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The Relationship Between Housing Affordability and Demographic Factors: Case Study for the Atlanta Beltline

Chapman T. Lindstrom

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THE RELATIONSHIP BETWEEN HOUSING AFFORDABILITY AND DEMOGRAPHIC FACTORS:
CASE STUDY FOR THE ATLANTA BELTLINE

by

CHAPMAN LINDSTROM

(Under the Direction of Xiaolu Zhou)

ABSTRACT

Housing affordability has been a widely examined subject for populations residing in major metropolitan regions around the world. The relationship between housing affordability and the city’s demographics and its volume of urban development are important to take into consideration. In the past two decades there has been an increasing volume of literature detailing Atlanta Georgia’s large-scale redevelopment project, the Atlanta BeltLine (ABL), and its relationship with Atlanta’s Metropolitan population and housing affordability. The first objective of this paper is to study the relationship between housing affordability at two scales within the Atlanta Metropolitan Area (AMA) for both renters and homeowners. The two separate scales in this study include an area representing the entire ABL loop and ten AMA suburban districts. The second objective is to study the relationship between demographic factors and housing affordability for four cases. The four cases are ABL renters, ABL homeowners, suburban renters, and suburban homeowners. Data for housing affordability and demographics were obtained for the year 2016 from the U.S. Census Bureau website. Data from 208 census tracts were used to represent the ten AMA suburbs selected based on criteria and 39 census tracts to represent the ABL region. The data was analyzed using GIS, t-test, and variations of multiple regression. Findings showed that the average percent of income allocated to pay for monthly housing costs (APIHC) for ABL renters are more influenced by demographics than the APIHC for ABL homeowners and the population living in AMA suburbs. Results showed that the APIHC for ABL renters decreased as median income and number of household earners increased thus improving their status of affordability. An increase in APIHC for ABL
renters was tied to an increase in household size. These results can be used to assist in further
investigation of renters living near the ABL and how development of the ABL is impacting housing
affordability within its vicinity and beyond.

INDEX WORDS: Housing affordability, Demographics, Atlanta BeltLine, Suburbs
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CASE STUDY FOR THE ATLANTA BELTLINE

by

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DEDICATION

I would like to dedicate this work to my family and friends that have supported me during this journey.
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I would like to thank my thesis committee and the geography program for their encouragement and assistance for my study.
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CHAPTER 1
INTRODUCTION

The term ‘housing affordability’ has risen in popularity and found its way into the discussion of important matters such as urban growth, shifting demographics, and fluctuating markets among many others [1,2,3]. Households are assumed to have a housing affordability problem when they pay more than a certain percentage of their income to obtain housing [4]. That percentage has been known to vary based on a variety of factors (location, market, demographics, etc.) that researchers struggle to accurately weigh when measuring their impact on housing affordability. The standard definition of housing affordability has been set by the U.S. Department of Housing and Urban Development (HUD) stating that households who spend more than thirty percent of their income on housing cost live an unaffordable lifestyle and are housing cost burdened [5]. For those households who pay 30 percent or less of their income on housing cost, they are considered to be living affordable lifestyles because of their ability to allocate at least 70 percent of their income towards discretionary costs. It is very common although in research and studies for variables, specific to the characteristics of a study area, to be accounted for and factored into the HUD housing affordability definition in order to better suit the study area. A study area will come with its own unique quantifications of the demographic factors involved. It is determined that demographic factors are responsible for influencing the levels of housing affordability for a given region [6]. This relationship will differ largely based on the area of consideration.

The purpose of this study is to investigate housing affordability in the Atlanta Metropolitan Area (AMA). Atlanta’s population saw dramatic growth towards the end of the 20th century which caused rapid suburbanization to the surrounding counties of the city and reshaped the AMA [7]. To support the rising and expanding Atlanta population a series of re-development projects were launched with perhaps the largest and most intensive project of them all being the
Atlanta BeltLine (ABL). The ABL seeks to alleviate some of the city’s biggest problems today such as traffic, public transportation, pollution, and racially and socio-economically segregated neighborhoods [8]. A project tasked with the hopes of solving a magnitude of issues will certainly create an immediate and lasting impact, both positive and some cases negative, on the surrounding region. These impacts can take on many forms. For starts the ABL, in itself, is a giant infill development project that is spurring surrounding infill development at a much smaller scale. Once abandoned lots and vacant structures in the ABL’s vicinity are being recycled and revitalized in order to accommodate the attraction generated by the ABL. Gentrification is automatic in most ABL subareas where previously overgrown passages of decommissioned railways are being converted into profitable urbanized green and open spaces. The formation of tax allocation districts are used to fund subareas of the ABL and will impact the lifestyles of populations living within the districts. The housing market is being reshaped in the general area as a result of the processes mentioned. The degree of impact and influence on the surrounding area caused by the ABL will vary in different ways based on the location in relation to the ABL and the demographic makeup of the location. In all there are constant discussions today as to whether the ABL project is still a sustainable one and to whom.

Significance of Study

In this study gaps in research help to guide the process for developing noteworthy research questions to attempt to answer. In conclusion of this process it was determined that an investigation is beneficial on relationship between housing affordability and demographic factors at the ABL scale and compare the results to another scale within the AMA where housing affordability is of major importance and demographics are predicted to be dissimilar. Through the comparison of ABL results with that of another scale, important contributing inference can be
made about housing affordability’s relationship with demographic factors. Studies investigating the ABL’s impact on the cost of living are very popular since the conception of the ABL idea by Ryan Gravel [9] in 1999. Dan Immergluck [10, 11, 12] in particular has, or is a part of, numerous published studies on the ABL. The ABL’s influence on housing values, gentrification, and urban development are usually the focus for his research surrounding the ABL. In relation to housing values and affordability, Immergluck [12] investigated the degree of speculation surrounding the ABL project and how the pricing of housing nearby were influenced by distance and location on the trail route. Immergluck [10] also explored green urban development and environmental gentrification’s impact on housing cost in the ABL’s vicinity. When it comes to selecting a different scale to be compared to that of the ABL, specific AMA suburbs are fittingly used.

Between 1982 and 1997, the central city of Atlanta saw roughly 20 percent of its jobs in business and professional services move to AMA suburbs [13]. For the AMA suburbs, similar studies, as to those performed on the ABL, have been conducted. Wang and Immergluck [14] studied the impact of suburban smart growth planning initiatives on home values in the AMA suburb county of Gwinnett. When it comes to gauging the relationship between housing affordability and demographic factors, the amount of available literature is minimal compared to other subtopics in this study. Bujang [6] found that marital status, household income, education attainment, and household size showed a strong relationship with affordable housing in Johor Bahru, Malaysia. Of the four only marital status had a negative relationship with housing affordability meaning that when a person entered into married life their status of affordability will likely decrease. The population within the city limits of Johor Bahru were surveyed and results studied as a whole. The relationship between housing affordability and demographics were not compared at two geographies. It is due to these holes in existing literature that I seek to investigate these two research questions listed below:

- **R1**: Is housing affordability near the ABL significantly different than AMA suburbs?
• R2: Does housing affordability have a relationship with specific demographic factors at the two scales?
CHAPTER 2
LITERATURE REVIEW

Demographics

Demographic factors are defined as socioeconomic characteristics of a population expressed statistically such as age, sex, income level, religion, marital status, occupation, education attainment level, birth rate, etc. [15]. Therefore, demographics can be used to describe the relationship of populations and factors that allow populations to be categorized and viewed as uniquely similar or different.

