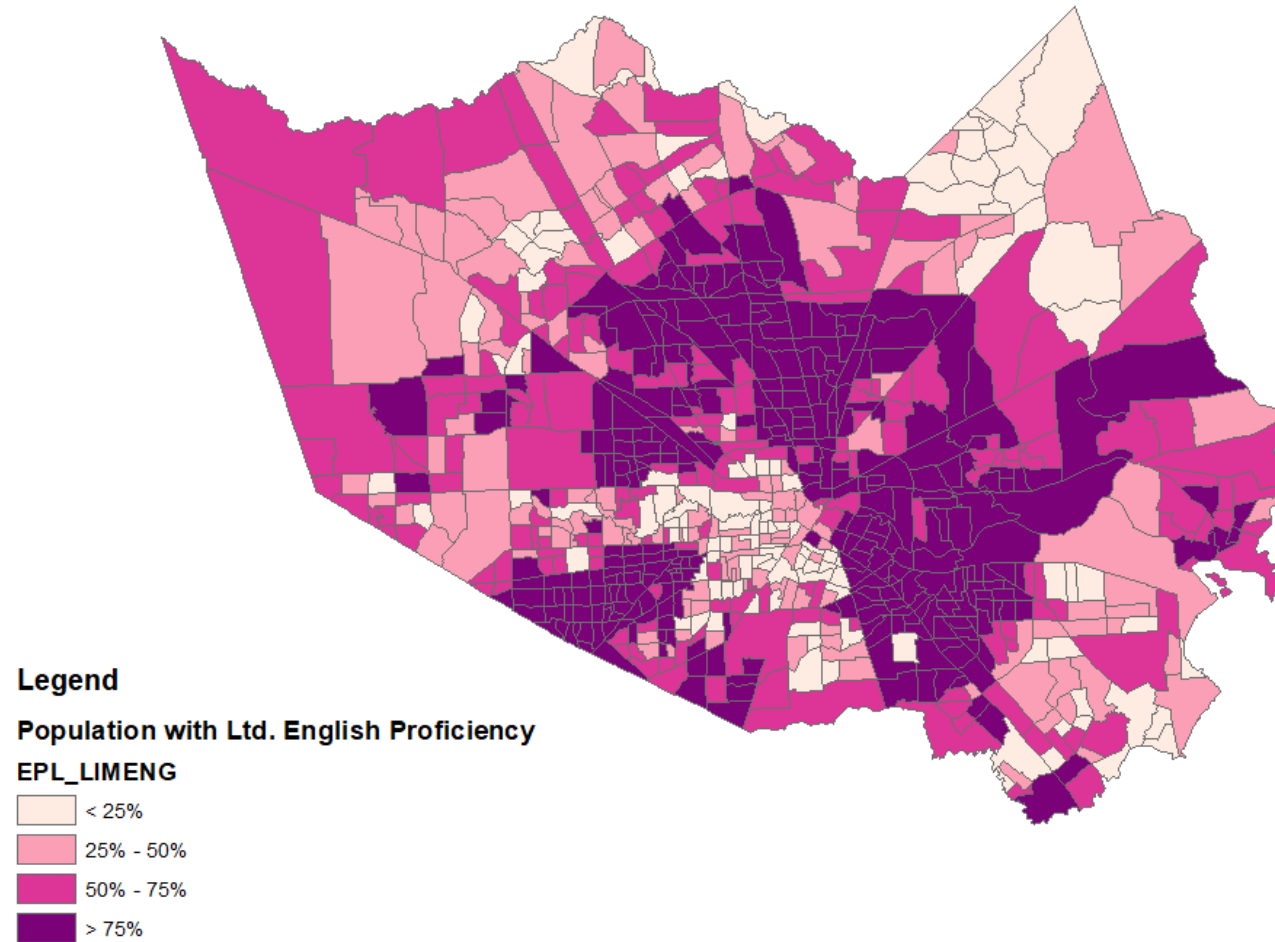


Figure 19 - Population with Limited English Proficiency

