# Assessing Housing Options for Recent College Graduates

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## 1 Introduction

With housing expenses comprising a large percentage of monthly earnings, individuals are looking for more affordable housing. Despite the interest, there is little research regarding the costs and benefits of housing alternatives. Even more rare is research regarding the costs and benefits of living in a tiny house. While one American social movement seeks larger more luxurious homes and skips the traditional small startup homes (Cohen, 2017 [4]), the tiny house movement seeks the exact opposite. Tiny houses gained popularity from individuals interested in alternative and sustainable housing. However, tiny homes continue to gain attention by the financially frugal. Advocates view tiny homes as more environmentally friendly and financially attainable, in addition to being a natural promoter of a healthy lifestyle. On the other hand, critics argue tiny houses do not yield the expected benefits, primarily due to a lack of storage and the requirement to lease or purchase land for the home.

For young adults, specifically recent college graduates, the combined monthly expense of student loan payments and housing can be overwhelming. In order to minimize cost, many recent graduates seek to payoff loans in a speedy manner to reduce the total interest cost. However, in doing so, the graduates are forced to be financially frugal in all areas, including housing. Thus, affordable housing is of the utmost importance. A recent graduate's choice in housing could potentially impact their future financial stability by hindering their ability to repay loans and/or accrue savings.

The purpose of this analysis is to explore the costs and benefits of housing options for financially frugal recent college graduates. The analysis seeks to answer the following research

questions:

- What are the costs and benefits of different one-person housing options?
- What housing option yields the greatest net present benefit?

This report is organized as follows. Section 2 discusses the background and definitions of tiny houses. Section 3 discusses the study perspective, standing, and housing alternatives. The model and analysis framework is discussed in Section 4. Section 4 also contains discussions regarding assumptions and data sources. Section 5 describes the estimated costs and benefits used to calculate the benefit to cost ratio. Lastly, Section 6 discusses final suggestions for young adults and areas of further expansion for this analysis.

## 2 Background

According to *The Tiny Life* 2018[31] the typical tiny home ranges between 100 and 400 square feet; however, some building codes require homes to have a minimum square footage. The minimum requirement varies depending upon local building codes; thus, the legal definition of a tiny home is ambiguous. For this report, a tiny home will be defined as a dwelling less than 300 sq. ft., as used by Kilman 2016 [18], making the average square feet approximately 150 square feet. Due to the smaller size, tiny homes cost only a fraction of an average sized home. Despite the decreased square footage, the price of tiny homes is attracting increased demand.

Like traditional houses and apartments, tiny houses come in all shapes and sizes. However, land does not accompany the purchase of most tiny homes, like traditional real-estate. In fact, most tiny homes are built on trailers to circumvent local building codes (Kilman 2016 [18]). The smaller space inspires unique and abstract designs that include open-floor plans with condensed spaces, fewer appliances, and multi-purpose furniture. Clever storage designs and lofted beds help to efficiently use the space without sacrificing the overall comfort.

Wilson et al. claims, since the 1950s, the average American home has nearly doubled in size (Wilson 2015 [32]). Other sources claim the average American home jumped from 1,600 sq. ft. in 1973 to 2,598 sq. ft. in 2015, a nearly 64% increase over 42 years (Kilman 2015 [18]). The growth in house size is surprising given the decline in household size from 3.37 people in 1950 to 2.54 people in 2015 (US Census Bureau 2018 [28]). Increasing square footage directly translates into a higher

price tag. The average price of a new home in the United States in 1975 was $177,361.78 (inflated to 2015 dollars); whereas, the average price in 2015 was $348,300.00 (US Census Bureau 2018 [28]). Where over 42 years, the average household size decreased approximately 64%, the average price increased approximately 96%. The increasing price of housing, let alone the increasing price per square foot, is enough to make financially limited individuals to question the real necessity of luxury space.