Housing Affordability

At its greatest level housing affordability, also referred to as affordability, is concerned with securing some given standard of housing (or different standards) at a price or rent which does not impose, in the eyes of some third party (usually government), an unreasonable burden on household incomes [16]. Out of this definition we find three concepts of affordability. There is purchase affordability, repayment affordability and income affordability. Purchase affordability considers whether a household is able to borrow enough funds to purchase a house [17]. This particular concept requires several steps and checks just to ensure that the individual(s) are capable of purchasing a unit. Notable determinants of affordability for this concept include household income, unit costs, and unit production costs. There are a lot of outside factors that can affect the process. When measuring for home purchasers it is common around the world to use the Housing Affordability Index which compares a person(s) income to a person(s) house price to calculate affordability when they meet the mortgage qualification rules [18]. Meeting the rules are essential as explained earlier. The next widely used affordability concept is repayment affordability which considers the burden imposed on a household when repaying the mortgage. It
is because of the repaying process that this concept has almost the identical guidelines to its
description as purchase affordability. Income affordability is the other case that is a considerably
different process. It is the simplest of the three concepts making it more widely used. Income
affordability simply measures the ratio of house prices to resident’s income [17]. When
calculating income affordability there are two most commonly used methods. They are the ratio
method and the residual method. The ratio method is the simpler of the two. It is based on the
ratio of housing cost to income of the residents. To the researcher it allows one to identify the
proportion of income that should not be exceeded when paying for a home of adequate size and
quality [19]. The ratio method has been the standard for measuring income affordability for a
long time. However, a key flaw is its inability to specify individual cases. By individual cases
we are taking into account the differences in individual lifestyles and how they chose to spend
their own money. After all an individual’s expenditures on non-shelter necessities are not all the
same. It cannot be assumed that if a group of individuals spend the same on housing cost that
they spend the same amount for other necessities. It has been a thorough debate as to whether
this approach is acceptable for today’s lifestyles. There were a few attempts to signify the ratios
efforts to be a viable calculation. In the 1980s, Feins and Lane [20] formulated the ratio
indicator. In this instance one would apply these terms to the issues of housing affordability and
with it find the ratio of shelter expenditures to household income as a suitable indicator. With the
uncertainty of the ratio methods still a discussion, the residual income method would come to
prominence. At its simplest form, like the ratio method, the residual method is a residents
remaining income after meeting their housing costs. A more in-depth description did summarize
the method as an assessment of whether the income left over after paying for a decent home is
sufficient to allow a “reasonable” standard of living [19]. With this approach there is now
recognition of the housing’s distinctive physical attributes in comparison with necessities [21].
As a result, its cost makes a significantly reduced flexible claim on income when compared to the
ratio approach. Stone [21] argues definitively that the residual approach is the most responsible
option when it comes to measuring income affordability. Much like the ratio indicator, there is a residual indicator signifying the connection between income and housing costs and it is the actual difference between them rather than a ratio between the two. To further explain the residual advantage by Stone [21], one can compare the incomes of two households. There are two separate cases to be compared. The first case you have two households with the same incomes, but one requires more nonshelter necessities. The need for more nonshelter essentials can be generated by a variety of factors such as a larger household consisting of four members. So as a result, the larger household will have less to spend on housing naturally than the smaller household. In the second case you have two identical households but with dissimilar incomes. Those with lower incomes will have less to afford for housing as well. It is because of this that Stone [21] states that “the residual income standard emerges as a sliding scale of housing affordability with the maximum affordable amount and fraction of income varying with household size, type, and income”. To conclude, the importance of the residual income concept over the ratio income concept is its capability of recognizing the differences in household makeup and income that have impacts on its affordability.

**Housing Affordability and Demographics**

According to Stone [21] affordability is a relationship between income and relative prices rather than being a fundamental characteristic of housing. This approach allows one to view an individual or household’s income to be a determining factor of their level of affordability when owning a home or renting a living space. Segel et al. [22] demonstrated how demographics impact homeowners in a variety of ways. Increases in population, educational attainment and growth in real income have shown to cause homeownership rates to increase significantly. On the contrast, a reduction in the average household size, due to a decline in married households,
have contributed to a decrease in homeowner rates. Bujang et al. [6] cited that income, household size, educational attainment, and marital status produced the strongest correlation with housing affordability among a list of demographics tested. Also, tests signified that income had a strong relationship with the other demographics influencing affordability. One might assume that most demographics indirectly affect affordability through income. For example, educational attainment can be linked to an individuals’ level of income. Glick et al. [23] describes how completion of additional increments of education create increased earning power. On average college graduates fair a better chance of obtaining a greater income than those who go to work straight out of high school. Jacobson et al. [24] found that high levels of post-secondary degrees are associated with higher earnings. Two-year certificates are shown to lead to well-paid careers while four-year and STEM related degrees are most lucrative. Hill [25] put forward a study showing that workers with more significant financial responsibilities to their families, married individuals with a large number of children, received much higher wages. Similarities can be drawn to where increases in the average household size leads to higher wages because of more potential earners or obligation to provide for the household. Dunga [26] supports the effects of marital status on income by claiming that married people are at an advantage of having a higher household income than those who are not. This contributes to Rubin et al.’s [27] study that households with multiple earners, on average, will be more financially stable. Dual earning households can be attributed to the rise in women’s labor force participation in the 1970s and 80s. Dual earning families could see a 47% higher median income than single earner families. Choi et al. [28] demonstrates the value of marriage by confirming that marital status continuity buffers mortality risks among men with low income. Marriage has the potential of keeping low income household’s from falling deeper into poverty.
Housing Affordability and Location

Just like demographics, location will have a form of impact on affordability. To investigate affordability it is important to understand the factors that have impacted affordability at these locations. Baldassare [29] explains the evolution of suburbs in relation to affordability. The appealing suburban characteristics such as larger homes, increased privacy, and outdoor space brought a rise in suburban dwellers in the 1950s and 60s due to cheap land, low interest loans, increase income growth, and federal home loan programs. This occurred due to the fact that suburban residents could afford the commute to cities along with housing and other attributed living costs. The 1970s and 80s saw a decline in suburban housing affordability due to employment growth in suburbs thus increasing demand for housing in the areas and driving up home costs. A study by Freeman [30] showed that low income housing tax credit (LIHTC) neighborhoods in the suburbs were predominantly white and exhibit lower levels of poverty, higher median incomes and greater home values and homeownership when compared to LIHTC neighborhoods in inner cities. Government programs, such as LIHTC, have been administered in locations to help aid affordability efforts throughout the country. Steinecker [31] addresses the relationship between infill development and affordability for cities and its metropolitan area. Her study suggests that the availability of infill development will intensify affordability issues in cities. Nelson et al. [32] discusses how metropolitan growth management influence factors such as cost for infrastructure, traffic, and urban disinvestments that in return impact affordability for the area. It was concluded that growth management policies for metropolitan areas do have the ability to increase the cost of housing thus significantly influencing affordability in communities.
CHAPTER 3

ANALYSIS OF HOUSING AFFORDABILITY AND SELECTED DEMOGRAPHICS

Methodology

This research is conducted to study the relationship between housing affordability and demographics. The framework for this study was conducted in the following sequences:

1. Select parameters for study area to perform the research questions.
2. Collect the data necessary to measure housing affordability and demographics in the study area.
3. Perform data organization, management, and manipulation in order to carry out the desired analysis for the research.
4. Use GIS and statistical analysis to interpret the data.

