# ANALYZING MEASUREMENTS OF HOUSING AFFORDABILITY

Zi Cai

A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Urban Planning

University of Washington

2017

Committee:

Himanshu Grover (Chair)

Sofia Dermisi

Program Authorized to Offer Degree

Urban Design and Planning

University of Washington

## Abstract

# Analyzing Measurements of Housing Affordability

Zi Cai

Chair of the Supervisory Committee:
Himanshu Grover, Assistant Professor
Urban Design and Planning

Measuring housing affordability is a key challenge for most communities. Traditionally, the 30 percent rent-income ratio has been the cornerstone of housing affordability policies. Recently, however, a number of researchers have recommended new affordability measures. Given the complexity of determining realistic housing affordability, identifying the best and most appropriate measure is a challenge. This thesis is the first research attempt to develop a comprehensive methodological framework for the comparative assessment of commonly used housing affordability indicators. Six housing affordability measures were selected for analysis: NAR Housing Affordability Index, HUD Guideline, Amenity-Based Housing Affordability Index, H+T Affordability Index, Shelter Poverty Measure, and Self-Sufficiency Standard. These measures were compared in terms of their underlying standards, data accuracy, and comprehensiveness. Specific indicators for each of the three components were developed and applied to the six housing affordability indicators. Detailed analysis of the collected data revealed that the Self-Sufficiency Standard measure is the best measure of housing affordability among the six indicators analyzed. This measure outranks each of the other measures on all three dimensions of comparison. Therefore, it is recommended that local planners, stakeholders, and policymakers adopt the Self-Sufficiency Standard to assess housing affordability outcomes.

# Table of Contents

## List of Figures



## List of Tables

## ACKNOWLEDGEMENTS

I would like to thank my thesis committee members Himanshu Grover and Sofia Dermisi for their help.

In addition, I would like to thank Diana Canzoneri, my intern supervisor at City of Seattle, who inspired me on this topic. I would also like to thank Al Levine, who peaked my interests in this topic.

A big thanks to Jialing, who helped me a lot.

DEDICATION

TO MY FRIENDS

# I. Introduction

Housing affordability describes the relationship between housing and its users. It is a measure of a person's ability to afford to live in a given housing unit. A reliable and efficient measure of housing affordability is very important for local policymakers for a number of reasons. Firstly, an efficient measure of housing affordability is often used as the basis for allocating government funds for housing programs. Secondly, individuals can utilize this measure to make informed decisions about where to live. Third, the housing affordability measure can assist government agencies and non-profit organizations to develop realistic estimates, and thus utilize public funds more efficiently.

The most popular housing affordability definition in the U.S. comes from the Department of Housing and Urban Development (HUD): Families who pay more than 30 percent of their income for housing are considered cost burdened and may have difficulty affording necessities such as food, clothing, transportation and medical care ("Affordable Housing - CPD - HUD" 2017). This 30 percent figure is also called the rule of thumb for housing affordability. However, it is not a good housing affordability measure. Firstly, it ignores the different non-housing expenditures for different households earning the same income. Secondly, for households with different incomes, it assumes that they can afford all non-housing expenditures with 70 percent of their income. Thirdly, it does not take location influences on non-housing expenditures into account. (Bogdon and Can 1997, Stone 2006, Fisher, Pollakowski, and Zabel 2009)

A number of researchers have recognized the disadvantages of the 30 percent ratio and developed other measures for housing affordability (Stone 1993, "Affordable Housing - CPD - HUD" 2017, Pearce 2001, Fisher, Pollakowski, and Zabel 2009). Four the common measures include (write the name of the measures and cite the author). Because each of these measures are based on independent assumptions and utilize different data sources, they often do not provide consistent outcomes. While multiplicity of affordability measures is a useful tool for research, it represents a challenge in policy making. Decision makers need to objectively developed criterion to identify the best measure for policy making. However, currently are no

standards available to discern whether one housing affordability measure is better than another. This thesis aims to fill this gap in affordable housing metrics by developing a relative standard to compare commonly used housing affordability measures.

### 1.1 Definition of housing affordability

To understand the concept of housing affordability, it is best to start with the definition of affordability. Some of the definitions of affordability from major English dictionaries are presented below:

- The state of being cheap enough for people to be able to buy. (Cambridge)
- Ability to be afforded; inexpensiveness. (Oxford)
- Able to be afforded: having a cost that is not too high (Merriam-Webster)[1]

No matter how different these definitions appear, they all indicate that the concept of affordability has two elements: people and what they want to buy. It is essential that the affordability of a given item be correlated with the buying power of its users. Therefore, the two elements of housing affordability should be housing and its users. Thus, housing affordability describes the relationship between those two elements.

There are several ways to describe the relationship between housing units and people who live in them. For example, it can be a **relative concept** showing the housing affordability through history. A relative measurement can tell people whether housing in a given area is becoming more affordable. But it doesn't provide a benchmark that can tell people whether the housing is affordable or not (Jewkes and Delgadillo 2010).

Housing affordability can also be a **subjective concept** based on the classic assumption of Economic Man[2]. In this case, people choose to live in units they consider to be affordable, which means that all who have somewhere to live are living in an "affordable" unit. This ends

[1] There is no definition for affordability in the Merriam-Webster dictionary. The definition is for the word "affordable", and affordability is presented as the noun form of affordable.
[2] A hypothetical person who behaves in exact accordance with their rational self-interest.

most of the discussion on housing affordability and will not advance any policy-related debates very far (Stone 2006).

The **income-ratio approach** is the most popular way to describe housing affordability. It assumes that no matter their income, people always devote a certain portion of their income to housing-related expenses. By using this approach, researchers are able to set a benchmark for housing affordability based on empirical data analysis (Feins and Lane 1981).

The **family budget approach** aims to determine whether a household's income can support all basic expenses, both housing and non-housing. This approach usually uses the Fair Market Rent as the standard of housing expenses in its calculation. Thus, in most cases, the basic income generated by this approach is higher than the amount a household actually needs for basic necessities (Stone 2006).

The **residual income approach** identifies whether the family's income can cover all the non-housing expenses after paying their housing expenses. Like the family budget approach, the residual income approach's benchmark is also based on "enough or not" with different focuses (Stone 1993).

## 1.2 Issues with the rule of thumb

### 1.2.1 External validity

Engel's Economic Law[3] is the foundation of the rule of thumb. Engel's research showed that the proportion of income that families spend on housing (lodging and fuel) is a fixed ratio no matter the income. However, his research was based on a survey of Belgian working-class families (Stigler 1954). It is obvious that his research had external validity problems, because the spending habits of working-class families cannot represent the whole society. Below is the figure showing the evolution of the rule of thumb in the U.S. As shown, the story has two major parts: public rental housing programs and homeownership mortgage lending.

[3] See details in literature review.

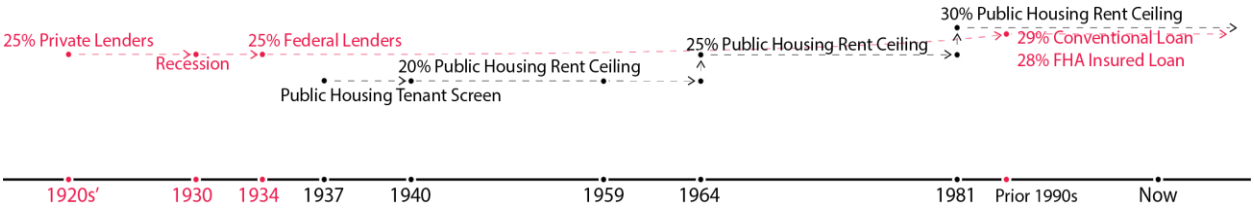


*Figure 1. Rule of thumb*

From 1937 to 1940, the public housing program relied on income limits instead of maximum rents; that is, the income of tenants could not exceed five to six times the rent. In 1940, income limits gave way to a maximum rent standard: rent could not exceed 20 percent of income. This worked in the same way as a tenant screening process because rent was determined by operation and maintenance costs. The program was designed to serve the lowest income group. However, it failed due to escalating operation and maintenance costs when the program was funded in its original way. To compensate, the 1969 Brooke Amendment tied public housing rent to tenant income. Tenants were asked to pay no more than 25 percent of their income. At that time, the 25 percent figure was the rule of thumb used by various federal and private financial institutions. It can be traced back in history to two national household expenditure studies conducted by researchers like Kenngott from the 1910s to the 1920s and by BLS before 1930.

The Omnibus Budget Reconciliation Act of 1981 raised the rent cap of public housing to 30 percent. This act assumed that increased rent would decrease the need for operating subsidies. Since this act aimed to limit increases in funding for operating subsidies, the 30 percent figure, unlike the previous 25 percent figure, is not based on housing affordability studies (Stoloff 2004).

Homeownership mortgage lending, as the other part of the story, embedded the rule of thumb years before the public sector. When the 25 percent figure became “common sense,” backed by data available in the 1920s, lenders began to create new underwriting criteria based on it. After the recession in 1930, FHA loan underwriters kept using the 25 percent figure (Feins and Lane 1981). And as mentioned in the previous section, in the early 1990s (when 30 percent had become the rule of thumb in public rental housing programs), lenders from Freddie Mac

and Fannie Mae used a figure of 28 percent to underwrite conventional loans and 29 percent for FHA-insured loans. Unlike mission-driven public sector officials, lenders' primary job is to ensure that the money they lend out will be paid back in the future. Their underwriting criteria reveal their understanding of risks (Schwartz and Wilson 2008).

In conclusion, the rule of thumb is based on research hindered by external validity issues and federal budget adjustments.

### 1.2.2 Income variability

The rule of thumb assumes that a housing unit can be considered affordable if those who live there pay no more than a certain proportion of their income. In saying that a housing unit is affordable, it is implied that those who live there will still keep enough income to devote to expenses other than housing.

The problem with the rule of thumb is actually embedded in this assumption. Firstly, it is unfair to determine rent burden simply by using the rent-income ratio when comparing households at different income levels. For example, even if they spend more than 30 percent of their income on housing, a rich household can have more money left for non-housing expenditures than a low-income household paying less than 30 percent of their income on housing.

Secondly, even for people with the same income, the rent-income ratio fails to describe their rent burden accurately because people have different non-housing expenses. Imagine a single man and a single woman with a child who each have the same income and pay the same rent. The single woman has greater non-housing expenses than the single man for healthcare, education, food, and so on. Therefore, the single woman's rent burden should be higher than the single man. But according to the rule of thumb, their rent burden should be considered the same.

Furthermore, the rule of thumb doesn't take location factors into consideration. Housing units farther away from a metropolitan area are often cheaper than nearer units.

Location also matters for units in a metropolitan area with higher transportation costs. For low-income households, extra transportation costs can eat into their savings and leave them less money for other necessary non-housing expenditures. By using the rent-income ratio, one paying higher transportation costs can falsely be considered to have the same rent burden as one who lives in an area requiring lower transportation costs, as long as they pay the same portion of their income for housing.

In conclusion, the rule of thumb, which is based on the rent-income ratio approach, fails to accurately describe the condition of housing affordability.

## 1.3 Purpose of the study

### 1.3.1 A literature review on housing affordability measures

It is not only my own opinion that the rule of thumb functions poorly to describe housing affordability. Numerous researchers and institutes have critiqued this approach and established their own measurements based on their understandings of housing affordability. This research aims to list all major housing affordability measures in the field. This literature review provides a broad overview of how people think about housing affordability while revealing the limitations and challenges of measuring it.