Further, the standard repayment schedule for federal student loans is 10 years[14] and the average student loan debt was $37,172 in 2016 (Fay 2018 [11]). Assuming graduates accept the 10-year repayment plan and a 4.29% interest rate, Fay 2018 [11] claims students can expect to pay $382 per month for ten years. Students may choose another payment plan, extending the duration of their payments; however, this dramatically increases the overall cost due to increased interest. The idea of large debt and a decade of payments further causes individuals to entertain the concept of forgoing luxury space to save money.

Additionally, young adults, especially recent college graduates, typically move often. According to Benestsky et al. 2015 young adults (18-34 years old) are most likely to move, but for various reasons, including school, jobs, and affordable housing. Young adults make up approximately 23.7% of the national population, but account for over 43% of American movers (Benetsky 2015 [2]). With limited financial resources, student debt, and a significant chance of moving, affordable and sustainable housing is a priority. Thus this paper seeks to explore the ex-ante environmental, financial, and health benefits and costs of housing options for recent college graduates. According to Cilluffo et al. 2017, young adults, meaning adults younger than 35, are the most likely to rent, as 65% of renters in 2016 were young adults. However, living with roommates or living alone can highly alter housing costs (Cilluffo et al. 2017 [3]).

Yet the question remains whether downsizing to a tiny home actually yields the perceived benefits.

# 3 Scope

## 3.1 Study Perspective and Standing

This analysis is conducted from the perspective of a recent college graduate. For this analysis the term 'young adult' and 'graduate' are the same. Due to limited financial resources, the young adult desires to minimize the financial costs both in the present and future. This ex-ante analysis assumes all costs and benefits are assumed by the young adult, meaning the graduate is no longer a dependent of his or her parents. For the purposes of this study, it is assumed a young adult does not have kids, and desires to live alone, either in a one bedroom or studio apartment. Though third parties may be affected by a difference in natural resource consumption through utilities and transportation, the affect on an entire population is considered to be minuscule when discussing from the perspective of a single individual. Similar to environmental impacts, several other industries could have standing in the decision to live in a tiny house; however, the costs and benefits for such industries are minuscule in this study. However, this study is done from the perspective all young adults or all individuals, other industries would have standing. Therefore, for this analysis there are no other parties with standing.

## 3.2 Alternatives

Most college students rent an apartment or house; thus, the status quo decision is to rent a one bedroom or studio apartment. However, there are several alternatives, including: purchasing an apartment, purchasing a tiny home and leasing land, and purchasing a tiny home and land. Further, the individual has the choice to finance the tiny home. The following study seeks to evaluate the costs and benefits of each option in order to best inform the recent graduate of the optimal financial option.

# 4 Model Framework

This analysis evaluates the financial costs of post-graduation housing. Research conducted by Benestsky et al. 2015 [2] regarding which age groups are most likely to move, and Cilluffo et al. 2017 [3] regarding which age groups are most likely to rent align. Young adults, between eighteen and thirty-five years of age are most likely to move and rent. Hence, making the 'status quo' most

likely. It is also assumed that at some point individuals will follow the societal norm of 'settling down' in one location for an extend period of time. Therefore, this analysis seeks to quantify the total cost of housing for a recent college graduate from graduation until age thirty-five. Assuming college graduates are twenty-two at time of graduation, then the analysis will span thirteen years.

This analysis estimates the total cost through the monetization and predictions of seven factors: (1) cost of physical space, as shown through rent, mortgage, and down payments; (2) taxation costs, including property tax and trailer registration fees; (3) utility costs, including electric and natural gas; (4) financial costs of daily commute to the work place; (5) avoided costs of moving; (6) avoided health costs due to increased activity levels from spending more time outdoors; and (7) acquired equity from apartment or land purchases.

This model monetizes and predicts the eight factors within each of the eleven U.S. General Services Administration (GSA) Regions 2017 [13], as many of the variables explored in this analysis vary depending upon the region of the United States. Figure 1 provides a visual of the eleven GSA regions (jpeabody 2017 [17]). Due to a lack of data for Washington D.C., GSA region 11, it is excluded from this analysis.