Study Area

This study is conducted within the boundaries of the Atlanta Regional Commission (ARC) which serves as a model for the AMA. The AMA has been represented by a variety of parameters ranging from 5 to 39 counties. ARC is a regional planning and intergovernmental coordination agency for the ten county Atlanta region as seen in Figure 1. The ten counties forming ARC effectively represent the two scales being investigated. The ABL is a long-term project, formulated by Georgia Tech graduate Ryan Gravel [9], that will have enormous influence on its surrounding communities in various ways. An important aspect of housing quality depends on public amenities tied to the location of housing [33]. Instead of locating and investigating every small-scale amenity (green spaces, transportation, cultural districts, etc.) that can have a multitude
of effects on its surrounding societal environment, I have selected the ABL region which is a partially completed project that combines a variety of amenities into one easy to define area of study.

Figure 1 ARC (Atlanta Regional Commission) and the ten counties that form the base line map.
As seen in Figure 2, the ABL, when completed entirely, is a 6,500-acre ring of parks, open space, light rail transit and mixed-use development by tying together infrastructure and related development along a 22-mile industrial line that circles the Atlanta central business district, Midtown, and the core city [12]. The ABL has vast potential to improve the quality of life for many of Atlanta’s neighborhoods. However, it goes without question that the ABL will have its fair share of negative impacts that will need to be addressed such as increases in taxes and housing cost that will alter a large percentage of household’s affordability status. At the moment the ABL is less than 50 percent complete. Completed portions are marked as the Northside Trail, Eastside Trail, and West End Trail. Due to its great anticipation that was generated by mass produced speculation the ABL is a valuable study area for housing affordability and its demographics within ARC. The housing affordability and demographics of the AMA suburbs will serve as the area of study that is to be compared to the ABL. The distinguished suburban areas have been selected base on a criterion that produces a society similar to that around the ABL but at a significantly smaller and suburban scale. The parameters for the suburban areas are set to be within ARC and outside the 285 Loop that circles the downtown core of Atlanta and encapsulates the ABL. The 285 Loop works as a natural buffer separating the central business district and downtown congestion of Atlanta from major Georgia suburbs. From here the next step is to look at suburban areas that, over the years, have sought to bring the big city feel to a smaller more localized area. The Main Street Program (MSP) has often been used over the decades to revitalize downtown districts in order to expand the city’s economy, promote diversity, and improve its overall appearance. Founded by the National Trust for Historic Preservation (NTHP) in 1977, the MSP has a four-point method for the economic revitalization of the downtown core and helps oversee the development [34]. The four points are: organization, design, promotion and economic restructuring. Three Atlanta suburban cities used in this study have already adopted the MSP four-point method to their downtown districts. It is also common for cities to implement the four-point method on their own without collaborating with the NTHP.
In short, these suburban areas will contain characteristics such as revitalized downtown districts, entertainment districts, and the blending of shops and restaurants with apartments into one cultural district. Based on this given criteria I selected ten suburban cities to be used in this study. The ten suburban cities are listed as followed with an asterisk denoting that they have partnered with the MSP:

- Kennesaw
- Lawrenceville
- Marietta
• Peachtree City
• Peachtree Corners
• Roswell/Alpharetta
• Sandy Springs
• McDonough*
• Suwanee*
• Woodstock*

See Figure 3 below of the ten suburban cities being studied.

![Map of Atlanta Metropolitan Area Suburbs]

Figure 3 Suburbs of the Atlanta Metropolitan Area to be used in this study.

By comparing the ABL and suburban regions, housing affordability and demographic measurements can be analyzed at different scales within the AMA.
Selecting Demographics Factors for Study

The selection process for the demographic factors to be used in this study was heavily based off of the combination of prior studies and data availability. Bujang et al. [6] selected demographic features for their housing affordability study based on their interrelation with the property market for the study area. Riche [35] view age and race as the strongest demographic factors that influence housing choice and location. They also consider differences in individual demographics, such as race, to be influenced by other demographics such as age, educational attainment, marital status and geographic location. For this study eight demographics were selected and listed as followed:

- Median income
- Median age
- Race
- Education attainment
- Number of earners in household
- Household size
- Marital status
- Employment status

For six of the eight categories variables were selected to represent the category. The variables for each of the six categories were selected based on their belief that they best represent the demographic. The six variables being tested are listed as followed:

- Percent of population white (Race)
- Percent of population attained a bachelor’s degree and above (Educational attainment)
- Percent of households with one earner (Number of earners in household)
- Percent of households with three or more occupants (Household Size)
• Percent of households now married (Marital status)

• Percent of individuals employed (Employment status)

\textit{Data Collection and Analysis}

All data used in this study is secondary data retrieved from the U.S. Census Bureau American Community Survey and Atlanta Regional Commission (ARC) websites [36]. The sample data will be collected as 5-year estimates for the years 2012-2016 [37, 38, 39, 40, 41, 42]. 5-year estimate data was used because of the large population being analyzed in this study. The census data is downloaded and converted into a Microsoft Excel file. Excel files could easily be imported into ArcMap and SPSS for further analysis. The ARC website contains a database that provides shapefiles for the counties in my study area at the census tract level and the ABL corridor. Data at the census tract level was collected for the ten counties that form ARC. This was a total of 748 census tracts. The ten selected AMA suburban cities and their boundaries encompassed 208 census tracts. The conditions used to form the boundaries for the AMA suburban cities was to incorporate census tracts that fell with 3-6 miles of the town center and did not exceed any of the set buffers (ex: ARC and 285 Loop). Census tracts intersected by the ABL corridor were used as the criteria for selecting the area of study. In total 39 census tracts intersected the ABL. ArcMap tools were used to extract these census tracts from their original shapefile and then used to create two separate shapefiles that contained the census tracts representing the ABL and AMA suburbs. Now housing affordability and demographic data belonging to the ABL and AMA suburbs census tracts could be joined to these new shapefiles and used for mapping and statistical analysis.

Demographic data packages were all organized in ratio scale for each census tract upon downloading resulting in no necessary data manipulation. The data management process in
ArcMap for demographic data was minimal mainly used to extract the necessary sample sizes representing the ABL and AMA suburban cities to be used for statistical analysis. On the other hand, managing the housing affordability data was a much more tedious procedure. The housing affordability data packages will go through several organizational and manipulating processes in order to get it in the desired format. The preferred format was to have the average percent of household income used to pay monthly housing costs for both renters and homeowners at the ABL and AMA suburban city scales. Figure 4 shows the framework for managing housing affordability data. Three different housing affordability categories were selected for this study. Two of the three categories were combined to represent all homeowners while the remaining category represented renters. Housing affordability data packages came categorized by a set of ranges differing based on their category. I used an average across ranges formula to calculate the average percent of income used to cover monthly housing cost for each census tract for each category necessary. The formula for finding the average across ranges is given below.

\[
p = \frac{\sum p_i f_i}{\sum f_i}
\]

and

\[
q = \frac{\sum q_i f_i}{\sum f_i}
\]

There is a minimum percent \( p_i \) and a maximum percent \( f_i \) for each range for the two categories created and value (the total population) which falls within that range. The average percent of income used to cover monthly housing cost can then be calculated by finding the average between the lower bound average \( p \) and the upper bound average \( q \).