### 1.3.2 A relative standard to identify whether one housing affordability measurement is better than another

While many researchers have established particular measures for housing affordability, it is hard to determine which one is better than the others. They all rely on different assumptions, data sources, and rationales. This research uses a relative standard to analyze selected housing affordability measures: that is, it is not a normative standard but is intended to determine whether one measurement is better than another one.

## 1.4 Research questions

This thesis aims to provide a relative standard to identify whether one housing affordability measure is better than another. This research question leads to three sub-

questions: 1) What are the various measures of housing affordability? 2) How should a comparative methodology to analyze these measures be developed? 3) Which measure is the best among them?

### 1.5 Limitations and assumptions

The analysis is primarily based on a literature review. Data used for this analysis was collected by reviewing the methodology documents of all selected housing affordability measures and their included datasets. Secondary data (rather than primary survey data) was used.

It is impossible to eliminate all subjective bias. The analysis criteria, based on my understanding of the literature reviewed, are limited by my own understanding of the literature as well as the literature itself.

The research focuses on the internal validity of a housing affordability measure. The external influence of these housing affordability measures will be generally discussed after the analysis, meaning it will not factor into the ranking criteria. For example, I do not analyze the ability of each selected measure to generate affordable housing. This is primarily because of the lack of applications of all selected housing affordability measures in real decision-making processes. As a result, this research does not label these housing affordability measures as "good" or "bad," but simply indicates whether one is better than another based on the criteria explained here.

# II. Literature review

In order to better understand housing affordability measures, this chapter reviews four bodies of literature: 1) the history of the 30 percent rule of thumb, 2) critiques of the rule of thumb, 3) contemporary housing affordability measures, and 4) index comparison methodologies. The first part provides a brief history of the 30 percent rule of thumb, which helps explain the historic root of the HUD measure and reveals its problems. The second part shows critiques from contemporary housing affordability researchers. The third part provides a list of contemporary housing affordability measures. The last part of this chapter reviews methodologies to compare indices and measurements.

## 2.1 History of the 30 percent rule of thumb

Based on the analysis of a survey of Belgian work-force families in 1857, the “economic law," proposed by Ernst Engel, a famous German statistician and economist, claimed that the percentage of income that households spend on housing (lodging and fuel) is a fixed ratio no matter the income. Herman Schwabe, in 1868, suggested that the relation between housing expenditures and income was not fixed. His research showed that “as total family income rises, the amount allocated to housing increases at a lower rate” (Feins and Lane 1981).

In the late 1880s, “A week’s wage for a month’s rent” became a well-known saying which precisely described the housing expenses of many people. Kenngott’s research of expenditures by laborers and mill operatives in Lowell, Massachusetts, revealed that 20 to 25 percent of these workers’ income was usually set aside for housing, which included rent, light, and fuel. Since people needed a convenient way to estimate housing expenditures, the 25 percent figure became the rule of thumb (Kenngott 1912).

The trace of the rule of thumb in public policies was first seen in 1940, when United States Department of Housing and Urban Development (HUD) authorized and funded the public housing program. At that time, rents for public housing units were set far below market rate, which allowed low-income households to live in more convenient locations rather than move far away from the city for lower rents. Tenants living in public housing units would pay no more

than 20 percent of their incomes. The 1959 American Housing Act maintained the maximum rent ceiling for public housing. 1969 is the benchmark when the rule of thumb was embedded in the public housing program. From 1940 to 1969, maintenance and operation costs had been escalating faster than the tenants' incomes. In order to continue serving low-income households, the Brooke Amendment (1969) set the maximum rent cap at 25 percent of family income and introduced federal rent subsidies into the program. And in 1981, it was raised to 30 percent due to limited funds and escalating maintenance and operation costs. The 30 percent figure remains the rent standard for most rental housing programs today (Schwartz and Wilson 2008).

The rule of thumb not only influenced rental housing, but also made its way to owner-occupied housing. In 1920, mortgage lenders began to use the rule of thumb to determine the maximum mortgage payment a household could afford in order to reduce mortgage defaults. At that time, the U.S. Bureau of Labor Statistics (BLS) conducted two nationwide studies of household expenditures that suggested that, although the proportion of income that people paid for housing varied at different income levels, people usually spent no more than 25 percent of their incomes on housing. Therefore, before 1930, lenders used the 25 percent figure for homebuyer loans (Feins and Lane 1981).

During the 1930s' economic recession, millions of people faced the loss of their homes and lenders faced heavy investment loss due to defaults and foreclosures. The Home Owner Loan Corporation (HOLC), established by the federal government in 1933, refinanced many threatened mortgages and alleviated the crisis. In 1934, the Federal Housing Administration, which was authorized by the National Housing Act, was set up to protect the financial system and revive the nation's economy. While underwriting loans, FHA underwriters also used the 25 percent ratio to avoid default (Carliner 1998). In the 1990s, Fannie Mae and Freddie Mac would not purchase loans if the payment (including principle, interest, taxes, and insurance, a.k.a. PITI) exceeded 28 percent of the borrower's income for a conventional loan, or 29 percent for an FHA-insured loan (Schwartz and Wilson 2008).

In the late 1990s, many households chose to devote a greater proportion of their income to larger houses, even if the payment exceeded 30 percent of their income. These households typically still had enough income left for other needs. In these cases, for these households, spending more than 30 percent of income for housing cannot be regarded as a housing affordability issue but rather a lifestyle choice. However, for low-income households, the 30 percent figure is still widely used as a housing affordability indicator (Schwartz 2014).

As a result, although the ratio has been changed over time, the rule of thumb for family housing expenditures was rooted deeply in the common wisdom and experience from the nineteenth century to now. It became a way for most families to choose housing and a standard for the maximum proportion of income in mortgage payments.

### 2.2 Critiques of the 30 percent rule of thumb

Nelson, Pendall, Dawkins, and Knapp argue that one of the problems of the rule of thumb is that it fails to determine whether a household spends more than 30 percent of their income on housing by necessity or by choice. They also mention other problems such as the definition of income and the definition of housing expenditure (Nelson, Pendall, Dawkins, and Knapp 2002).

In Fisher, Pollakowski, and Zabel's study on the Amenity Based Housing Affordability Index, they mention that the 30 percent ratio fails to measure the spatial opportunity set facing households: "Rent-burden measures all focus on the demand-side of the market without matching demand with the supply of appropriate housing units." They also remark that if we use the ratio of an area's median income to median house price to judge whether an area is affordable, we will be misled, because neither the distribution of housing units nor the distribution of marginal households is portrayed by that ratio (Fisher, Pollakowski, and Zabel 2009).

Bogdon and Can's study of indicators of local housing affordability reveals that the percentage of income as a measure of housing affordability does not take the quality change over time into consideration. They argue that some households may choose to dedicate a

substantial share (sometimes more than 30 percent) to live in a larger or high-quality unit, but they may have a housing affordability issue due to the percentage of income they spend on housing. And sometimes, a household may not be able to afford to live in a housing unit that costs 30 percent of their income while still retaining enough money to cover all their non-housing expenses.

Another problem is that the ratio of housing cost to income often includes transitory income rather than permanent income in the denominator. Bogdon and Can believe that it would be better to use permanent income in the denominator in order to reflect long-term housing affordability problems. There are also advantages of the percentage-of-income measure. It is firstly very easy to calculate because the data for this measure can be gathered from various sources. It can also be easily used to compare across regions and over time (Bogdon and Can 1997).

In Schwartz and Wilson's report on housing affordability in the U.S. using 2006 American Community Survey data, they found that for those who choose to spend a large share of their income on housing to live in a larger, more amenity-laden home, the 30 percent ratio is not an indicator of a true housing affordability problem but rather a lifestyle choice. For those households struggling at the bottom rungs of the income ladder, the use of the 30 percent income ratio is still as relevant today as it was 40 years ago (Schwartz and Wilson 2008).

Stone, Burke, and Ralston argue that even if the 30 percent ratio gives a correct standard for housing affordability, it fails to identify the interval of income that can be applied to this method. They also argue that a housing affordability standard should include a minimum amount of money needed by the household to meet minimum basic non-housing necessities (Stone, Burke, and Ralston 2011).

## 2.3 Contemporary measures of housing affordability

### 2.3.1 National Association for Realtors (NAR) - Housing Affordability Index

NAR's Housing Affordability Index is one of the most widely cited relative measures in the U.S. Using the most recent income and home price data, it calculates whether a typical family's income can qualify for a conventional loan to purchase a typical home on the national and regional level.

A typical family is defined as a family earning median income, according to the U.S. Census Bureau. A typical home means an existing median-priced single-family home calculated by NAR. The loan interest rate is determined by the effective rate of loans closed on existing homes from the Federal Housing Finance Board. NAR uses these three components to calculate the Housing Affordability Index, assuming a 20 percent down payment for the home. The qualification standard judges whether the monthly payment of the mortgage is no more than 25 percent of the typical family's income. A value of 100 means that a family earning the median income has exactly enough money to qualify for a typical home loan. Values lower than 100 indicate that the typical family does not have enough money to qualify for a loan to purchase a typical house. And a value larger than 100 implies that the typical family has more than enough money to qualify for a loan for a typical house.

The 25 percent threshold is based on HUD's 30 percent rent-income housing affordability standard. NAR adjusted the 30 percent figure down because the HUD ratio includes other housing expenses like utilities, insurances, and real estate taxes in addition to rent. NAR does not give a standard for housing affordability, but rather a relative comparison tool that can easily show housing affordability conditions as they vary over time and across regions ("Methodology" 2017).

### 2.3.2 HUD Guideline

The U.S. Department of Housing and Urban Development has its own guideline for housing affordability, stated as: "Families who pay more than 30 percent of their income for

housing are considered cost burdened and may have difficulty affording necessities such as food, clothing, transportation and medical care" ("Affordable Housing - CPD - HUD" 2017).

The HUD Guideline is an implementation of the rule of thumb for housing affordability. It is widely embedded in most housing policies and subsidy programs like the Section 8 Voucher program and the public housing program. The HUD Guideline is easy to compute and simple to comprehend. Many concepts are developed based on the HUD Guideline, including the housing cost-burden. According to HUD, a household paying more than 30 percent but less than 50 percent of its income on housing is considered housing cost-burdened. And a household paying no less than 50 percent of its income on housing is considered severely housing cost-burdened. This is also used as a tool to determine affordable rent for different income levels.

### 2.3.3 Self-Sufficiency Standard

The Self-Sufficiency Standard, developed by Dr. Diana Pearce at the University of Washington, measures the amount of income (without public or private subsidies) needed for a family of a given composition in a given space to meet all basic needs including housing, medical services, education, transportation, and so on.

The standard is based on a family budget approach to identify the "adequate basic needs" for a given family in a given place, without either combining or averaging the circumstances that families face. In fact, it takes into account many costs that differ by family size and composition. The standard also incorporates location factors, as well as taxes and tax credits, in costs (Pearce 2001).

Furthermore, the standard gives people advice to improve their income if their income is lower than needed for the Self-Sufficiency Standard. One argument against this standard relates to its possible implementation in solving the housing affordability problem. According to this argument, the standard is disadvantaged by focusing more on income than on housing.