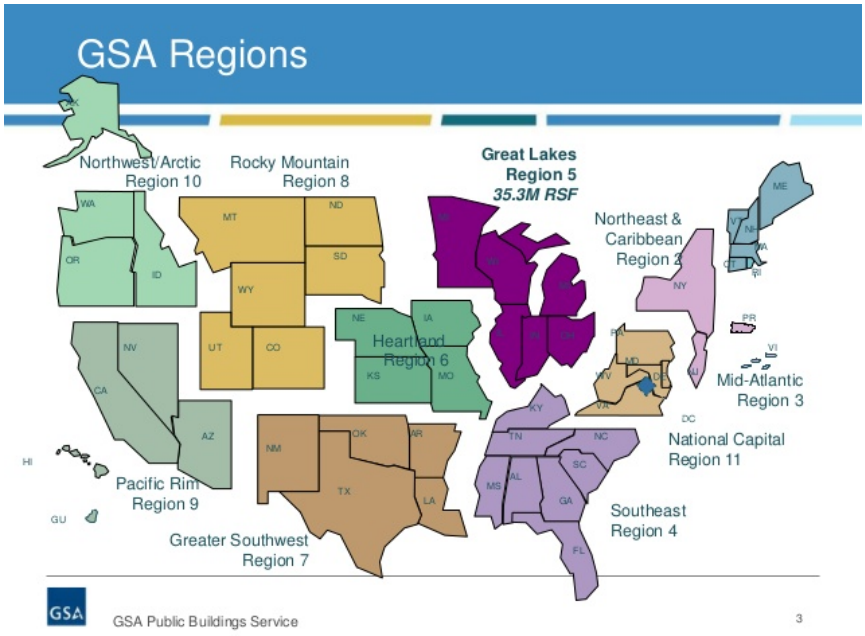


Fig. 1: The eleven GSA Congressional Regions obtained from jpeabody 2017 [17].

## 4.1 Key Assumptions

Table 1 describes which of the eight factors apply to each alternative and whether the factor is a cost or benefit. However, in assigning factors as costs or benefits involve five few key assumptions: (1) tiny home owners have farther daily commutes; (2) all tiny homes are mobile, meaning they exist atop trailers; (3) the individual will keep the tiny home after the thirteen-year span, meaning the individual does not receive financial benefits of equity; and (4) tiny home owners spend more time outdoors due to less indoor space, and thus are more active.

| **Cost/Benefit** | **Rent Apartment** | **Buy Apartment** | **Tiny House & Rent Land** | **Tiny House & Buy Land** |
|---|---|---|---|---|
| Rent | C | | C | |
| Loan Payment | | C | possible C | possible C |
| Down Payment | | C | C | C |
| Taxes | | C | C | C |
| Utilities | C | C | C | C |
| Commute Costs | C | C | C | C |
| Avoided Moving Costs | | | B | B |
| Health | | | B | B |
| Equity | | B | | B |

Tab. 1: Costs and Benefits of Each Housing Option. Possible C due to the young adult choosing to finance the tiny home. **C = Cost, B = Benefit**

## 4.2 Data Sources

There is little research conducted regarding tiny houses. This is likely due to the fact that tiny houses are a new fad. As a result, monetizing factors required more calculations, and the data and statistical values used in this analysis were obtained from a wide range of sources. To simplify the explanation of the origin of values in the following models, Appendix A provides an extensive description and breakdown of origin of each value or data set used to calculate the value in each of the models.