The GIS work involved in this study was performed in ESRI ArcMap software. This software was used to build graduated colors maps using housing affordability and demographic data. GIS produced maps were used for preliminary analysis and visual interpretation of housing
affordability and demographic data. Maps allowed the opportunity to identify any trends in the level of housing affordability and measurement of the demographic categories being observed for the ABL and AMA suburbs.

Figure 4 Housing affordability data workflow.
GIS work will be used to provide validation for the statistical analysis performed on the data. In this study two statistical tests were performed on the data. A *t-test of unequal variance* was used to establish significant statistical difference between the housing affordability means for the ABL and AMA selected suburbs for both renters and homeowners. This was important to verify since the housing affordability data means, for both renters and homeowners residing in the ABL and AMA suburban study areas, will be used in further statistical tests. Three separate multiple regression tests were administered in this study. An *unadjusted multiple regression test* (UMRT), *adjusted multiple regression test* (AMRT), and *stepwise multiple regression test* (SMRT). For each multiple regression test there were four cases being put into the model. The four cases are listed as followed:

- Case 1: ABL renters vs eight demographic factors
- Case 2: ABL homeowners vs eight demographic factors
- Case 3: AMA suburban renters vs eight demographic factors
- Case 4: AMA suburban homeowners vs eight demographic factors

In the multiple regression tests the eight demographic factors are serving as the independent variables while the scale and housing tenure are representing four separate dependent variables.

UMRT will be used to test for any multiple regression violations (ex: heteroscedasticity, multicollinearity, etc.) in the four cases. If no violations occur then the multiple regression results can be assumed valid. AMRT will be used to address any multiple regression violations that occur and to apply techniques that could improve results. Data and variable modifications will be used to resolve any multiple regression violations. The tests to perform modifications are listed as followed in order of administration:

- Testing for linear relationship between the dependent variable and independent variables.
- Residual scatter plot and Glejser test for heteroscedasticity.
- Observing variance inflation factors for multicollinearity.
- Testing for outliers with Cook’s Distance test.
- Test for normality of the residuals with Shapiro-Wilks test.

SMRT will eliminate any biased that could potentially be involved in the AMRT process. Statistical Package for the Social Sciences (SPSS) software was used to perform all multiple regression tests. In its entirety, the data for this study will go through a variety of importing, exporting, organizing, manipulating and statistical process. Figure 5 below shows the data flow process in its totality.
Figure 5 Overall data flow process
CHAPTER 4
RESULTS

Affordability at Different Scales

GIS provides the opportunity to identify trends as well as highs and lows in the *average percent of income allocated to pay for monthly housing costs* (APIHC) value which can now be expressed for each census tract, scale, and housing tenure type. Figure 6 shows a mapping of housing affordability for renters at the ABL and suburban scale.

![Map of housing affordability for renters](image)

There is an immediate noticeable trend in renter housing affordability at the ABL scale compared to the suburban scale. Strong visual results as so create the assumption that the trend might be
influenced in some way. Also there are suburban census tracts that have a lower APIHC value than the lowest ABL census tract APIHC value. Figure F displays the mapping of housing affordability for homeowners at the ABL and suburban scale.

Figure 7 Measuring housing affordability for homeowners.

Here there is a far less noticeable trend but an inference can still be made as to what might be causing homeowner housing affordability variation at the two separate scales. By observing these four maps it can be perceived that homeowners, regardless of location, have a lower APIHC value than renters. To verify this claim a t-test of unequal variance was used to confirm that there is a statistically significant difference between the two scales for renters and homeowners. The t-test results can be viewed in the Table 1 and Table 2. Using an alpha of 0.05 both t-test returned a significant p-value. With these results I can conclude that the populations at the two scales are
statistically different from one another and show a real difference from which the groups were sampled.

<table>
<thead>
<tr>
<th></th>
<th>ABL Renters</th>
<th>Suburban Renters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Renters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>41.05</td>
<td>37.89</td>
</tr>
<tr>
<td>Variance</td>
<td>62.46</td>
<td>45.21</td>
</tr>
<tr>
<td>Observations</td>
<td>39</td>
<td>208</td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td><strong>t Stat</strong></td>
<td>2.33849126</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) one-tail</td>
<td>0.011743072</td>
<td></td>
</tr>
<tr>
<td>t Critical one-tail</td>
<td>1.676550893</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
<td>0.023486143*</td>
<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>2.009575237</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 T-test for Housing affordability of ABL and suburban renters.

<table>
<thead>
<tr>
<th></th>
<th>ABL Home Owners</th>
<th>Suburban Home Owners</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Home Owners</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>26.79</td>
<td>24.19</td>
</tr>
<tr>
<td>Variance</td>
<td>29.27</td>
<td>14.97</td>
</tr>
<tr>
<td>Observations</td>
<td>39</td>
<td>208</td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td><strong>t Stat</strong></td>
<td>2.870221855</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) one-tail</td>
<td>0.003089381</td>
<td></td>
</tr>
<tr>
<td>t Critical one-tail</td>
<td>1.678660414</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
<td>0.006178761*</td>
<td></td>
</tr>
<tr>
<td>t Critical two-tail</td>
<td>2.012895599</td>
<td></td>
</tr>
</tbody>
</table>

Table 2 T-test for Housing affordability of ABL and suburban homeowners.
Finding the Relationships

GIS and variations of multiple regression are used in order to evaluate which demographic factors have the strongest or most impactful relationship with housing affordability for the two scales and housing tenure types. Through GIS mapping several relationships can be proposed between the demographic factors and housing affordability. Figure 8 shows a comparison between the APIHC value for renters at the ABL scale and percent of population that has attained a bachelor’s degree of higher. By looking at the two maps it is evident that some sort of relationship exists between renters and the level of education attained for the ABL region.

Figure 8 Comparing demographics and housing affordability. The eastern and northern portions of the ABL have lower APIHC values and higher percentage of the population has attained at a minimum a bachelor’s degree when compared to the southwestern
portion of the ABL which displays a lower APIHC value and a fewer percent of the population has attained at the minimum a bachelor’s degree. A variety of assumptions and opinions can be made through visual interpretation of mapping the relationships between housing affordability and demographics. The results of the maps did indicate that as individuals attain a higher degree of education they will live more affordable life styles. However, these maps lack the ability to uncover any underlying relationships as well as quantify the strengths of the relationships between housing affordability and demographics. UMRT, AMRT, and SMRT are used to identify and quantify the relationships for the four cases previous mention. Each case has a different groups APIHC being tested against the same eight independent variables. Each case was subjected to the three variations of multiple regression producing a variation of outcomes. It must be noted that for Case 4 one of the samples was removed. This sample was a census tract that contained zero homeowners as seen in the satellite image in Figure 9 and was deemed an effective outlier.