Self-Sufficiency Standard calculators have been developed for most states throughout the U.S. They can help individuals develop and test their own strategies to achieve the Self-

Sufficiency Wage. These calculators can also be used as a counseling tool by career planners and other public agencies.

### 2.3.4 Shelter Poverty Measure

Stone developed the Shelter Poverty Measure for housing affordability, based on the residual income approach. This measures whether the income of a given family can meet basic non-housing necessities after paying for housing. Those who do not have enough income left for their non-housing expenditures will be considered to be in "shelter poverty."

Stone's implementation of Shelter Poverty in the U.K. did not find a significant difference in the number of people who were housing cost-burdened compared to the number of households who were cost-burdened based on the ratio approach. Rather, Stone found a different distribution of the housing cost burden. Some families paying more than 25 percent of their income were not experiencing shelter poverty, while some others paying less than 25 percent were considered to be in shelter poverty.

Unlike the Self-Sufficiency Standard, the Shelter Poverty measure focuses more on housing than income. Rather than measuring all expenses as a whole, it subtracts housing expenses from total income and measures the amount available for non-housing expenses (Stone 1993).

### 2.3.5 Amenity-Based Housing Affordability Index

Fisher, Pollakowski, and Zabel developed the Amenity-Based Housing Affordability Index. Their rationale is that a housing affordability index should take location factors into account because the goal of housing affordability policy should not only be to provide shelter, but also to supply units that are accessible to jobs, education, and other amenities. The affordability standard for this index is based on the HUD Guideline with an embedded location adjustment element. Thus, this index measures affordable housing stock in a given area for families within a given income range.

From their application of this index in the Boston Metropolitan Area for families earning 50 percent to 80 percent of Area Median Income (AMI), they found substantial shifts away from affordability in neighborhoods with poor safety, job accessibility, and schools. According to this index, housing considered unaffordable may be considered affordable after improvements to job accessibility, public transportation, and other amenities are made (Fisher, Pollakowski, and Zabel 2009).

### 2.3.6 H+T Index

The H+T Index provides a comprehensive view of affordability that includes the cost of housing and the cost of transportation. This index was developed by the Center for Neighborhood Technology (CNT). Like the Amenity-Based Housing Affordability Index, it also assumes that housing affordability should take location factors into account. Their standard for affordability is that if a family spends more than 45 percent of their income on housing and transportation, they should be considered cost-burdened.

The 45 percent affordability standard is based on a transportation cost threshold of less than 15 percent of a household's income, according to their own study of the national transportation cost pattern, plus the 30 percent HUD Guideline. The transportation cost is not generated from direct data but rather from modeling various data including commuting time, job accessibility, and other factors ("Affordable Housing - CPD - HUD" 2017).

## 2.4 Comparing measures and indicators

In Bogdon and Can's study of the Local Housing Affordability index, they established three criteria for selecting a housing affordability index, stated below:

"1) Relevance: Importance for policy/Comprehensive/Level of priority/Includes the most disadvantages. 2) Usefulness: Easily understood/Cost-effective and timely/Available for geographic area or social groups. 3) Data collection and reliability: Measurable/Reliable/Sensitive/Unambiguous/Independent."

The paper selected the ratio approach and its alternatives due to its simplicity and convenience for adopting housing affordability measures in local jurisdictions. These criteria will be used as a reference in this thesis (Bogdon and Can 1997).

Mori and Christodoulou provide a critical review of various sustainability indices. There were two major parts of their evaluation of the original unit of analysis. Firstly, they evaluate whether an index can satisfy two important conceptual requirements: it must be able to 1) assess external impacts of cities and 2) cover the triple bottom line of sustainability. Second, they discuss the methodology by which indices and indicators are created and structured (Mori and Christodoulou 2012).

Generally, to compare different indices describing the same subject, it is important to firstly see whether they can fully cover the subject and secondly measure whether the supporting rationale makes sense.

Cairns and Schwager performed a comparison of association indices. "Association" here means the frequency of two individuals present in the same social group at the same time. Their comparison is based on three criteria: 1) when and how often a sample will be taken, 2) the method of sampling, and 3) how the data is summarized by a given index (Cairns and Schwager 1987). The paper focuses on data while comparing these indices, because the subject they are measuring is not as complicated as housing affordability. Regardless, this method can be used as criteria to compare housing affordability measures when it comes to data.

# III. Methodology

This thesis selects housing affordability measures by definitions of housing affordability. As mentioned in Chapter 1, the definitions can be categorized as relative, subjective, ratio, family budget, or residual income approaches. The measures selected are stated below:

- Relative measurement: NAR Housing Affordability Index
- Ratio approach: HUD Guideline, H+T Affordability Index, Amenity-Based Housing Affordability Index
- Family budget approach: Self-Sufficiency Standard
- Residual income approach: Shelter Poverty Measure

These housing affordability measures will be evaluated by one criterion on three dimensions. The only criterion to evaluate them is whether the selected measurement can accurately describe the relationship between housing and those who live in it. The three dimensions of the criterion are 1) standards, 2) data accuracy, and 3) comprehensiveness.

This thesis attempts to create a ranking tool for housing affordability measures rather than an absolute standard to measure housing affordability. The three dimensions of the criterion are considered to have the same weight. And in this thesis, a radar chart will be used to present the ranking results of selected housing affordability measures, as well as a tool for generating overall rank. The shape of the radar chart will determine each measure's overall rank. It is important to note that this tool is an open system, which allows one to add other housing affordability measures to this ranking game at any time.

## 3.1 Standards

An indicator measures the empirical relationship between housing and its users, while a standard specifies a normative appropriate value to judge the indicator. When it comes to housing affordability, the standard should be able to measure whether a household living in a certain housing unit needs subsidies.

A standard for housing affordability is usually either a monetary figure or a ratio. Using a simple ratio as a normative standard for housing affordability can be misleading in individual case and therefore invalid when interpreting aggregate data as well. Many researchers try to use location factors such as jobs, schools, and medical services to adjust the simple ratio. These attempts are considered to improve the simple ratio approach. However, they still retain most of the statistical weaknesses of the ratio approach.

A monetary standard is considered to be better than a standard based on the ratio approach. Firstly, a monetary standard directly measures whether a household has enough money to live in a given housing unit. Secondly, a monetary standard can vary not only by family composition, size, and so on, but can also provide individual standards for personal use. Moreover, it lacks the applicable interval issue of the ratio approach (Kutty 2005).

Thus, the evaluation of those standards will be based on the list below, ranked in descending order of quality:

- A monetary standard with other inputs
- A monetary standard without other inputs
- A ratio standard with other inputs
- A ratio standard without other inputs

### 3.2 Data accuracy

Each housing affordability measure uses data from a broad range of sources. The accuracy of data directly influences the validity of the measure while describing current housing affordability conditions. Moreover, data shows how a housing affordability measure is used in practice.

Note that some of housing affordability measures listed above are developed by public agencies and have been used for years. Others are developed by individual researchers and subsequently may have very limited applications (except for the researchers' own case studies). In these cases, the list of datasets used by these case studies will be used to evaluate data

accuracy. Moreover, the Self-Sufficiency Standard is developed separately for many states in US using different data sources. This thesis chooses the Self-Sufficiency Standard developed for Washington State as the case study (Pearce 2014).

A list of aspects that will be evaluated for a given dataset is presented below:

- Sample size
- Use of data
- Data source and collection method

Sample size can dramatically influence a dataset's accuracy. For instance, the Decennial Census data is most accurate in terms of sample size because it collects population data rather than sample data.

The use of data can also influence the data accuracy. All datasets carry a certain margin of error. The margin of error will be amplified if a number of datasets are added together for calculation. Moreover, the result will be more unreliable if it is generated through an estimation model that uses historic data. Furthermore, even using the most recent data for estimation would not be as reliable as using data from a direct source.[4]

There are several data collection methods available when data is based on surveys (internet, mail, telephone, face-to-face, etc.). Each survey method has advantages and disadvantages. For example, a telephone interview and a face-to-face interview can generate more detailed data than a simple mail survey, but they also increase the possibility of interviewer bias. However, if a dataset is based on several different data collection methods, it should be considered a better dataset than one that collects data through only one method.

[4] For example, the Decennial Census data is released every decade. If a researcher is using the data to calculate the housing affordability of a year when the data was released, the results of the research can be considered to have the greatest accuracy possible. But if a researcher is using the Decennial Census data to measure the housing affordability in a year between data release cycles, the data must be adjusted based on the researcher's own assumptions, which will make the results less reliable than results from the year when the data was released.

Official data should also be considered more reliable than other data sources based on the assumption that federal and other governmental employees are trained professionally in data collection.

Moreover, datasets that collect data through mandatory surveys are more reliable than optional surveys launched by private or non-official agencies because people take them more seriously when responding.

A radar chart will be used to present the ranking results for each housing affordability measure, in which each axis of the radar chart represents one aspect of data accuracy. In order to reach a conclusion on the ranking of data accuracy, the size of each radar chart will be calculated as a value.

### 3.3 Comprehensiveness

A housing affordability measure should take many factors into consideration. This is because housing affordability is the relationship between housing and its users, two elements that represent the supply side and the demand side of the problem.

A housing affordability measure may focus on either the supply or demand side, or sometimes both. For example, the HUD Guideline focuses primarily on the supply side of housing affordability. In several policies and public housing programs, the 30 percent figure is primarily used as the rule to determine rental rate for a given income level. The Self-Sufficiency Standard focuses on the demand side. The standard tells people the amount of money that would support a given family living in a given place without private or public subsidies. The Fair Market Rent (FMR) is used to determine the rent (or in other words, the housing expenses) in its equation. The FMR in this equation is influenced primarily by family size. Other expenses like healthcare and education can be influenced by both the size of a family and its composition. Clearly, this standard can generate advice related to household income, but it is not able to influence the supply side, as it does not include any housing indicators.

The comprehensiveness of a housing affordability measure will be evaluated based on the list below:

Demand side
- Family/household composition
- Family/household size
- Family/household income
- Non-housing expenses

Supply side
- Housing cost
- Location factors
- Finance

The list above shows how a housing affordability measure can cover topics related to the housing affordability problem. However, it does not give detailed information on each element included in a given housing affordability measure. For example, NAR's Housing Affordability Index has two components: 1) the income of a typical family and 2) the price of a typical home. Therefore, it has covered two topics: housing cost and household income. But there are no further details related to those elements included in its calculation. Compare this to the HUD Guideline, which also covers housing cost and household income. But beyond that, it has the ability to calculate housing affordability for households with different income and sizes. Therefore, the NAR Index's comprehensiveness is undoubtedly inferior to that of the HUD guideline.

### 3.4 Summary

My analysis of these selected measures is based on analyzing the three dimensions of standards, data accuracy, and comprehensiveness. A detailed table to summarize the methodology is provided below.

*Table 1. Methodology*

| **Dimensions** | |
|---|---|
| Standard | A monetary standard with other inputs |
| | A monetary standard without other inputs |
| | A ratio standard with other inputs |
| | A ratio standard without other inputs |
| Data Accuracy | Sample size |
| | Use of data |
| | Data source and collection method |
| Comprehensiveness | Family/household composition |
| | Family/household size |
| | Family/Household income |
| | Other expenses |
| | Housing cost |
| | Location factors |
| | Finance |

# IV. Results

This chapter provides a thorough analysis of the six selected housing affordability measures guided by the methodology given in Chapter 3. This chapter is structured in five sections: 1) standard analysis, 2) data accuracy analysis, 3) comprehensiveness analysis, 4) overall ranking results, and 5) discussion.