## 4.3 Modeling of Costs

Throughout the paper the subscript $n$ will refer to the ten GSA regions, as shown in Figure 1. The average values within a region were calculated by:

$$\overline{value_n^k} = \frac{1}{n}\sum_{i=1}^{I}\overline{value_i^k} \tag{1}$$

where $i$ represents a specific state within region $n$, and $I$ is the total number of states within region $n$. The superscript $k$ refers to either an apartment (k = 1) or a tiny home (k = 2). Common statistical notation of $\bar{x}$ is used to represent averages. All values used in calculations were either provided in 2017 units or adjusted to 2017 units by:

$$\frac{(1+inflationRate)^{t-2017}}{(1+discountRate)^{t-2017}} \tag{2}$$

where $t$ is a year in the future, $inflationRate = 0.04$, and $discountRate = 0.02$.

Rent and mortgages make up a great portion of the overall cost of housing. The average cost of rent and the average cost per square foot for an apartment and plots of land varies by GSA region. For a young adult who, in this analysis, is assumed to move and live alone, purchasing a property may be a hassle. Young adults likely do not have the financial capital to purchase property. With a high likelihood of moving, the young adult would be caught in a circle of purchasing and selling properties. The short duration of owning a property does not allow the property to acquire equity (discussed in Section 4.4), and can result in a financial loss due to housing market fluctuations. On the other hand, empty lots of land for rent are more difficult to find than lots for sale. Meaning, the individual may have limited options for leasing land, and may be pressured to purchase a lot due to the scarcity of rental lots.

For this analysis, the rent of land and apartments is modeled by the following two equations:

$$LandRent_n = \sum_{t=2017}^{2030}(rent\ to\ price\ ratio)_n * \overline{land\_price_n} * (12months) * Equation2 \tag{3}$$

$$AptRent_n = \sum_{t=2017}^{2030}\overline{apt\_price_n} * (12months) * Equation2 \tag{4}$$

where $\overline{apt\_price_n}$ includes rental prices for one bedroom and studio apartments. Due to the rarity of the empty lot rentals, the $(rent\ to\ price\ ratio) = 4.18\%$ calculated by Davis 2018 [7] is used to calculate rent prices rather than actual rent prices of lots of land. Allowing actual rental

prices to form the average rental land price could result in an inaccurate approximation due to the small sample size. Real monthly rental prices for one bedroom and studio apartments are abundant; thus, the resulting average rental price of an apartment in each region will more accurately reflect the actual rental prices.

On the other hand, purchasing an apartment, a tiny home, and land for a tiny home typically translates to a down payment, sometimes followed by a monthly mortgage payment. It is rare for an individual to pay in full when purchasing an apartment or plot of land, but it is common for purchasers of tiny homes to pay in full. For this analysis, like down payments, the money used to purchase a tiny home comes from the individual's savings.

The individual may choose to apply for a loan to purchase a tiny home. However, due to the significantly smaller price, the individual would neither apply for, nor receive, a mortgage loan. In fact, many lenders do not consider tiny homes to actually be a home due to local zoning codes and the fact the tiny homes are on trailers. Hence, it is assumed the individual will finance the tiny home through application of a loan similar to an RV loan. If the individual chooses to pay for the tiny home in entirety, the down payment of the tiny home (as indicated by superscript TH) is equivalent to the entirety of the average purchase price, as shown in Equation 5. *The Tiny House Life* 2018 [31] estimates the average price of a tiny house is $23,000.

$$DownPayment^{TH} = \overline{purchaseprice^{TH}} \tag{5}$$

It is assumed if the individual chooses to finance the tiny home, the individual will have a down payment similar to that of a down payment on an apartment. According to Cook's *Down Payment Report* 2017 [5], the median down payment for first time buyers when purchasing a house or apartment for 2017 was 5% of the purchase price. Yet, the average down payment required for land loans is typically around 20% (Dixon 2018 [8]). Similarly, Sweren 2015 [27] claims typically down payments for RV loans range from about 10% to 20%, so for this analysis the down payment is considered to be 15% of the purchase price. Notice how the estimated down payments for all three loans, especially land and RV loans, are ranges. Hence, these percentages of total purchase price would be good variables for future sensitivity analysis.