![Figure 9 Omitted census tract for Case 4 analysis containing no homeowners.](image)

Table 3 and Table 4 show descriptive statistics of the dependent variables and independent variables for the ABL and AMA suburbs respectively. The difference in averages for the
demographics are significant between the two scales. The suburban scale had a higher average in each demographic category with the exception of education and number of earners in household. Also the suburban scale had lower APIHC averages for both renters and homeowners when compared to the ABL scale.

**Descriptive Statistics For The ABL**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>APIHC Renters</td>
<td>41.05</td>
<td>7.90</td>
<td>39</td>
</tr>
<tr>
<td>APIHC Homeowners</td>
<td>26.79</td>
<td>5.41</td>
<td>39</td>
</tr>
<tr>
<td>Percent White</td>
<td>43.74</td>
<td>32.26</td>
<td>39</td>
</tr>
<tr>
<td>Percent Of Individuals With A Bachelor’s Degree And Above</td>
<td>47.42</td>
<td>26.72</td>
<td>39</td>
</tr>
<tr>
<td>Percent Employed</td>
<td>89.29</td>
<td>8.88</td>
<td>39</td>
</tr>
<tr>
<td>Percent Of Households With One Earner</td>
<td>49.28</td>
<td>9.33</td>
<td>39</td>
</tr>
<tr>
<td>Percent Of Households With Three Or More Occupants</td>
<td>22.68</td>
<td>12.29</td>
<td>39</td>
</tr>
<tr>
<td>Percent Of Households Married</td>
<td>24.96</td>
<td>10.90</td>
<td>39</td>
</tr>
<tr>
<td>Median Age (Years)</td>
<td>34.12</td>
<td>4.33</td>
<td>39</td>
</tr>
<tr>
<td>Median Income (Dollars)</td>
<td>53525.44</td>
<td>27691.24</td>
<td>39</td>
</tr>
</tbody>
</table>

Table 3 Descriptive statistics for the ABL
### Descriptive Statistics For The AMA Suburbs

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>APIHC Renters</td>
<td>37.89</td>
<td>6.72</td>
<td>208</td>
</tr>
<tr>
<td>APIHC Homeowners</td>
<td>24.30</td>
<td>3.49</td>
<td>207</td>
</tr>
<tr>
<td>Percent White</td>
<td>63.14</td>
<td>18.33</td>
<td>208</td>
</tr>
<tr>
<td>Percent Of Individuals With A Bachelor’s Degree And Above</td>
<td>44.47</td>
<td>18.13</td>
<td>208</td>
</tr>
<tr>
<td>Percent Employed</td>
<td>93.47</td>
<td>2.77</td>
<td>208</td>
</tr>
<tr>
<td>Percent Of Households With One Earner</td>
<td>43.80</td>
<td>8.35</td>
<td>208</td>
</tr>
<tr>
<td>Percent Of Households With Three Or More Occupants</td>
<td>43.86</td>
<td>12.02</td>
<td>208</td>
</tr>
<tr>
<td>Percent Of Households Married</td>
<td>51.44</td>
<td>12.77</td>
<td>208</td>
</tr>
<tr>
<td>Median Age (Years)</td>
<td>36.65</td>
<td>5.58</td>
<td>208</td>
</tr>
<tr>
<td>Median Income (Dollars)</td>
<td>75948.33</td>
<td>31631.41</td>
<td>208</td>
</tr>
</tbody>
</table>

Table 4 Descriptive statistics for the AMA suburbs

---

**Case 1**

For Case 1, ABL renters, both AMRT and SMRT could be validated and their results considered dependable. UMRT encountered a violation by showing multicollinearity between race and education. This can most likely be attributed to the small sample size for the ABL scale. With the violation Case 1 did produce two strong predictors in income and number of household earners, however, these results were determined to be unreliable. When conducting AMRT, in Case 1 there were seven strong linear relationships (six negative and 1 positive) between the dependent variable
and independent variables. Only age showed no relationship with the APIHC of ABL renters. Of the seven linear relationships only household size showed a positive relationship while the rest were negative relationships. Multiple regression was performed with these seven independent variables. Results showed multicollinearity between race and education attainment. The multiple regression model was run twice more, each with either race or education attainment variables removed from the model, and neither contributed to a significantly reduced R-squared value. A decision was made to remove the race variable from further multiple regression testing for Case 1. No other violations (heteroscedasticity, outliers, etc.) occurred in the AMRT for Case 1. Both the variables number of household earners and median income were significant predictors. Standardized coefficients (Betas) were observed since both predictors used a different unit of measurement (percent and dollars). A significant regression equation was found (F (6, 32) = 28.686, p < 0.00), with an R-squared of .843. A renting household at the ABL has a predicted APIHC equal to 54.453 -.618 (income) -.260 (household earners) where both income and household earners are measured in standardized coefficients since they are separate measurements. APIHC for ABL renters decreased .260 standard deviations (SD) for each SD increase in percent of households with one earner. APIHC for ABL renters decreased .618 SDs for each SD increase of median income in dollars. This model explains 84% of the change in APIHC for ABL renters. This model is convincing where statistically significant coefficients continue to represent the mean change in APIHC for ABL renters given one standard deviation shift in household median income and households with one earner. These results can be seen in Table 5 and 6. The third multiple regression method, SMRT, will eliminate bias that might have occurred when removing variables in AMRT that were considered to be unimportant by removing variables based on their statistical contribution in explaining the variance in the dependent variable APIHC. When conducting SMRT for Case 1 a model containing earners, income, and household size was produced that was most effective at predicting the APIHC for ABL renters. The best model produced an R-squared of .842 in Table 7, which is almost identical to the AMRT R-squared value. The duplicated significant
predictors in SMRT had the same negative relationship with the dependent variable. The third variable, household size, that was introduced in SMRT, and not present in AMRT, had a positive relationship with the dependent variable. Case 1 will ultimately produce the strongest and most reliable findings.
### Table 5 AMRT Case 1

#### Model Summary$^b$

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>R Square Change</th>
<th>F Change</th>
<th>df1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.918$^a$</td>
<td>.843</td>
<td>.814</td>
<td>3.41</td>
<td>.843</td>
<td>28.686</td>
<td>6</td>
</tr>
</tbody>
</table>

#### Model Summary$^b$

<table>
<thead>
<tr>
<th>Change Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

### ANOVA$^a$

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Regression</td>
<td>2001.488</td>
<td>6</td>
<td>333.581</td>
<td>28.686</td>
<td>.000$^b$</td>
</tr>
<tr>
<td>Residual</td>
<td>372.125</td>
<td>32</td>
<td>11.629</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2373.613</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes:

- a. Predictors: (Constant), Number Of Earners In Household, Household Size, Employment Status, Marital Status, Education Attainment, Median Income
- b. Dependent Variable: APIHC Renters
- $^a$ Dependent Variable: APIHC Renters
- $^b$ Predictors: (Constant), Number Of Earners In Household, Household Size, Employment Status, Marital Status, Education Attainment, Median Income