HARRIS COUNTY POPULATION WITH NO VEHICLE

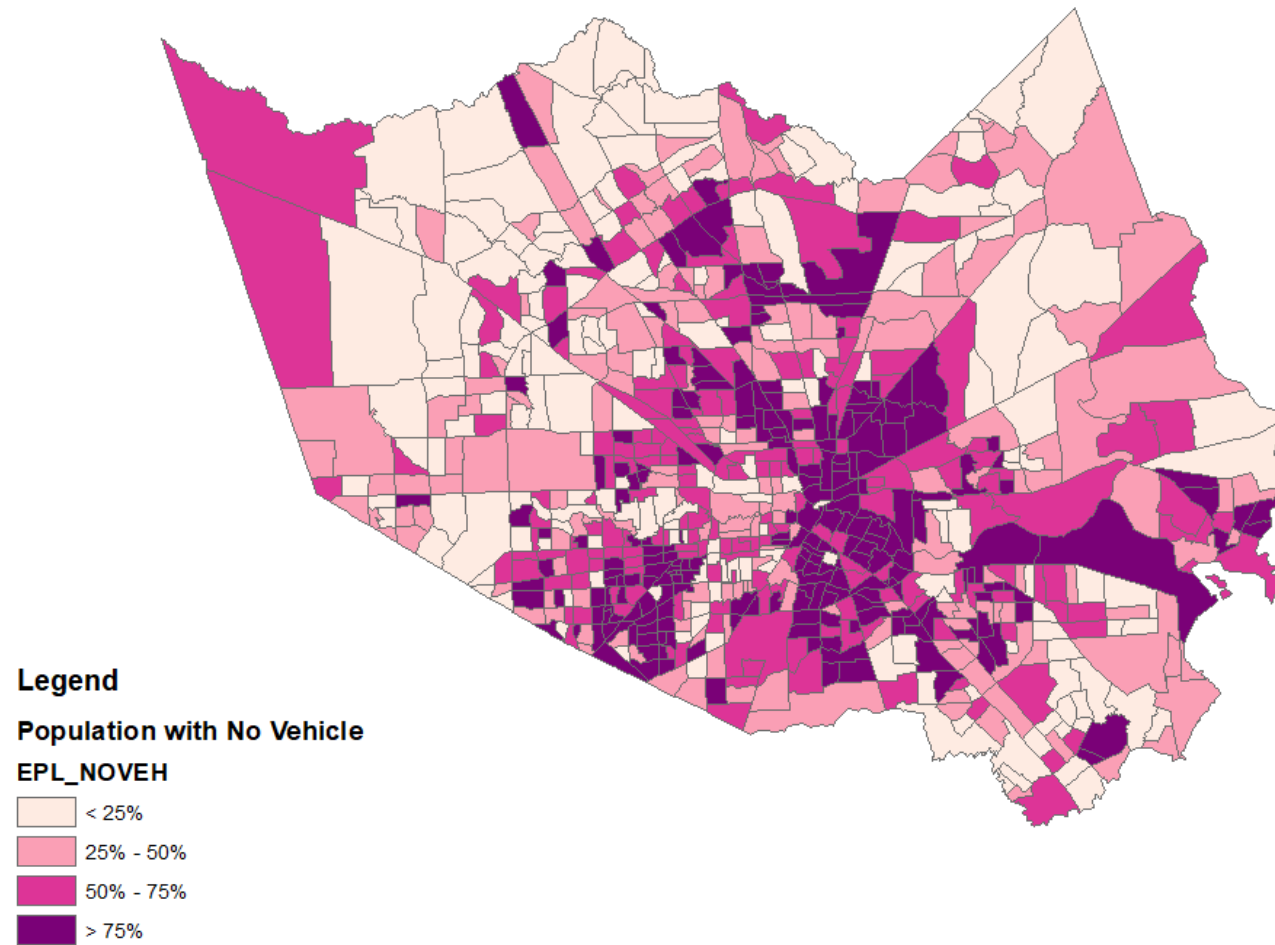


Figure 20 - Population with No Vehicle