The down payments are modeled by the following equation:

$$DownPayment^{type} = rate^{type} * \overline{purchaseprice^{type}} \tag{6}$$

where *rate* is the suggested percent of property value suggested for a down payment, as set forth by Cook 2018 [5], Dixon 218 [8], and Sweren 2015 [27]. *type* indicates the down payment for an apartment, lot of land, and tiny home when financed. It is important to note that especially on RV loans, a higher down payment could result in a reduced interest rate. Though a reduction in interest rate would reduce total cost, the young adult would likely chose to finance due to limited savings, meaning the young adult may not have the financial resources for a higher down payment.

Understandably, the types of loans and interest rates available for the purchase of an apartment, plot of land, and tiny home are very different. Therefore, the loans will have varying durations and interest rates, as shown in Table 2. The interest rates are assumed to be fixed, and it is assumed the individual would not seek to re-finance during the thirteen-year span. The average interest rate for land loans, 5.55%, is calculated from the range of interest rates for land loans shown in Table 2 (USAA 2018 [26]). The total cost of loan payments for the thirteen-year span is modeled by:

$$LoanPayment^{type} = \sum_{t=2017}^{2030} (monthlypayment)^{type} * (12months) \tag{7}$$

where the monthly payment is calculated using the monthly payment mortgage formula and *type* indicates the monthly payments calculated using the respective type of loan for an apartment, lot of land, and tiny home. The monthly payments are calculated according to the average purchase prices. To avoid double counting, the down payment is subtracted from the purchase price used to calculate the monthly payments.

| Loan Type | Interest Rate | Duration |
|---|---|---|
| Mortgage[6] | 4.15% | 30 yrs |
| Land Loan[26] | 5.05% - 6.05% | 30 yrs |
| RV Loan[25] | 5% | 20 yrs |

Tab. 2: Interest rates and duration of loans.

Moreover, in both the case of purchasing a property and/or a tiny home, the individual will pay taxes in some form. The individual will be required to pay state property taxes on purchases of apartments and land. Since it is assumed tiny homes are mobile, the individual will be required to pay state registration fees for the trailer. The property taxes are modeled by:

$$PropertyTax = \sum_{t=2017}^{2030} \overline{rate_n^{type}} * \overline{property\_price_n^{type}} * Equation2 \tag{8}$$

where *type* includes apartments and plots of land. The property taxes are dependent upon the property value, which varies by GSA region; hence, the property taxes are calculated for each GSA region.

Modeling registration fees is a little challenging, as each state has very different trailer and RV registration requirements. Registration rates can be flat rates, dependent upon the age of the trailer/RV, or dependent upon the value of the trailer/RV. The document provided by the U.S. National Conference of State Legislatures 2018 [30] describes registration pricing in all states. The cost of registration ranges from approximately $20 - $220 (U.S. National Conference of State Legislatures 2018 [30]). For this analysis the cost of registration is estimated to be the median of these values: $120. Registration is also assumed to occur on an annual basis. Hence, the total registration is modeled by:

$$RegistrationFees = \sum_{t=2017}^{2030} 120 * Equation2 \tag{9}$$

The wide range of registration fees and methods of calculating registration fees lends the annual registration fee to be a good variable for sensitivity analysis.

Regardless of location or type of housing, the individual will have the monthly expense of utilities. Though, the expense of utilities will differ primarily due to two factors: (1) square feet; and (2) the cost of utilities in each GSA region. For this analysis, the square feet of a tiny home will be 150 sq.ft., as together Kilman 2016 [18] and The Tiny Life 2018 [31] suggest the square feet of a tiny home ranges from 100-300 square feet. The square footage of a tiny home is assumed to be the same for all GSA regions. The cost of utilities is modeled by:

$$TotalUtilities^k = \sum_{t=2017}^{2030} (12 months) \frac{\overline{sqft_n^k}}{\overline{sqft_{all}}} \left( \overline{electric_n} * \frac{\overline{e\_price_n}}{100} + \overline{gas_n} * \overline{g\_price_n} * 1000 \right) * Equation2 \tag{10}$$