## 4.1 Standard analysis

In this section, the standard of each housing affordability measure will be discussed and ranked based on the list provided in Chapter 3.

**NAR Housing Affordability Index**: As a relative housing affordability measure, this does not have a standard. As mentioned previously, the index uses a 25 percent qualifying ratio instead of the traditional 28 percent because it does not account for property taxes and insurance costs (which the traditional 28 includes in its assumptions). Thus, the index relies on a ratio based on the income-ratio approach ("Methodology" 2017).

**HUD Guideline**: The HUD guideline measures a family's housing cost burden by examining the ratio of a family's housing costs to their income. The standard of this measure is that if the ratio exceeds 30 percent, then the family is considered to be housing cost-burdened. This is a ratio without other inputs ("Affordable Housing - CPD – HUD" 2017).

**H+T Affordability Index**: This index considers housing and transportation costs as a whole. The standard of affordability is that housing and transportation costs should not exceed 45 percent of a family's income. This standard should be categorized as "a ratio with other inputs" ("About The Index | H+T Index" 2017).

**Amenity-Based Housing Affordability Index:** This index tries to identify the affordable housing stock in a given area, starting with a base of those housing units considered affordable under the HUD guideline. The stock is then adjusted according to the location factor generated by this index. This is an upgraded use of the income-ratio approach. Its standard should be categorized as "a ratio with other inputs" (Fisher, Pollakowski, and Zabel 2009).

**Self-Sufficiency Standard**: The Self-Sufficiency Standard identifies the minimum wage necessary for a given family to live in a given place without private or public subsidies. It gives a monetary standard based on a family's real needs. Thus, this standard is categorized as "a monetary standard with other inputs" (Pearce 2014).

**Shelter Poverty Measure**: The Shelter Poverty Measure is an application of the residual income approach, which identifies the minimum amount of money for a given family to live in a given place after paying for housing. It is also considered "a monetary standard with other inputs" (Stone 1993).

The result of the standard analysis is shown below:

*Table 2. Housing affordability measures ranked by standard*

| **Measure** | **Rank** |
|---|---|
| Self-Sufficiency Standard | 1 |
| Shelter Poverty Measure | 1 |
| H+T Affordability Index | 3 |
| Amenity-Based Housing Affordability Index | 3 |
| HUD Guideline | 5 |
| NAR Housing Affordability Index | 5 |

According to the standard analysis, the Self-Sufficiency Standard and Shelter Poverty Measure rank at the top of the six selected measures. The H+T Affordability Index and Amenity-Based Housing Affordability Index rank higher than the HUD Guideline and NAR Housing Affordability Index.

### 4.2 Data Accuracy Analysis

The first step of analyzing data accuracy is to list all the data used by each housing affordability measure.

*Table 3. List of datasets used*

| | |
|---|---|
| **NAR Housing Affordability Index ("Methodology" 2017)** | National Association of Realtors: Monthly survey of existing home sales |
| | Federal Housing Finance Board: Monthly mortgage rate |
| | Census Bureau American Community Survey: Median family income |
| **HUD Guideline ("Affordable Housing - CPD – HUD" 2017)** | Census Bureau American Community Survey: Household Income and housing cost |
| **H+T Affordability Index ("H+T Index Methods" 2017)** | Census Bureau American Community Survey: Housing characteristics, housing costs, transportation use, community demographics, income, and employment |
| | U.S. Census TIGER/Line mapping files |
| | U.S. Census Longitudinal Employment-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES): Spatial distribution of workers' employment and residential locations |
| | Census Transportation Planning Package, to adjust the data above |
| | State of Massachusetts ES-202, to adjust the data above |
| | Bureau of Labor Statistics Consumer Expenditure Survey, to adjust the data above |
| | National Transit Database: Fare box revenue and number of transit trips |
| | AllTransit™ : General Transit Feed Specification (GTFS) data |
| | Odometer readings from the Illinois Department of Natural Resources: Auto use |
| **Amenity-Based Housing Affordability Index (Fisher, Pollakowski, and Zabel 2009)** | Census Bureau Decennial Census: Existing housing stock |
| | Warren Group Transaction Data: New owner-occupied housing stock |
| | Department of Housing and Community Development: Subsidized housing stock |
| | Case-Shiller-Weiss repeat sales index, for adjusting Census data |
| | Zillow.com price appreciation data, for adjusting Census data |
| | American Housing Survey: Inadequate structural units |
| | Massachusetts Department of Education: School scores |
| | Massachusetts Department of Labor's ES-202: Employment data |
| | Boston Metropolitan Planning Organization: Commuting time |
| | The Best Place to Live Boston: Safety measure |
| | Department of Housing and Urban Development: Fair Market Rent (FMR) |

| | |
|---|---|
| **Self-Sufficiency Standard (Pearce 2014)** | American Community Survey: Housing cost |
| | Child Care Aware of Washington: Child care |
| | Bureau of Labor Statistics: Inflation |
| | U.S. Department of Agriculture, Center for Nutrition Policy and Promotion: Food cost |
| | Craig Gunderson, Emily Engelhard, Amy Satoh, and Elaine Waxman, Feeding America's "Map the Meal Gap 2014: Food Insecurity and Child Food Insecurity Estimates at the County Level": County-level food cost adjustments |
| | American Community Survey: Public transportation use |
| | National Association of Insurance Commissioners: Auto insurance |
| | Washington State Office of the Insurance Commissioner: Auto insurance market share and county-level insurance adjustments |
| | Bureau of Labor Statistics data query for the Consumer Expenditure Survey: Auto cost |
| | American Automobile Association: Per-mile auto cost estimation |
| | U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality, Center for Financing, Access, and Cost Trends, Medical Expenditure Panel Survey-Household Component Analytical Tool: Out-of-pocket health cost |
| | U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality, Center for Financing, Access, and Cost Trends: State-level healthcare cost adjustments |
| | Internal Revenue Service: Income tax and tax credits |
| | Washington State Department of Revenue: Local sales tax |
| | Census Bureau Current Population Survey: Job tenure |
| | U.S. Department of Labor, Employment and Training Administration: Unemployment |
| | Washington State Employment Security Department: Unemployment insurance |
| | Federal Deposit Insurance Corporation: Saving rate |
| **Shelter Poverty Measure (Stone 1993)** | Bureau of Labor Statistics Lower Standard Budget: Standard calculation |
| | American Housing Survey: Standard adjustments of household size, household composition, housing costs |
| | Current Population Survey: Non-federal personal taxes for standard adjustments |
| | Census Bureau Decennial Census: Income |

Some of the data sources presented above provide a single number for either calculation or adjustments. For example, the federal income tax rate, as calculated, will not influence data accuracy because it is a number written in the law. Mortgage rates that are collected from actual practices should also be considered to have absolute accuracy.

Moreover, some of the datasets are included for the purpose of making adjustments. The influence of these datasets will be accounted in “use of data." Some datasets present reality recorded by institutions. For example, U.S. Census TIGER/Line files are only used for mapping, which reflects the real geographical context of U.S. This data will not be built into the calculation of a given index. Thus, the data accuracy analysis will exclude those datasets providing actual figures for calculation and those used for data visualization purposes.

### 4.2.1 Sample size

The sample size analysis includes those data listed above whenever the data has a sample. This analysis will not include those datasets that are used for estimations or adjustments, as they will be discussed later in “use of data.”

**NAR Housing Affordability Index (NAR)**

- The Existing Home Sales Monthly Survey collects home sales data from 160 participating boards and MLS's. The data represents accurate sales activities in each region of the country ("Methodology" 2017).
- The American Community Survey (ACS) selects nearly 3 million samples each year in the U.S., which amounts to approximately 1 percent of the U.S. population ("Sample Size | American Community Survey | U.S. Census Bureau" 2017). (NAR uses the 1-year American Community Survey.)

**HUD Guideline (HUD)**

- The American Community Survey (ACS) selects nearly 3 million samples each year in the U.S., which amounts to approximately 1 percent of the U.S. population ("Sample Size | American Community Survey | U.S. Census Bureau" 2017). (The HUD Guideline uses the 5-year American Community Survey.)

**H+T Affordability Index (H+T)**

- The American Community Survey (ACS) selects nearly 3 million samples each year in the U.S., which amounts to approximately 1 percent of the U.S. population ("Sample Size | American Community Survey | U.S. Census Bureau" 2017). (H+T uses the 5-year American Community Survey.)
- The U.S. Census Longitudinal Employment-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) collect unemployment insurance earnings data. Quarterly Census of Employment and Wages (QCEW) data from all states in U.S. is also collected. Data is then combined with additional administrative data and data from censuses and surveys. In terms of sample size, this should rank below the Decennial Census but above all other datasets, including the American Community Survey (US Census Bureau 2017).
- The National Transit Database (NTD) collects transit data reported by over approximately 850 transit providers in urbanized areas. The legislative requirement for NTD can be found in Title 49 U.S.C. 5335 (a). It states that: “The reporting and uniform systems shall contain appropriate information to help any level of government make a public-sector investment decision.” Given this statement, this data source should be ranked at the same level as the Decennial Census in terms of its sample size ("What Is the National Transit Database (NTD) Program?" 2017).

**Amenity-Based Housing Affordability Index (AHAI)**

- The Decennial Census has been conducted in years ending in "0" since 1790, as required by the U.S. Constitution's Article I, Section 2**.** The Census sends out surveys to every family in the U.S. to collect population data rather than sample data.
- Warren Group is a fourth-generation family-owned business that provides real estate data service in New England and New York. The index uses transaction data from Warren Group to calculate new owner-occupied housing units. Real estate transactions are easy to track and record. Thus, transaction data from Warren Group will be considered population data ("Warren Data Solutions | The Warren Group" 2017).

- To report data required by Chapter 334 of the Act of 2006, the Massachusetts Department of Housing and Community Development created a spreadsheet for local housing authorities administrating state public housing. This data is considered population data ("Required Annual LHA Reporting On Tenant And Unit Data" 2017).
- The American Housing Survey (AHS) selected 115,398 housing units as a sample in 2015. According to the Census Bureau's housing inventory estimation, there were approximately 135,064,000 housing units in US, which indicates that AHS's sample size is smaller than 0.1 percent of total inventory (Bureau 2017).
- Massachusetts Employment and Wage (ES-202) data is derived from reports filed by all employers subject to both state and federal unemployment compensation laws. It is population data ("Employment And Job Statistics" 2017).
- Boston Metropolitan Planning Organization Commuting Time data is actually 5-year American Community Survey data ("Data Inquiry | Boston Region MPO" 2017).

**Self-Sufficiency Standard (SSS)**

- The American Community Survey (ACS) selects nearly 3 million samples each year in the U.S., which amounts to approximately 1 percent of the U.S. population ("Sample Size | American Community Survey | U.S. Census Bureau" 2017). (The SSS uses the 5-year American Community Survey.)
- Child Care Aware of Washington provides data on child care-related topics, collected from child care providers, throughout Washington State. It is population data ("Data — Child Care Aware Of WA" 2017).
- The U.S. Department of Agriculture's Center for Nutrition Policy and Promotion's (CNPP) Food Cost data is generated from its own 2001-2002 food price database. Current data reports present historic data with CPI adjustments. In terms of sample size, although the actual sample size is smaller than the ACS, it covers a greater proportion of all food types. Thus, this database will rank higher than ACS but lower than other population data ("USDA Food Plans: Cost Of Food | Center For Nutrition Policy And Promotion" 2017).