---

Table 5 AMRT Case 1
Table 6 AMRT Case 1 continued

<table>
<thead>
<tr>
<th>Model</th>
<th>Coefficientsa</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>54.453</td>
<td>9.754</td>
<td>5.582</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Percent Employed</td>
<td>.048</td>
<td>.122</td>
<td>.054</td>
<td>.397</td>
</tr>
<tr>
<td></td>
<td>Percent Of Households With One Earner</td>
<td>-.220</td>
<td>.077</td>
<td>-.260</td>
<td>-2.866</td>
</tr>
<tr>
<td></td>
<td>Percent Of Households With Three Or More Occupants</td>
<td>.158</td>
<td>.087</td>
<td>.246</td>
<td>1.817</td>
</tr>
<tr>
<td></td>
<td>Percent Of Households Married</td>
<td>-.013</td>
<td>.141</td>
<td>-.017</td>
<td>-.090</td>
</tr>
<tr>
<td></td>
<td>Median Income (Dollars)</td>
<td>.000</td>
<td>.000</td>
<td>-.618</td>
<td>-3.485</td>
</tr>
<tr>
<td></td>
<td>Percent Of Individuals With A Bachelor’s Degree And Above</td>
<td>-.015</td>
<td>.065</td>
<td>-.050</td>
<td>-.228</td>
</tr>
</tbody>
</table>

a. Dependent Variable: APIHC Renters ABL

Table 6 AMRT Case 1 cont.
### Table 7 Case 1 SMRT Model Summary<sup>f</sup>

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Change Statistics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R Square Change</td>
<td>F Change</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Change</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>.832&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.693</td>
<td>.685</td>
<td>4.44</td>
<td>.693</td>
<td>83.54</td>
</tr>
<tr>
<td>2</td>
<td>.867&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.752</td>
<td>.738</td>
<td>4.04</td>
<td>.059</td>
<td>8.55</td>
</tr>
<tr>
<td>3</td>
<td>.902&lt;sup&gt;c&lt;/sup&gt;</td>
<td>.813</td>
<td>.797</td>
<td>3.56</td>
<td>.061</td>
<td>11.53</td>
</tr>
<tr>
<td>4</td>
<td>.894&lt;sup&gt;d&lt;/sup&gt;</td>
<td>.800</td>
<td>.789</td>
<td>3.64</td>
<td>-.014</td>
<td>2.58</td>
</tr>
<tr>
<td>5</td>
<td>.918&lt;sup&gt;e&lt;/sup&gt;</td>
<td>.842</td>
<td>.829</td>
<td>3.27</td>
<td>.043</td>
<td>9.46</td>
</tr>
</tbody>
</table>

<sup>a</sup> Predictors: (Constant), Education Attainment

<sup>b</sup> Predictors: (Constant), Education Attainment, Number of Earners in Household

<sup>c</sup> Predictors: (Constant), Education Attainment, Number of Earners in Household, Median Income

<sup>d</sup> Predictors: (Constant), Number of Earners in Household, Median Income

<sup>e</sup> Predictors: (Constant), Number of Earners in Household, Median Income, Household Size

<sup>f</sup> Dependent Variable: APIHC Renters ABL

Table 7 SMRT Case 1

---

**Case 2**

Similar to Case 1, Case 2 (ABL homeowners) could not be validated with UMRT and validated with AMRT and SMRT. Case 2 showed the same violation of multicollinearity with race and education but produced no significant predictors with this failed model. AMRT for Case 2 produced far fewer and weaker linear relationships between the independent and dependent variable. Case 2 showed weak negative relationships between the APIHC of ABL homeowners and marital status, age, and median income. There were no instances of multicollinearity or
heteroscedasticity for the variables. The multiple regression model showed no significant predictors and an R-squared of .183. Case 2’s best SMRT model showed income as the most effective at predicting the APIHC for ABL homeowners and an R-squared of .123 as seen in Table 8. The combination of an invalid UMRT, an AMRT with no significant predictors, and a SMRT whose best model produced one significant predictor and the lowest R-squared, a statement can be made that Case 2 provided the most undependable and unpredictable results in this study.

Table 8 SMRT Case 2 Model Summary\(^b\)

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>R Square Change</th>
<th>F Change</th>
<th>df1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.350(^a)</td>
<td>.123</td>
<td>.099</td>
<td>5.13</td>
<td>.123</td>
<td>5.17</td>
<td>1</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Median Income

b. Dependent Variable: APIHC Homeowners ABL

Table 8 SMRT Case 2

Case 3

Unlike Cases’ 1 and 2, Case 3 (suburban renters) produced valid models for each of the three multiple regression methods. For UMRT with Case 3, age showed a significant relationship with APIHC suburban renters. A low R-squared of .180 meant that that any change in age had very little correlation with change in APIHC for suburban renters. AMRT for Case 3 showed a weak negative linear relationships between the APIHC of suburban renters and income, education attainment, marital status, and employment status. There were no recorded instances of heteroscedasticity or multicollinearity for the variables. Education attainment was the only significant predictor for Case 3. A significant regression was found (F (4, 203) = 8.956, p < .000),
with an R-squared of .150 can be seen in Table 9 and 10. APIHC for suburban renters decreased .129 percent for every percent increase in the population that has attained a bachelor’s degree and above. Case 3’s best SMRT model showed education attainment again as the most effective at predicting the APIHC for suburban renters but with a slightly smaller R-squared value of .145 as seen in Table 11.
Table 9 AMRT Case 3

Model Summary\textsuperscript{b}

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>R Square Change</th>
<th>F Change</th>
<th>df\textsuperscript{1}</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.387\textsuperscript{a}</td>
<td>.150</td>
<td>.133</td>
<td>6.26</td>
<td>.150</td>
<td>8.96</td>
<td>4</td>
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</tbody>
</table>

Change Statistics

<table>
<thead>
<tr>
<th>Model</th>
<th>df\textsuperscript{2}</th>
<th>Sig. F Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>203</td>
<td>.000</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Predictors: (Constant), Employment Status, Marital Status, Education Attainment, Median Income

\textsuperscript{b} Dependent Variable: APIHC Renters Suburbs

ANOVA\textsuperscript{a}

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Regression</td>
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<td>350.93</td>
<td>8.96</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>7954.54</td>
<td>203</td>
<td>39.19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>9358.25</td>
<td>207</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a} Dependent Variable: APIHC Renters Suburbs

\textsuperscript{b} Predictors: (Constant), Employment Status, Marital Status, Education Attainment, Median Income
Table 10 AMRT Case 3 continued

**Coefficients**

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>Std. Error</th>
<th>Beta</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>62.558</td>
<td>16.467</td>
<td></td>
<td>3.799</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Median Income (Dollars)</td>
<td>-2.190E-7</td>
<td>.000</td>
<td>-.001</td>
<td>-.007</td>
<td>.994</td>
</tr>
<tr>
<td></td>
<td>Percent Of Individuals With A Bachelor’s Degree And Above</td>
<td>-.129</td>
<td>.041</td>
<td>-.348</td>
<td>-3.134</td>
<td>.002</td>
</tr>
<tr>
<td></td>
<td>Percent Of Households Married</td>
<td>.011</td>
<td>.057</td>
<td>.020</td>
<td>.186</td>
<td>.853</td>
</tr>
<tr>
<td></td>
<td>Percent Employed</td>
<td>-.208</td>
<td>.184</td>
<td>-.086</td>
<td>-1.130</td>
<td>.260</td>
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</tbody>
</table>

a. Dependent Variable: APIHC Renters Suburbs

Table 10 AMRT Case 3 cont.