where $\overline{sqft_n^k}$ is the average square feet of an apartment or tiny home in each GSA region, $\overline{sqft_{all}}$ is the average square feet of a single family home in the United States, $\overline{electric_n^k}$ is the average Kilowatt-hours of electricity used by single family homes, $\frac{\overline{e\_price_n}}{100}$ is the average price of dollars per Kilowatt-hour in each region, $\overline{gas_n^k}$ is the average million cubic feet of natural gas used by single family homes, $\overline{e\_price_n} * (1000)$ is the average price of dollars per million cubic feet of natural gas in each region. The prices for electricity and natural gas have different units than the average measurements of usage (cents per Killowatt-hour and dollars per thousand cubic feet,

respectively); hence, the prices are converted in Equation 10.

Other factors such as insulation and open floor plans may affect the cost of utilities; however, they are not considered in this study. The openness of a floor plan is dependent upon numerous factors such as square feet, the year the built, and the height of ceilings. Thus, quantifying the openness of a floor plan proves extremely complicated.

A natural assumption is the recent graduate will be employed from graduation until thirty-five years of age. Thus, for the thirteen-years, the individuals will have travel costs of commuting every work day. By nature, most apartments are located very close to or in metropolitan areas. Land availability for tiny homes is typically outside of dense populous areas, meaning the land available for tiny homes is outside of the metropolis area. This results in a longer daily commute for tiny home owners. For this analysis, it is assumed that the individual drives a gasoline car and will drive to work every work day. The monetized cost of commuting for apartment and tiny home dwellers is modeled by:

$$TotalCommute^k = \begin{cases} \frac{\overline{commute}}{\overline{mpg}} * (260days) * \overline{price} * Equation2 & apartment(k=1) \\ \\ \frac{\overline{commute}+\sigma}{\overline{mpg}} * (260days) * \overline{price} * Equation2 & tinyhome(k=2) \end{cases} \tag{11}$$

where $\overline{commute}$ is the average commute of a metropolitan resident and $\overline{mpg}$ is the average fuel efficiency of a gasoline car (Kneebone 2015 [19] and Federal Highway Administration 2015 [1]). The calculated average commute distance for a tiny home owner relies on the assumption that commutes distances are normally distributed. This further assumes the average commute of a tiny home owner is equal to or more than one standard deviation larger than that of an apartment owner. The value of $\sigma$ would be a good variable for sensitivity analysis.

The assumption that tiny home owners have a longer commute would further assume tiny home owner must travel a greater distance to all other commodities within metropolitan areas. Meaning, living farther from metropolitan areas represents an opportunity cost in terms of ability to spontaneously decide to go out and the duration of time out. Though an area of further development, this analysis does not incorporate the cost of travel for any other purposes besides work. Further, notice how the calculated commute distance and price is not dependent upon GSA region. The average commute distance and price per gallon of fuel may vary by GSA

region; however, such factors are not included in this analysis due to a lack of data.

## 4.4 Modeling of Benefits

Though there are several costs of the choice of housing, there are several benefits and avoided costs. Young adults are most likely to move, but moving can be very expensive, especially for individuals with limited financial resources. The expense of moving depends on the distance, region, and possible reimbursement by employers. In this analysis, the cost of moving is assumed to be approximately the same for all regions. Moving costs are considered avoided costs, as tiny homes were assumed to be mobile. Thus, tiny home owners avoid the money and hassle of packing and moving belongs, as all belongings can remain in the home itself during relocation. The avoided moving costs is modeled by:

$$AvoidedMovingCost = \sum_{t=2017}^{2030} P(moving) * \overline{moving} * Equation2 \tag{12}$$

where $P(moving)$ is the probability of moving per year and $\overline{moving}$ is the average cost of an individual move as estimated by the World Wide ERC Foundation 2011 [16] (Benetsky 2015 [2]). The probability of moving each year is estimated to be approximately 11.25%, and the average cost of moving a household is $5,630. Although some individuals move less or more than predicted, the estimation of the avoided moving costs provides a basis for understanding the potential financial costs of adhering to the social trend of young adults moving. It is more likely for a young adult to move during the thirteen-year span than to remain in one location; therefore, it is imperative to take into consideration the potential high costs of moving.