- The Bureau of Labor Statistics Consumer Expenditure Survey covers a sample of 7,000 each year. However, these 7,000 samples generate 14,000 diaries each year. Moreover, each sample is interviewed quarterly ("CE Methodology" 2017).
- The Medical Expenditure Panel Survey collects sample data from households and employers who provide health insurance plans to employees. In 2015, the initial sample size was 178,113 (Quality 2017).
- The Current Population Survey (CPS) provides data about employment status. It has a monthly sample size of 72,000 households (Bureau 2017).

**Shelter Poverty Measure (SPM)**

- The Bureau of Labor Statistics Lower Standard Budget uses data from its Consumer Expenditure Survey.
- The American Housing Survey (AHS) selected 115,398 housing units as a sample in 2015. According to the Census Bureau's housing inventory estimation, there were approximately 135,064,000 housing units in the U.S., which indicates that AHS's sample size is smaller than 0.1 percent of total inventory (Bureau 2017).
- The Decennial Census has been conducted in years ending in "0" since 1790, as required by the U.S. Constitution's Article I, Section 2**.** It sends out surveys to every family in U.S. and therefore provides population data rather than sample data.

**Conclusion**

A list of all datasets that are included in the sample size analysis is shown below.

*Table 4. Datasets ranked by sample size*

| **Data Source** | **Rank** |
|---|---|
| Decennial Census | 1 |
| NAR Home Sales Monthly Survey | 1 |
| National Transit Database | 1 |
| Massachusetts Department of Housing and Community Development | 1 |
| Massachusetts Employment and Wage data | 1 |

| | |
|---|---|
| Warren Group | 1 |
| Child Care Aware of Washington | 1 |
| LEHD Origin-Destination Employment Statistics | 2 |
| CNPP Food Cost Data | 3 |
| 5-year American Community Survey | 4 |
| Boston Metropolitan Planning Organization | 4 |
| 1-year American Community Survey | 5 |
| Current Population Survey | 6 |
| Medical Expenditure Panel Survey | 7 |
| American Housing Survey | 8 |
| Bureau of Labor Statistics Consumer Expenditure Survey | 9 |

Based on this ranked list, the overall ranking of all the housing affordability measures with regard to their sample sizes is shown below. The overall ranking of sample size assumes the same weight for each dataset.

*Table 5. Housing affordability measures ranked by sample size of the data*

| **Measure** | **Rank** |
|---|---|
| H+T Affordability Index | 1 |
| Amenity-based Housing Affordability Index | 2 |
| NAR Housing Affordability Index | 3 |
| HUD Guideline | 4 |
| Shelter Poverty Measure | 5 |
| Self-Sufficiency Standard | 6 |

According to the sample size analysis, the H+T Affordability Index ranks at the top of the list. The Amenity-Based Housing Affordability Index ranks second. The NAR Housing Affordability Index takes third place, followed by the HUD Guideline in fourth place. The Shelter Poverty Measure and Self-Sufficiency Standard rank at the bottom of the list.

### 4.2.2 Use of data

The “data” in the “Use of data” section refers to the datasets selected for the sample size analysis in the previous section. “Use of data” measures how these datasets are used to calculate each housing affordability measure, ranked based on the list below.

- Data can be used directly
- Data must be adjusted by one or more official sources
- Data must be adjusted based on research assumptions.

**NAR Housing Affordability Index (NAR)**

NAR uses all data directly.

**HUD Guideline (HUD)**

HUD uses all data directly.

**H+T Affordability Index (H+T)**

- The H+T Affordability Index uses demographic data from the American Community Survey directly.
- The U.S. Census Longitudinal Employment-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) generates a spatial distribution of workers' employment and residential locations, which is used in the calculation of commute by either personal automobile or public transit. Based on research assumptions, this data must be adjusted by the Census Transportation Planning Package and the State of Massachusetts ES-202 before being used in calculations.
- Costs of public transportation are primarily based on the National Transit Database. Based on research assumptions, this database is adjusted by data from AllTransit™, a database owned by the research institution.
- Auto use data derives from the American Community Survey. Based on research assumptions, this data is adjusted by odometer readings from the Illinois Department of Natural Resources.

**Amenity-Based Housing Affordability Index (AHAI)**

- Existing housing stock is calculated by adding housing stock data from the Decennial Census to Warren Group Transaction data and subsidized housing data from the Department of Housing and Community Development. This should be considered direct use of each data. However, the data is then further adjusted by the Case-Shiller-Weiss repeat sales index and Zillow.com price appreciation data for its value purpose.
- Data from the American Housing Survey is used directly to compute the number of inadequate structural units.
- School score data from the Massachusetts Department of Education is directly used, but it is used to generate school-quality affordable housing stock adjustments. The same goes for safety data from The Best Place to Live Boston and commuting time data from Boston Metropolitan Planning Organization. Based on research assumptions and calculations, these adjustments are made for safety and accessibility-related reasons.

**Self-Sufficiency Standard (SSS)**

- Data on child care expenses from Child Care Aware of Washington is directly used. The Consumer Price Index (CPI) from the Bureau of Labor Statistics is used to make adjustments for inflation.
- Food cost data from the CNPP food database is adjusted by data from “Map the Meal Gap” at the county level.
- Public transportation use data from the American Community Survey is used directly.
- Fixed auto-cost data from the Bureau of Labor Statistics Consumer Expenditure Survey is adjusted by CPI and per-mile cost data from the American Auto Association.
- Auto insurance data, as part of the auto cost, comes from the National Association of Insurance. It is then adjusted by data from the Washington State Office of the Insurance Commissioners.
- Data on out-of-pocket healthcare expenses comes primarily from the U.S. Department of Health and Human Services. It is then adjusted by CPI and data from the Washington State Office of the Insurance Commissioners.

- The Self-Sufficiency Standard assumes 10 percent of total cost as miscellaneous costs for clothing, shoes, paper products, diapers, non-prescription medicines, cleaning products, telephone services, and so on.
- Taxes and tax credits are calculated directly according to federal and state laws.
- The Emergency Saving Fund is determined by job tenure data from the Census Bureau Current Population Survey, unemployment data from the U.S. Department of Labor, Employment, and Training Administration (ETA), unemployment insurance data from the Washington State Employment Security Department, and the savings rate from the Federal Deposit Insurance Corporation. Each of these datasets is considered to be used directly.

**Shelter Poverty Measure (SPM)**

- Based on research assumptions, data from the Bureau of Labor Statistics Lower Standard Budget is adjusted by data from the American Housing Survey and the Current Population Survey in order to calculate the basic necessity standard.
- Demographic data from the Decennial Census and the American Housing Survey is directly used.

**Conclusion**

*Table 6. Use of data summarized for each housing affordability measure*

| **Measure** | **Adjustments[5]** | **Assumptions[6]** |
|---|---|---|
| NAR Housing Affordability Index | 0/2 | 0 |
| HUD Guideline | 0/1 | 0 |
| H+T Affordability Index | 4/3 | 3 |
| Amenity-Based Housing Affordability Index | 5/4 | 3 |
| Self-Sufficiency Standard | 8/9 | 1 |
| Shelter Poverty Measure | 2/3 | 1 |

[5] X/Y means there are X adjustments for Y datasets.
[6] "Assumptions" refers to the number of assumptions made by researchers.

The table above summarizes the use of data by each housing affordability measure. The rank of each housing affordability measure in terms of its use of data is shown below.

*Table 7 Housing affordability measures ranked by use of data*

| **Measure** | **Rank** |
|---|---|
| NAR Housing Affordability Measure | 1 |
| HUD Guideline | 1 |
| Shelter Poverty Measure | 3 |
| Self-Sufficiency Standard | 4 |
| Amenity-Based Housing Affordability Index | 5 |
| H+T Affordability Index | 6 |

Based on this analysis, the NAR Housing Affordability Index and HUD Guideline rank at the top of the list. The Shelter Poverty Measure and Self-Sufficiency Standard rank higher than the Amenity-Based Housing Affordability Index and the H+T Affordability Index because they make fewer assumptions in adjusting data.

### 4.2.3 Data sources and collection method

The data collection method of each database will be ranked according to the list below.

- Official data, required by law, collected from other official sources
- Official data collected from other official sources
- Official data collected by recording actual activities
- Private data collected by recording actual activities
- Official data collected by multiple survey methods

**NAR Housing Affordability Index (NAR)**

- The Existing Home Sales Monthly Survey records actual sales activities collected from 160 participating boards and MSAs.
- The American Community Survey collects its data by internet, mail, telephone, and personal visits. The figure below is a timetable from the American Community

Survey Design and Methodology report.

| ACS sample panel | Month of data collection | | | | | |
|---|---|---|---|---|---|---|
| | 2013 | | | | | |
| | January | February | March | April | May | June |
| November 2012 | Personal visit | | | | | |
| December 2012 | Phone | Personal visit | | | | |
| January 2013 | Mail/ Internet | Phone | Personal visit | | | |
| February 2013 | | Mail/ Internet | Phone | Personal visit | | |
| March 2013 | | | Mail/ Internet | Phone | Personal visit | |
| April 2013 | | | | Mail/ Internet | Phone | Personal visit |
| May 2013 | | | | | Mail/ Internet | Phone |
| June 2013 | | | | | | Mail/ Internet |

*Figure 2. ACS data collection*

The written description in the report provides more clarity: "the first phase includes a mailed request to respond via Internet, followed later by an option to complete a paper questionnaire and return it by mail. If no response is received by mail or Internet, the Census Bureau follows up with computer assisted telephone interviewing (CATI) when a telephone number is available. If the Census Bureau is unable to reach an occupant using CATI, or if the household refuses to participate, the address may be selected for computer-assisted personal interviewing (CAPI)."

**HUD Guideline (HUD)**

- The American Community Survey collects its data by internet, mail, telephone, and personal visits. Refer to Figure 2 for a timetable from the American Community Survey Design and Methodology report.

**H+T Affordability Index (H+T)**

- American Community Survey collects its data by internet, mail, telephone, and personal visits. Refer to Figure 2 for a timetable from the American Community Survey Design and Methodology report.

- The U.S. Census Longitudinal Employment-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) data is administrative data collected from employers. Some of data provided by LODES is collected through surveys.
- The National Transit Database (NTD) collects data from transit providers across the U.S. Established by Congress, this data is used as a reference for allocating the annual $5 billion Federal Transit Administration grant.

**Amenity-Based Housing Affordability Index (AHAI)**

- Decennial Census data is primarily collected through mail surveys and interviews. It is constitutionally mandated for the apportionment of the 435 seats of the House of Representatives. This data also provides information for drawing Congressional, state, and local legislative districts.
- The Warren Group transaction database collects local transaction data by recording actual home transactions.
- The Massachusetts Department of Housing and Community Development collects mandatory public housing data from local housing authorities.
- The American Housing Survey (AHS) is required by Congress to provide up-to-date information on housing quality and housing costs. Census Bureau interviewers gather data by visiting or telephoning the household occupying each housing unit in the sample.
- The Massachusetts Employment and Wage (ES-202) gathers reports filed by all employers to collect data.
- Boston Metropolitan Planning Organization Commuting Time data comes from the American Community Survey.