Table 11 SMRT Case 3 Model Summary

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>R Square Change</th>
<th>F Change</th>
<th>df1</th>
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<td>.145</td>
<td>34.82</td>
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</tbody>
</table>

a. Predictors: (Constant), Education Attainment

b. Dependent Variable: APIHC Renters Suburbs

Table 11 SMRT Case 3
Case 4

Case 4 (suburban homeowners) also produced valid models for each of the three multiple regression methods. For UMRT with Case 4, both age and household size showed to be a strong indicator. However an R-squared of .201 showed that age and household size explained very little of the variability in APIHC for suburban homeowners. AMRT for Case 4 showed a weak negative linear relationships between the APIHC of suburban homeowners and the two demographics income and education attainment. However this case tested positive with heteroscedasticity by viewing a scatter plot of the residuals and implementing a Glejser test. Multiple attempts were made to transform the data in order to resolve the heteroscedasticity. All attempts failed and AMRT results for Case 4 were considered invalid. Case 4’s best SMRT model showed education attainment and race as the most effective at predicting the APIHC for suburban homeowners as seen in Table 12. Yet another low R-squared value of .172 meant that these significant predictors show imprecise predictions for APIHC of suburban homeowners.

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>R Square Change</th>
<th>F Change</th>
<th>df1</th>
</tr>
</thead>
<tbody>
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<td>.152</td>
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<td>.156</td>
<td>37.86</td>
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<td>2</td>
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<td>.172</td>
<td>.164</td>
<td>3.19</td>
<td>.016</td>
<td>3.91</td>
<td>1</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Education Attainment  
b. Predictors: (Constant), Education Attainment, Race  
c. Dependent Variable: APIHC Homeowners Suburbs

Table 12 SMRT Case 4 Model Summary  
Table 12 SMRT Case 4
CHAPTER 5

DISCUSSION

Average APIHC

When looking at the overall averages for percent of income used to cover monthly housing cost, ABL renters had the highest average of the four categories at 41.1% making them the least affordable category. The next highest is suburban renters at 37.9% of their income on average needed to cover monthly housing cost. Pre-existing literature and studies provide practical explanations as to why these results occurred in this study. Immergluck et al. [10] point out that the City of Atlanta has no rent control because it is prohibited under state law in Georgia. This means there is no limit on the amount that a landlord can demand for leasing a home or renewing a lease. This appears to be impacting the level of affordability for renters at both scales in this study where the APIHC for renters is 39.47% and the APIHC for homeowners in this study is 25.49%. Also contributing to this explanation is a separate study by Immergluck [12] that addresses the increases in leases and property values around the ABL planned route in the mid-2000s. Immergluck [12] stated that the mass speculation and anticipation of the ABL project drove up the cost of living and impact renters more so than homeowners.

Weakest Cases

The statistical results involving housing affordability’s relationship with demographics for each case can be divided into two discussions. Population’s living in the study area for the suburban scale and ABL homeowner’s (Cases’ 2, 3, and 4) produced far less significant results and findings when compared to the population of renters living in the study area for the ABL scale (Case 1). Between the three multiple regression methods for Cases’ 2, 3, and 4 that could be
validated, an average R-squared value of .162 was produced and five variables were proven significant. This means that the five significant predictors being age, household size, income, education attainment, and race for their respectable cases are correlated with APIHC but explain very little of the variability in APIHC and provide an imprecise prediction. This can be attributed to the fact that some of the regressors and each of the regressands revolve around human behavior which can be very unpredictable. Unpredictable in a sense that the lifestyle for households in the AMA will vary based on a multitude of factors. Factors not like race and age, which are predictable for subjects in a household, but factors such as decisions made by the subjects which can impact their level of income, level of education, size of household, status of employment among many others. For example, a household may be complicit with paying a substantially large portion of their income to cover monthly housing costs, thus classifying them to be living an unaffordable lifestyle, because the home is located in a safe neighborhood. A separate household may have a different set of values when it comes to shelter and would rather spend their earnings elsewhere. Regardless the results for Cases’ 2, 3, and 4 should not be ignored. The most effective measure to take in order to provide an understanding could be to target these significant predictors in a new study with a new method of data attainment. First hand survey data could provide a more reliable outcome when it comes to dealing with variables that involve human life choices such as occupation or when and who to marry.

**Strongest Case**

For the population of renters living around the ABL (Case 1), a stronger and more compelling discussion can be made regarding their status of affordability. The valid multiple regression models for Case 1 are almost identical with the exception of an added significant predictor in the SMRT best model. AMRT showed income and number of household earners as the significant predictors while SMRT showed the same two significant predictors with the
addition of household size. The standardized coefficients for income saw a 1.9% change and a p-value change of less than a hundredth of a percent between the two models. For number of household earners there was a 5% change in the standardized coefficients and a four hundredth of a percent change in the p-value between each model. The R-squared values were also almost completely identical with AMRT producing an R-squared of .843 and SMRT producing an R-squared of .842. So across the board both multiple regression models were consistent with their outcomes. The high average R-squared value for Case 1 can reliably indicate that changes in demographics with the significant predictors being median income, number of households with one earner, and households with three or more occupants correlate with shifts in the average percent of income used to pay for monthly housing costs. In the similar study by Bujang et al. [6], a bivariate correlation model showed that income and household size had a relationship with housing along with education and marital status. However the increase in household size had the opposite results where the level of affordability increased for larger households in Johor Bahru, Malaysia. Renter households near the ABL showed a decrease in affordability when there was an increase in households with three or more occupants. Bujang et al. [6] support this finding by claiming that more occupants lead to more earners thus more income to cover housing costs. For ABL renters, the case where larger households tend to lead to less affordability can also be true. For renters especially, living quarters are usually multi-housing complexes, which have a tendency to be meant to support smaller households. Larger households living in this format are usually comprised of impoverished individuals where an impoverished individual can be defined as someone with a low level of income, unemployed or low-level job status, and low level of education attainment. There are to reasonable explanations for the differences in how household size was related to housing affordability for these similar studies. One explanation is the study area for the research. The samples in Bujang et al.’s [6] study are from Johor Bahru, Malaysia, an area and culture significantly different than that of the inner Atlanta region. Another explanation is the characteristics of the data being tested. For this study, Case 1’s findings only represented renters
living near the ABL in inner Atlanta. On the other hand, the Malaysian study represented individuals of all housing types and type of housing tenure was not factored into the data.