Yet another benefit of owning a tiny house is health. As stated previously, it is assumed tiny home owners spend more time outdoors due to less indoor space, and in doing so, the owners are more active. As commonly understood, being more active has positive affects on an individual's overall health. Since tiny home owners naturally spend more time outdoors, they avoid the expenses of having to pay to remain active. For this study, the avoided health costs of owning a tiny home is calculated according to the equation:

$$AvoidedHealthCost = \sum_{t=2017}^{2030} (360days) * (WTP) * Equation2 \tag{13}$$

where $WTP$ is a representative monetary value for an individual's willingness to pay to avoid a

'restricted activity day', as set forth by Field et al. 2008 [10]. The young adult's willingness to pay is assumed to be the same as the value set forth by Field et al. 2008 [10]: $38. The individual's willingness to pay is further assumed to be the same across all regions. Individuals are willing to pay to reduce the potential of premature mortality. Increased activity can help to reduce chances of developing diseases most commonly related to lack of exercise such as, heart disease, diabetes, and asthma. Since individuals who are naturally more active - tiny home owners in this case - would likely be willing to pay less to reduce the probability of premature death because their lifestyle reduces probability of premature death through increased activity.

The last financial benefit considered in this analysis is the equity of homes and property. One large financial benefit to purchasing property is the acquirement of equity. The purchase of a property today has the possibility of yielding financial returns in the future, when sold. For the purpose of this analysis, it is assumed the young adult will not sell the tiny home in the future, as tiny homes can be re-purposed. Tiny homes can be used as vacation cabins and guest houses once the individual decides to change housing situations. However, the purchase of an apartment or piece of land would result in the acquirement of equity. In this analysis, equity is modeled by:

$$Equity = \sum_{t=2017}^{2030} 0.067 * \overline{PropertyPrice_n^k} * Equation2 \tag{14}$$

where 0.067 is the House Price Index (HPI) for the fourth quarter of 2017, as calculated by the U.S. Federal Housing Finance Agency 2018 [29]. In this model it is important to note that k represents the type of property; however, this model only applies to purchasing an apartment and purchasing a lot of land for a tiny home. It is also important to note the HPI does not account for inflation. The model assumes the housing market to grow according to the HPI value of 6.7% for the next thirteen years. Since the housing market fluctuates, this method of estimation will likely result in an overestimation of equity.

## 5 Results

Housing costs make up a large portion of each individuals' income; however, the percentage of their income housing accounts for varies by region. It is commonly known that expenses are higher in some regions of the United States, causing the costs and benefits of housing to change. This model took into account six housing options, as seen in Table 3: (1) rent an apartment, (2) rent land and purchase a tiny home, (3) rent land and finance a tiny house, (4) finance an apartment, (5) purchase land and tiny home, (6) purchase land and finance a tiny home.

Tab. 3: Alternative housing options assessed in this study.

| Option | Description |
|---|---|
| Option1 | Rent Apartment |
| Option2 | Rent Land and Purchase Tiny Home |
| Option3 | Rent Land and Finance Tiny Home |
| Option4 | Finance Apartment |
| Option5 | Finance Land and Purchase Tiny Home |
| Option6 | Finance Land and Finance Tiny Home |

Due to a lack of data for Washington D.C., GSA region 11, it was excluded from this analysis. Yet, it is important to note the high price of living in Washington D.C. would likely result in a high cost of living. Meaning, it is very unlikely living in GSA region 11 would yield the greatest cost to benefit ratio. Therefore, the exclusion of region 11 will not affect the final decision.