**Self-Sufficiency Standard (SSS)**

- Child Care Aware of Washington collects data reported by child care providers in Washington State.
- The U.S. Department of Agriculture's Center for Nutrition Policy and Promotion (CNPP) combines data from four different datasets: NHANES 2001-02 (Center for

Disease Control [CDC] & USDA, 2004), the USDA Food and Nutrient Database for Dietary Studies version 1.0 (FNDDS) (UDSA, Agricultural Research Service [ARS], Food Surveys Research Group, 2004), the National Nutrient Database for Standard Reference (Release 16.1 and 18) (USDA, ARS, 2004, 2005), and the Nielsen Homescan™ Consumer Panel (Nielsen, 2005). NHANES database provides a list of food based on 24-hour dietary recall interviews. FNDDS provides food nutrient data based on the nutrient content of ingredients used in food preparation. The National Nutrient Database for Standard Reference also provides food nutrient data. Finally, the Nielsen Homescan™ Consumer Panel provides food price data. Households that are selected in its sample are equipped with an electrical home scan unit that allows them to record food purchases.

- The Bureau of Labor Statistics Consumer Expenditure Survey collects data by face-to-face interviews.
- The Medical Expenditure Panel Survey collects data from medical providers and employers. More detailed data is collected through interviews.
- The Current Population Survey collects data through telephone as well as face-to-face interviews.

**Shelter Poverty Measure (SPM)**

- The Bureau of Labor Statistics Lower Standard Budget uses data from the Consumer Expenditure Survey.
- The American Housing Survey (AHS) is required by Congress to provide up-to-date information on housing quality and housing costs. Census Bureau interviewers gather data by visiting or telephoning the household occupying each housing unit in the sample.
- Decennial Census data is primarily collected through mail surveys and interviews. It is constitutionally mandated for apportionment of the 435 seats of the House of Representatives. This data also provides information for drawing Congressional, state, and local legislative districts.

**Conclusion**

Based on the information above, the ranks of all databases are shown below.

*Table 8. Data collection ranking*

| Dataset | Rank |
|---|---|
| Massachusetts DHCD public housing data | 1 |
| Existing Home Sales Monthly Survey | 2 |
| National Transit Database | 3 |
| Massachusetts Employment and Wage (ES-202) | 4 |
| USDA food costs | 5 |
| Warren Group transaction data | 6 |
| Child Care Aware of Washington | 6 |
| LODES data | 7 |
| Medical Expenditure Panel Survey | 8 |
| Bureau of Labor Statistics Consumer Expenditure Survey | 9 |
| American Housing Survey | 9 |
| Current Population Survey | 9 |
| American Community Survey | 10 |
| Decennial Census | 11 |

The table above shows the result of data collection analysis for all included databases.

Given this, the overall rank of selected housing affordability measures is:

*Table 9. Housing affordability measures ranked by data collection*

| Measure | Rank |
|---|---|
| NAR Housing Affordability Index | 1 |
| Amenity-Based Housing Affordability Index | 2 |
| H+T Affordability Index | 3 |
| Self-Sufficiency Standard | 4 |
| Shelter Poverty Measure | 5 |
| HUD Guideline | 6 |

In this section of analysis, the NAR Housing Affordability Index ranks at the top of the list. The Amenity-Based Housing Affordability Index ranks in second place. The H+T Affordability Index and Self-Sufficiency Standard rank in third and fourth place. The Shelter Poverty Measure ranks fifth, while HUD Guideline ranks at the bottom of the list.

### 4.2.4 Conclusion

As mentioned in Chapter 3, in order to reach a conclusion, ranking results will be presented through radar charts. Additionally, overall rankings should be conducted by calculating the shape size of each chart. The radar charts below show the ranking results in sample size, use of data, and data source and collection method for each housing affordability measure.

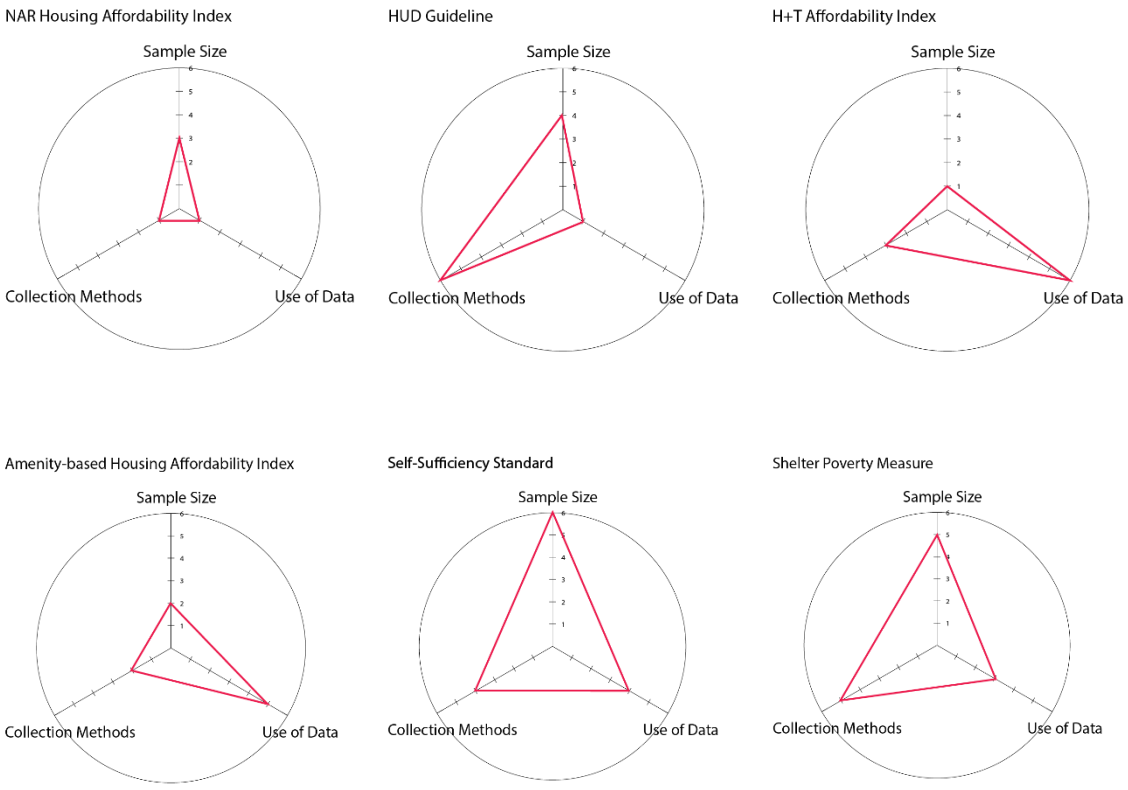


*Figure 3. Data accuracy diagrams for housing affordability measures*

The radar chart with the smallest size should rank highest. The ranking result of each selected housing affordability measure is shown below.

*Table 10. Housing affordability measures ranked by data accuracy*

| **Measure** | **Rank** |
|---|---|
| NAR Housing Affordability Index | 1 |
| Amenity-Based Housing Affordability Index | 2 |
| H+T Affordability Index | 3 |
| HUD Guideline | 4 |
| Shelter Poverty Measure | 5 |
| Self-Sufficiency Standard | 6 |

The data accuracy analysis shows that NAR Housing Affordability Index has the greatest data accuracy. The Amenity-Based Housing Affordability Index ranks in second place. The H+T Affordability Index ranks third, followed by HUD Guideline in fourth place. The Shelter Poverty Measure and Self-Sufficiency Standard rank at the bottom of the list.

### 4.3 Comprehensiveness Analysis

In this section, I measure not only the range of topics covered by each housing affordability measure, but also the level of detail in which each topic is covered.

Below is the combined list of topics covered by each housing affordability measure:

- Income
- Family/household size
- Family/household composition
- Housing expenditures
- Non-housing expenditures
- Location
- Finance

I exclude income and housing expenditures under the location. Transportation costs will be categorized under location topic and excluded from the non-housing expenditures. Note that this categorizing criterion is designed so as not to double-count comprehensiveness, which does not represent the real category of each sub-topic.

**NAR Housing Affordability Index (NAR)**

The NAR Housing Affordability Index covers three topics: housing expenditures, income, and finance. Under the housing expenditure topic, it takes only the median housing sales price and mortgage rate into account. And the income topic covers only median family income. However, the NAR Housing Affordability Index is the only measure that takes the mortgage interest rate into consideration.

**HUD Guideline**

The HUD Guideline covered two topics: housing expenditures and income. Under the housing expenditure topics, both renter and owner expenses have been considered. Renters' housing expenditures include rent and utilities. Mortgage payments, real estate property tax, utilities, association fees, and insurances comprise owners' housing expenditures. In terms of the income topic, the HUD Guideline is able to cover all households with all income levels, but no further details about household size or household composition are given.

**H+T Affordability Index (H+T)**

The topics covered by the H+T Affordability Index are income, housing expenditures, household size, and location. Transportation cost is the only sub-topic under the location topic. However, it serves as a dependent variable, which is calculated by many independent variables (e.g., commuters, employment accessibility, and transit connectivity.). The transportation sub-topic of the H+T Affordability Index is the most comprehensive among all selected housing affordability measures. Household size served as an independent variable to estimate transportation costs. The index only uses the typical regional household to represent the average condition of all households in a given jurisdiction. The household income topic is as detailed here as in the HUD Guideline.

**Amenity-Based Housing Affordability Index (AHAI)**

Income, household size, household composition, location, and housing expenditures are the five topics covered by this index. All household sizes and household compositions are included. The elements of income and housing expenditures are as detailed as in the HUD Guideline. Under the location topic, the index takes into account job accessibility, school quality, and safety. Transportation cost is also a sub-topic of the location topic in this index, and it is used as an independent variable to measure job accessibility.

**Self-Sufficiency Standard (SSS)**

The Self-Sufficiency Standard generally covered all topics except for income and finance. However, the income topic is covered in the standard when individuals identify whether their wage meets the family's Self-Sufficiency Standard. Transportation cost is the only sub-topic under the location topic. It has a comprehensive non-housing expenditure component, which includes many detailed expenses (e.g. child care, healthcare, insurance). This uses Fair Market Rent (FMR) as an assumption for housing expenses. The standard is designed for all types of households.

**Shelter Poverty Measure (SPM)**

The Shelter Poverty Measure covers all the topics. The income topic is as detailed as in the HUD Guideline. Like the Self-Sufficiency Standard, this measure only includes transportation cost under the location element. Its non-housing expenditure topic is not as comprehensive as in the Self-Sufficiency Standard. However, this measure is also designed for all types of households. Moreover, this measure covers the housing expenditure topic for the purpose of determining the condition of shelter poverty. This is done by comparing the shelter poverty standard to the total income available for non-housing expenditures.

**Conclusion**

The table below summarizes the results of comprehensiveness for each selected housing affordability measure. A cell with "X" means that the topic is covered by the measure. The number of "X"s represents the level of detail with which the topics are covered.