Limitations

The major limitation in this study revolves around the scale of data used. Census tract data, especially at the ABL scale, resulted in a small sample size to be used for statistical analysis. This has the potential to affect the outcome of the results. Green suggests that a minimum sample size of 50 + 8k, where k is the number of predictors, is needed for regression [43]. In this study 39 census tracts or cases represented the ABL data which is far short of the suggested minimum sample size of 114 according to Green’s study. One way to address this problem is to find data at a finer scale. Block and block group data are more likely produce more dependable results but these data types are very limited when it comes to demographic categories. For example, housing affordability data and data for certain specific demographics were not collected by the U.S. Census Bureau below the census tract level. Conducting a survey seems to be the only viable way to collect this type of data at such a fine scale. Either that or the data would need to be purchased by a vendor. Another limitation to take into consideration is the method used in this study to select the demographics that are used for testing. Some previous studies, as well as this study, simply use judgment when selecting demographics or independent variables to be tested. There are other studies that use principle component analysis when it comes to selecting independent variables. This aids in providing the best set of uncorrelated variables for a study.

Contributing to Future Studies

This study and its results will contribute effectively to new topics of exploration on the ABL. This study has provided the frame work to investigate the ABL at a finer scale where new
parameters can be set, and different independent variables be tested. This study tells us what housing affordability around the ABL is like in its entirety. The next valuable step is to separate the ABL into sections and explore the differences between them such as completed and incomplete portions of the trail or by designated subareas. Findings could show the area within the vicinity of the ABL to be more diverse in the levels of affordability and demographics than predicted. Another interesting angle of research is the use of a different set of independent variables or incorporate a new set of independent variables into a multivariate multiple regression model. ABL amenities, that have measurable impacts, could be an example that represents the new set of independent variables to be tested for a relationship with housing affordability. Amenities such as parks, trail access points, cityscapes (ABL version of cultural districts), streetcar stations, etc., are all likely to influence housing in some fashion.
CHAPTER 6

CONCLUSION

The value of this study showed what kind of relationship there is between housing affordability and demographics for the AMA population. The results clearly show that the APIHC for ABL renters are more influenced by demographics than the APIHC for ABL homeowners population and the population living in AMA suburbs. Multiple regression models for this case (Case 1) that could be validated, meaning no violations were committed in the process, had an average R-squared of .8425 and multiple significant predictors. For the ABL renters case, median income, household size and number of earners in household returned significant predictors of APIHC. Median income and number of earners in household were significant in both the AMRT model and SMRT’s best model. The standardized coefficients for median income and number of earners in household were negative. This explains that as median income mean or the number of earners in household mean decreases, the APIHC for ABL renters increases. Also since household size has a positive standardized coefficient we can justify that as the household size mean increases the APIHC for ABL renters increases. To put this in the context of affordability, decreases in a household’s median income and the number of households with one earner for ABL renters shows a decrease in their affordability status and will drive their status to unaffordable if not already at that level. Increases in the number of households with three or more occupants decreased the status of affordability and therefore contributed to a household lifestyle becoming or remaining unaffordable. When summarizing Case 1’s results they logically make since if you look at it from a perspective that most ABL (inner city) renters are living in some sort of multiple housing complex. Large household sizes living in small quarters can serve as an indicator for an impoverished household which can be a result of low median income for the individual(s) or low number of earners in the household. With Case 1’s multiple regression model(s) explaining a lot of variation within the data and is significant, it can be concluded that the power to live an affordable
lifestyle for renters near the ABL is influenced by median income, number of earners in household, and the size of the household.
REFERENCES


https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_5YR_B11016&prodType=table

[40] U.S. Census Bureau (2016). Household size by number of workers in household, 2012-2016 American Community Survey 5-year estimates. Retrieved from
https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_5YR_B08202&prodType=table

https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_5YR_DP02&prodType=table

https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_5YR_DP05&prodType=table

APPENDIX A

MAPS OF DEMOGRAPHICS FOR ABL AND SUBURBS
Individual Median Age
Scale: Atlanta BeltLine Census Tracts
Year: 2016

Legend

Atlanta BeltLine Corridor

Years

24 - 29
30 - 33
34 - 35
36 - 38
39 - 44

0 0.75 1.5 3 Miles

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Percent Of Population With A Bachelor's Degree And Above
Scale: Atlanta BeltLine Census Tracts
Year: 2016

Legend

Atlanta BeltLine Corridor
Percent
8.30 - 16.50
16.51 - 27.70
27.71 - 50.30
50.31 - 65.80
65.81 - 87.00
Percent Of Population Employed
Scale: Atlanta BeltLine Census Tracts
Year: 2016

Legend

Atlanta BeltLine Corridor
Percent
67.79 - 75.89
75.90 - 86.22
86.23 - 91.34
91.35 - 97.26
97.27 - 99.94
Percent Of Households With One Earner
Scale: Atlanta BeltLine Census Tracts
Year: 2016

Legend

Atlanta BeltLine Corridor
Percent
- 33.63 - 36.78
- 36.79 - 43.40
- 43.41 - 48.39
- 48.40 - 58.28
- 58.29 - 70.04
Percent Of Households With Three Or More Occupants
Scale: Atlanta BeltLine Census Tracts
Year: 2016

Legend

Atlanta BeltLine Corridor
Percent
5.80 - 9.80
9.81 - 18.50
18.51 - 27.70
27.71 - 36.10
36.11 - 57.30
Percent Of Population Married
Scale: Atlanta BeltLine Census Tracts
Year: 2016

Legend

<table>
<thead>
<tr>
<th>Percent</th>
<th>Description</th>
</tr>
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<tbody>
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<tr>
<td>12.91 - 21.00</td>
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<tr>
<td>21.01 - 32.00</td>
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<td>32.01 - 44.00</td>
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<tr>
<td>44.01 - 60.80</td>
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</tbody>
</table>
Percent Of Population White
Scale: Atlanta BeltLine Census Tracts
Year: 2016

Legend

Atlanta BeltLine Corridor

Percent

- 0.60 - 6.70
- 6.71 - 27.80
- 27.81 - 51.40
- 51.41 - 72.30
- 72.31 - 90.50

0 0.75 1.5 3 Miles

Eri, HERE, Garmin © OpenStreetMap contributors and the GIS user community
Individual Median Age
Scale: Atlanta Suburbs Census Tracts
Year: 2016

Legend

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<thead>
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<td>45 - 51</td>
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</tbody>
</table>

Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community
Percent Of Households With One Earner
Scale: Atlanta Suburbs Census Tracts
Year: 2016

Legend
Percent
- 26.35 - 33.79
- 33.80 - 40.11
- 40.12 - 45.90
- 45.91 - 54.03
- 54.04 - 66.54
Percent Of Population With A Bachelor's Degree And Above
Scale: Atlanta Suburbs Census Tracts
Year: 2016

Legend
Percent
7.60 - 26.20
26.21 - 40.20
40.21 - 51.60
51.61 - 63.40
63.41 - 84.80

0 5 10 20 Miles
Percent Of Households With Three or More Occupants
Scale: Atlanta Suburbs Census Tracts
Year: 2016
Household Median Income
Scale: Atlanta Suburbs Census Tracts
Year: 2016
Percent Of Population Married
Scale: Atlanta Suburbs Census Tracts
Year: 2016
Percent Of Population White
Scale: Atlanta Suburbs Census Tracts
Year: 2016

Legend
Percent
- 21.80 - 39.60
- 39.61 - 53.00
- 53.01 - 66.20
- 66.21 - 79.50
- 79.51 - 95.90

0 5 10 20 Miles

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