*Table 11. Comprehensiveness summarized for each housing affordability measure*

| Topic / Measure | Income | F/HH Size | F/HH composition | Finance | Housing Exp. | Non-housing Exp. | Location |
|---|---|---|---|---|---|---|---|
| NAR | X | - | - | X | X | - | - |
| HUD Guideline | XX | X | - | - | XXX | - | - |
| H+T | XX | - | - | - | XXX | - | XXX |
| AHAI | XX | X | X | - | XXX | - | XX |
| SSS | XX | X | X | - | XX | XXX | X |
| SPM | XX | X | X | - | XXX | X | X |

According to this table, the rank of selected housing affordability measures is:

*Table 12. Housing affordability measures ranked by comprehensiveness*

| Measure | Rank |
|---|---|
| Self-Sufficiency Standard | 1 |
| Shelter Poverty Measure | 2 |
| Amenity-Based Housing Affordability Index | 2 |
| H+T Affordability Index | 4 |
| HUD Guideline | 5 |
| NAR Housing Affordability Index | 6 |

The Self-Sufficiency Standard is the most comprehensive housing affordability measure among the six selected measures. The Shelter Poverty Measure and Amenity-based Housing Affordability Index both rank in second place. The H+T Affordability Index ranks in fourth place. The HUD Guideline and NAR Housing Affordability Index have the least comprehensiveness among the six selected measures.

### 4.4 Overall ranking result

The overall ranking result, as discussed in Chapter 3, is calculated by ranking the shape size of radar charts for each housing affordability measure. All rankings in each dimension are shown in the table below. Results are then shown graphically in radar charts.

*Table 13. Rank summary of housing affordability measures*

| Measure | Standard | Data Accuracy | Comprehensiveness |
|---|---|---|---|
| NAR Housing Affordability Index | 5 | 1 | 6 |
| HUD Guideline | 5 | 4 | 5 |
| H+T Affordability Index | 3 | 3 | 4 |
| Amenity-Based Housing Affordability Index | 3 | 2 | 2 |
| Self-Sufficiency Standard | 1 | 6 | 1 |
| Shelter Poverty Measure | 1 | 5 | 2 |


*Figure 4. Overall rank diagrams of housing affordability measures*

According to these radar charts, the overall rank of selected housing affordability measures is:

*Table 14. Overall ranking of housing affordability measures*

| Measure | Rank |
|---|---|
| Self-Sufficiency Standard | 1 |
| Amenity-Based Housing Affordability Index | 2 |

| | |
|---|---|
| Shelter Poverty Measure | 3 |
| H+T Affordability Index | 4 |
| NAR Housing Affordability Index | 5 |
| HUD Guideline | 6 |

Accordingly, the Self-Sufficiency Standard is the best housing affordability measure among the six selected measures. The Amenity-Based Housing Affordability Index then ranks above the Shelter Poverty Measure, which takes third place. The Affordability Index ranks fourth, followed by the NAR Housing Affordability Index in fifth place and the HUD Guideline at the bottom of the list.

## 4.5 Discussion

### 4.5.1 What does the result indicate?

Analysis indicates that the Self-Sufficiency Standard is the best housing affordability measure among those selected. It ranked in first place on both the “Standard” dimension and “Comprehensiveness” dimension. However, it ranked in sixth place, the bottom of the list, in terms of its use of data. This is primarily because most non-housing expenditure data is not available at the local level and therefore requires further adjustments.

The Amenity-Based Housing Affordability Index ranked in second place. Compared to the Self-Sufficiency Standard, it has a more balanced performance in each dimension. This index performed much better than the Self-Sufficiency Standard on the “Data Accuracy” dimension. This is primarily because the datasets used by this index tend to be available on the local level, from credible data sources.

Like the Self-Sufficiency Standard, the Shelter Poverty Measure can give a monetary standard for housing affordability. Both measures aim to take non-housing expenditures into account. The Self-Sufficiency Standard ranks higher than the Shelter Poverty Measure only In the Comprehensiveness dimension. This is primary because the application of the Shelter Poverty Measure was done by Stone himself, while the Self-Sufficiency Standard, although

developed by Pearce, received funding from the Ford Foundation in the early 2000s that allowed researchers access to more detailed data.

The H+T Affordability Index and Amenity-based Housing Affordability Index rank right before the NAR Housing Affordability Index and the HUD Guideline. Both measures tend to take location tradeoffs into account. AHAI, which calculates the affordable housing stock in a given area, focuses primarily on the supply side of the housing affordability issue. H+T focuses more on the demand side by adding housing costs and transportation costs together. Although H+T's transportation cost estimation model is very complicated, the researchers make assumptions that aim to simplify the calculations.

The NAR Housing Affordability and HUD Guideline rank at the bottom of the list. Both perform better than Self-Sufficiency Standard and the Shelter Poverty Measure on the Data Accuracy dimension because they use simple calculations, which allow them to use data directly without any adjustments. Yet for the same reason, they have the lowest comprehensiveness performance among all selected measures.

### 4.5.2 Shelter Poverty Measure vs. Self-Sufficiency Standard

The Shelter Poverty Measure is based on the residual income approach, while the Self-Sufficiency Standard is a budget-based measure of cost of living. Stone critiqued the family budget approach as follows:

"… Housing is unique; the budget standard methodology may be able to specify a reasonably precise physical standard for housing, but it cannot establish a precise monetary standard. Furthermore, in terms of policy, this means that housing affordability problems cannot be explained as just income problems. General and standardized Income Support alone would be neither efficient nor equitable for solving housing affordability problems" (Stone 2006).

I agree with his view on the family budget approach. And the Self-Sufficiency Standard does fail to explain the affordable housing expense, because it only uses the Fair Market Rent in

its calculation. However, in my opinion, the Self-Sufficiency Standard can in fact be the best application of the residual income approach and will be able to serve as well as the Shelter Poverty Measure if the Standard is used alternatively.

According to Stone, the residual income approach measures the amount of money available for basic non-housing expenditures. In terms of housing, the Shelter Poverty definition can be stated as follows: If, after paying for all non-housing expenditures, the income of a given household is not enough to cover their housing expenditures, then the house is considered not to be affordable for the household. In brief, the Shelter Poverty Measure focuses on the relationship between non-housing expenditures and residual income (the amount of income available after paying for housing) (Stone 1993). The Self-Sufficiency Standard measures the relationship between total expenditures and total income. This indicates that if one subtracts the FMR from Self-Sufficiency Standard, the result is the standard for residual income. Finally, the affordable rent standard generated by the Self-Sufficiency Standard, according to the Shelter Poverty Measure, can be stated as:

Affordable Rent = Total Income – Residual Income Standard = Total Income – (Self-Sufficiency Standard – Fair Market Rent) = Total Income + Fair Market Rent – Self-Sufficiency Standard

### 4.5.3 What is the value of the HUD Guideline?

Given the fact that the HUD Guideline ranks at the bottom of the list, it is essential to remember its unique advantages. When discussing the advantage of the HUD Guideline, most researchers mentioned that it is easy to understand and simple to compute (Bogdon and Can 1997). However, these two advantages alone cannot explain why the HUD Guideline is popular in the U.S. as a measure of housing affordability.

In my opinion, the HUD Guideline is in broad use because of its ability to provide rent assumptions so that affordable housing developers can anticipate their future income. In order to acquire funds from investors and loans from banks, housing developers need to demonstrate that they are able to generate a stable income from the project they plan to build. The HUD

Guideline's affordable rent for a given household's earning certain income simply multiplies the income by 30 percent. This calculation can be done without knowing the household's composition or other related non-housing expenditures. Thus, it enables developers to generate rent assumptions for their pro forma analysis without the need for any further details about future tenants.

Some may argue that, given the fact that many affordable housing developers manage a waiting list of tenants, it should be possible to generate rent assumptions by using the residual income approach. My opinion is that even with very detailed information from all families on the waiting list, this is still not a good source for rent assumptions.

Firstly, some of families may be on two or more waiting lists of different affordable housing developers. They may refuse to become a tenant when the project is finished. Secondly, the affordable rent generated by the residual income approach is not as stable as the one generate by the HUD Guideline. This is because the residual income approach considers the real non-housing expenditures that represent the household's current conditions. Theoretically, the residual income approach can generate a more reasonable rent assumption. But because of its instability, it cannot serve as well as the HUD Guideline for the purpose of attracting investors or receiving bank loans or public subsidies.

Thirdly, the residual income approach is difficult to embed in the qualification process of affordable housing. Household income is easy to track and verify from employers and tax records. For a given household earning a certain income, it is hard to lie in order to qualify to pay lower rents. However, a household can easily lie about their non-housing expenditures to qualify for a lower rent, because there are too many categories included in non-housing expenditures to be tracked or verified by leasing managers.

# V. Conclusions and Research Reflections

This thesis provides an evaluation methodology to compare six housing affordability measures by evaluating their performances along three dimensions: 1) standard, 2) data accuracy, and 3) comprehensiveness. The NAR Housing Affordability Index has a relative concept of housing affordability, which indicates the historic trend of housing affordability as opposed to affordability identified through a normative standard. The HUD Guideline is an application of the income ratio approach, which assumes that people devote a certain amount of income to housing no matter what their income is. The Amenity-based Housing Affordability Index and the H+T Affordability Index are revised applications of the income ratio approach. Both take more information into account when identifying housing affordability. The Self-Sufficiency Standard is based on the family budget approach, which calculates a basic wage to identify whether a family can meet basic needs including housing. Finally, the Shelter Poverty Measure is an application of the residual income approach. It measures the amount of income available for non-housing necessities after paying for housing.

The standard analysis shows that Self-Sufficiency Standard and Shelter Poverty Measure rank at the top of the six selected housing affordability measures. The H+T Affordability Index and Amenity-Based Housing Affordability Index rank in third place. The NAR Housing Affordability and the HUD Guideline rank at the bottom of the list.

The data accuracy analysis has three sections: 1) sample size, 2) use of data, and 3) data source and collection method. The sample size section measures the sample size of all the datasets used by each housing affordability measure. A dataset with a larger sample size is considered more accurate than one with a smaller sample size. The use of data section measures how these housing affordability measures handle data. A dataset that is used directly is considered more accurate than a dataset that is used after adjustment by other datasets or by researchers' assumptions. The last section evaluates how and where each dataset collects

data. A dataset with a more credible source, or a dataset that collects data through a more credible method, is considered more accurate than other datasets.

The data accuracy analysis indicates that the NAR Housing Affordability Index has the greatest data accuracy among the six selected measures. The Amenity-Based Housing Affordability Index ranks in second place. The H+T Affordability Index and HUD Guideline rank in third and fourth place. The Shelter Poverty Measure takes fifth place. And the Self-Sufficient Standard ranks at the bottom of the list.

The comprehensiveness analysis evaluates the amount of housing affordability-related topics covered by a given housing affordability measure. A housing affordability measure that covers more topics is able to describe housing affordability more accurately and is therefore considered a better measure than others. This section of analysis shows that the Self-Sufficient Standard is the most comprehensive housing affordability measure among the six selected. The Shelter Poverty Measure and Amenity-Based Housing Affordability Index rank in second place. The H+T Affordability Index has fourth place, the HUD Guideline takes fifth place, and the NAR Housing Affordability Index ranks at the bottom of the list.

Overall, based on my analysis, the Self-Sufficiency Standard is the best housing affordability measure among all six selected measures. This measure is best able to provide a monetary standard of housing affordability based on comprehensive data analysis.

### 5.1 Research reflections

The analysis of these six housing affordability measures can provide more insights into the housing affordability problem, on both the supply side and the demand side, than the simple results. The diagram below shows my understanding of the housing affordability problem after studying these six housing affordability measures.

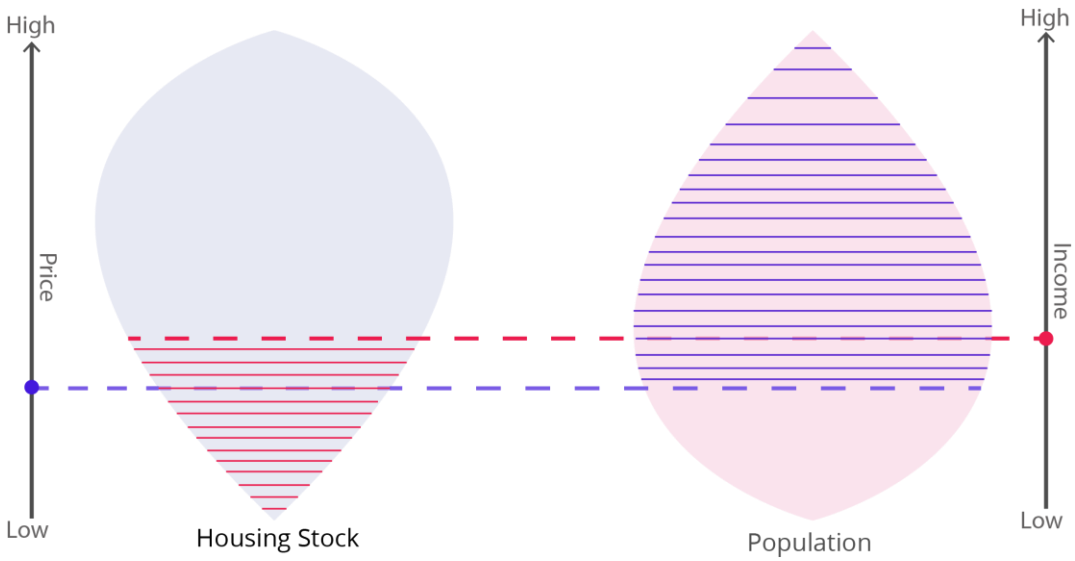


*Figure 5. Housing affordability issue diagram*

These two spindles represent housing stock and population. The axes on both sides represent the price of housing and the income of population. For a household earning certain income, the portion of housing that can be afforded by this household is shaded red on the housing stock spindle. For a housing unit at a certain price, the households that can afford it are shaded blue on the population spindle. In conclusion, the lower income a household has, the less affordable housing stock they can access, and the more potential competitors they will face. Because of this, even if the housing stock is managed such that there is just enough housing for all income levels, the housing affordability problem will still exist.

It is easier to solve the housing affordability problem for individual households than for the whole population. A passive solution is to provide them subsidies. To positively solve this problem, we can provide job training and counseling services for a given household to reach a higher income. Based on my study, the Self-Sufficiency Standard is the most powerful tool because of its ability not only to identify a household's target income, but also to provide information and advice for households in need.

It is more complicated to solve this problem at the level of the whole population and housing stock. Unlike individual households, we will not be able to improve the income of the households in need. The income of low-income households is primarily derived from their

wage. Wage reflects both the industry reality and the value created by workers. There is no way to ask a company to increase their workers' wage other than raising the minimum wage, which, in turn, will hurt many small businesses.

Increasing housing supply can mitigate the housing affordability problem but will not solve it completely. The way to increase supply is nothing more than establishing new land policies or incentive programs for developers. However, it is the housing market that primarily drives the housing supply. Developers will build when there is demand in the market and stop building when demand is saturated. As mentioned above, even if the housing supply matches demand perfectly, the housing affordability problem will still exist. And given housing developers' motivations, it is almost impossible to imagine a housing market that is so oversupplied in an economic environment so healthy that all people can find an affordable place to live.

Theoretically, a more efficient way to solve the problem is to increase supply only at the bottom rung of housing stock and keep these housing units available only to low-income households. This solution increases the choices of low-income households, but on the other hand, will not increase potential competition. The HUD Guideline, as mentioned previously, is the only affordable measure that can provide stable rent assumptions for affordable housing developers. Although the HUD Guideline fails to work as a housing affordability measure, it is (for now) the only tool that can help solve the housing affordability problem at the level of the whole population.

Based on the family budget approach and the residual income approach, an affordable housing measure can describe the relationship between housing and its users more accurately than those measures based on the income-ratio approach. The only disadvantage of these two approaches is that they cannot provide stable rent assumptions for affordable housing developers. In other words, if we can provide stable rent assumptions by using these two approaches, then we will be able to solve the housing affordability measure more efficiently because each approach can more accurately identify the households in need. Thus, future work

on this topic should focus on generating stable rent assumptions through the Self-Sufficiency Standard with the use of the residual income approach.

The real problem of embedding a new housing affordability measure into housing policies is to predict and track non-housing expenditures. Big data and machine learning have been widely used among tech companies and other businesses supported by tech companies. However, the housing industry seems not to have been affected by the development of current science and technology. Housing researchers should open up new horizons by partnering with technology providers like Amazon and Google to develop non-housing expenditure prediction methods.

## Bibliography

"About The Index | H+T Index." 2017. HTAIndex.CNT.org. http://htaindex.cnt.org/about/.

"Affordable Housing - CPD - HUD." 2017. Portal.HUD.gov. https://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/affordablehousing/.

"CE Methodology." 2017. BLS.gov. https://www.bls.gov/cex/ce_methodology.htm.

"Data — Child Care Aware Of WA." 2017. WA.ChildCareAware.org. http://wa.childcareaware.org/about-us/data.

"Data Inquiry | Boston Region MPO." 2017. CTPS.org. http://www.ctps.org/data_resources.

"Employment And Job Statistics." 2017. Labor And Workforce Development. http://www.mass.gov/lwd/economic-data/employment-jobs/.

"Methodology." 2017. www.NAR.realtor. https://www.nar.realtor/topics/housing-affordability-index/methodology.

"Required Annual LHA Reporting On Tenant And Unit Data." 2017. Housing And Economic Development. http://www.mass.gov/hed/housing/ph-manage/lha-data-collection.html.

"Sample Size | American Community Survey | U.S. Census Bureau." 2017. Census.gov. https://www.census.gov/acs/www/methodology/sample-size-and-data-quality/sample-size/index.php.

"USDA Food Plans: Cost Of Food | Center For Nutrition Policy And Promotion." 2017. CNPP.USDA.gov. https://www.cnpp.usda.gov/USDAFoodPlansCostofFood.

"Warren Data Solutions | The Warren Group." 2017. TheWarrenGroup.com. http://www.thewarrengroup.com/business/data-solutions/.

"What Is The National Transit Database (NTD) Program?" 2017. FTA. https://www.transit.dot.gov/ntd/what-national-transit-database-ntd-program.

Bogdon, Amy S., and Ayse Can. "Indicators of local housing affordability: Comparative and spatial approaches." Real Estate Economics 25, no. 1 (1997): 43.

Bureau, U.S. 2017. "AHS Methodology". Census.gov. https://www.census.gov/programs-surveys/ahs/about/methodology.html.

Bureau, U.S. 2017. "Current Population Survey". Census.gov. https://www.census.gov/programs-surveys/cps/about.html.

Cairns, Sara J., and Steven J. Schwager. "A comparison of association indices." Animal Behaviour 35, no. 5 (1987): 1454-1469.

Carliner, Michael S. S. "Development of Federal Homeownership 'Policy'." Housing Policy Debate 9, no. 2 (1998): 299-321.

Cervero, Robert, Karen Chapple, John Landis, Martin Wachs, Michael Duncan, Patricia Lynn Scholl, and Evelyn Blumenberg. "Making do: How working families in seven US metropolitan areas trade off housing costs and commuting times." (2006).

DeVaney, Sharon A., Sophia Chiremba, and Anne-Marie Vincent. "Life cycle stage and housing cost burden." Journal of Financial Counseling and Planning 15, no. 1 (2004): 31.

Feins, Judith D., and Terry Saunders Lane. How Much for Housing? : New Perspectives on Affordability and Risk. Cambridge, Mass.: Abt Books, 1981.

Fisher, Lynn M., Henry O. Pollakowski, and Jeffrey Zabel. "Amenity-Based Housing Affordability Indexes." Real Estate Economics 37, no. 4 (2009): 705-746.

Jewkes, Melanie D., and Lucy M. Delgadillo. "Weaknesses of housing affordability indices used by practitioners." (2010).

Kenngott, George Frederick. The Record of a City: A Social Survey of Lowell, Massachusetts. New York: Macmillan, 1912.

Kutty, Nandinee K. "A new measure of housing affordability: Estimates and analytical results." Housing policy debate 16, no. 1 (2005): 113-142.

Mattingly, K., and J. Morrissey. "Housing and transport expenditure: socio-spatial indicators of affordability in Auckland." Cities 38 (2014): 69-83.

Mori, Koichiro, and Aris Christodoulou. "Review of sustainability indices and indicators: Towards a new City Sustainability Index (CSI)." Environmental Impact Assessment Review 32, no. 1 (2012): 94-106.

Nelson, Arthur, Rolf Pendall, Casey Dawkins, and Gerrit Knaap. "The Link Between Growth Management and Housing Affordability: The Academic Evidence." Brookings Institution Reports, Feb 2002.

Pearce, Diana, Jennifer Brooks, Washington Association of Churches, Washington Living Wage Movement, Washington Self-Sufficiency Standard Committee, and Wider Opportunities for Women, Inc. The Self-Sufficiency Standard for Washington State. Seattle: Wider Opportunities for Women, 2001.

Pearce, Diana. "The Self-Sufficiency Standard for Washington State 2014." Prepared for Workforce Development Council of Seattle-King County.

Quality Agency. 2017. "Medical Expenditure Panel Survey Data Overview". MEPS.AHRQ.gov. https://meps.ahrq.gov/data_stats/data_overview.jsp.

Schwartz, Alex F. Housing policy in the United States. Routledge, 2014.

Schwartz, Mary, and Ellen Wilson. "Who can afford to live in a home?: A look at data from the 2006 American Community Survey." US Census Bureau (2008).

O., Kim S., Peter F. Orazem, and Daniel M. Otto. "The effects of housing prices, wages, and commuting time on joint residential and job location choices." American Journal of Agricultural Economics 83, no. 4 (2001): 1036-1048.

Stigler, George J. "The early history of empirical studies of consumer behavior." Journal of Political Economy 62, no. 2 (1954): 95-113.

Stoloff, Jennifer A. "A brief history of public housing." In annual meeting of the American Sociological Association, San Francisco, CA. 2004.

Stone, Michael E. "What Is Housing Affordability? The Case for the Residual Income Approach." Housing Policy Debate 17, no. 1 (2006): 151-84.

Stone, Michael E. Shelter Poverty: New Ideas on housing affordability. Philadelphia: Temple University Press, 1993.

Stone, Michael E., Terry Burke, and Liss Ralston. "The residual income approach to housing affordability: The theory and the practice." (2011).

U.S. Census Bureau, Center for Economic Studies. 2017. "Data - Longitudinal Employer-Household Dynamics". LEHD.CES.Census.gov. https://lehd.ces.census.gov/data/qwi_national_beta.html.