## 5.1 Predicted Costs

To account for the variability in cost in each region, the cost, benefits, and benefit-cost ratio were calculated for each of the GSA regions (Figure 1). It is important to note that while costs may be higher in some regions, the hourly wage also varies by region, as seen in the variation of the minimum wage between states.

Further it is important to note, that while the variation in hourly wages may help a recent graduate afford the higher cost of housing, an increase in wage does not necessarily mean the recent graduate can afford the higher cost of housing. Table 4 shows the cost of each housing option per year. The National Center For Education Statistics (NCES) 2017 [15] estimates the yearly income of an individual twenty-five to thirty-four years of age with a bachelors degree is $50,000. Notice how in some instances, the yearly cost of housing exceed the NCES's estimated yearly wage. Though an option, these housing options are unpractical for young adults. Nearly 70% of the options exceed $50,000 per year, as seen in Table 4. This extremely limits the options of affordable housing for young adults.

Table 5 shows the total costs spanning thirteen years for each housing option in each region. The range in cost for each housing option greatly varies. The range in cost is greater

Tab. 4: Cost of housing per year.

| Region | Option1 | Option2 | Option3 | Option4 | Option5 | Option6 |
|---|---|---|---|---|---|---|
| Region 1 | $24,838.51 | $58,014.04 | $81,948.72 | $153,631.67 | $81,269.48 | $105,204.15 |
| Region 2 | $70,464.70 | $125,667.49 | $149,602.17 | $191,804.63 | $164,708.83 | $188,643.51 |
| Region 3 | $30,008.80 | $88,986.74 | $112,921.41 | $141,610.33 | $123,107.70 | $147,042.37 |
| Region 4 | $25,610.85 | $48,932.30 | $72,866.98 | $103,439.20 | $65,926.91 | $89,861.58 |
| Region 5 | $39,704.71 | $50,129.11 | $74,063.79 | $111,271.55 | $60,641.33 | $84,576.00 |
| Region 6 | $19,527.69 | $27,153.24 | $51,087.92 | $74,758.45 | $34,750.85 | $58,685.52 |
| Region 7 | $24,224.67 | $33,055.88 | $56,990.56 | $73,497.50 | $42,453.73 | $66,388.40 |
| Region 8 | $18,270.51 | $80,861.22 | $104,795.90 | $136,195.26 | $114,765.60 | $138,700.27 |
| Region 9 | $51,985.75 | $266,948.16 | $290,882.84 | $261,277.07 | $373,758.03 | $397,692.71 |
| Region 10 | $23,280.52 | $101,383.76 | $125,318.44 | $164,828.33 | $144,412.74 | $168,347.41 |

when living in a tiny home than an apartment. This increase in variability is caused in part by the average cost of land in each region. Land in East and West Coast states is more expensive than land in the West and Midwest states. Further, one downside of living in a tiny house is the increased number of expenses. Tiny home owners must make monthly payment for land and pay for the tiny home. However, despite the larger number of costs, in several regions, living in a tiny home is either cheaper or comparable in price to purchasing an apartment.

Notice renting an apartment in GSA Region 8 is the least expensive; whereas, purchasing land and financing a tiny home in GSA Region 9 is the most expensive option, costing over $5,100,000. For a young adult, a $5.1 million price tag is unrealistic. This follows intuition, as financing land and a tiny home results in two down payments and two loans. Choosing to finance both land and the tiny home results in the additional cost of interest. Moreover, while living everywhere in Region 10 may not cost over $5.1 million, Region 10 includes the states California, New Mexico and Nevada. California is known for having a high cost of living, which leads to the suspicion that the high prices in California are likely have a dominating influence in the cost calculations for Region 10. In addition, the West and Midwest states typically have some of the lowest costs of living, so it was expected the least expensive housing option would occur in a West or Midwest region.

The cost distributions for each alternative is shown in Figure 2. There are two primary

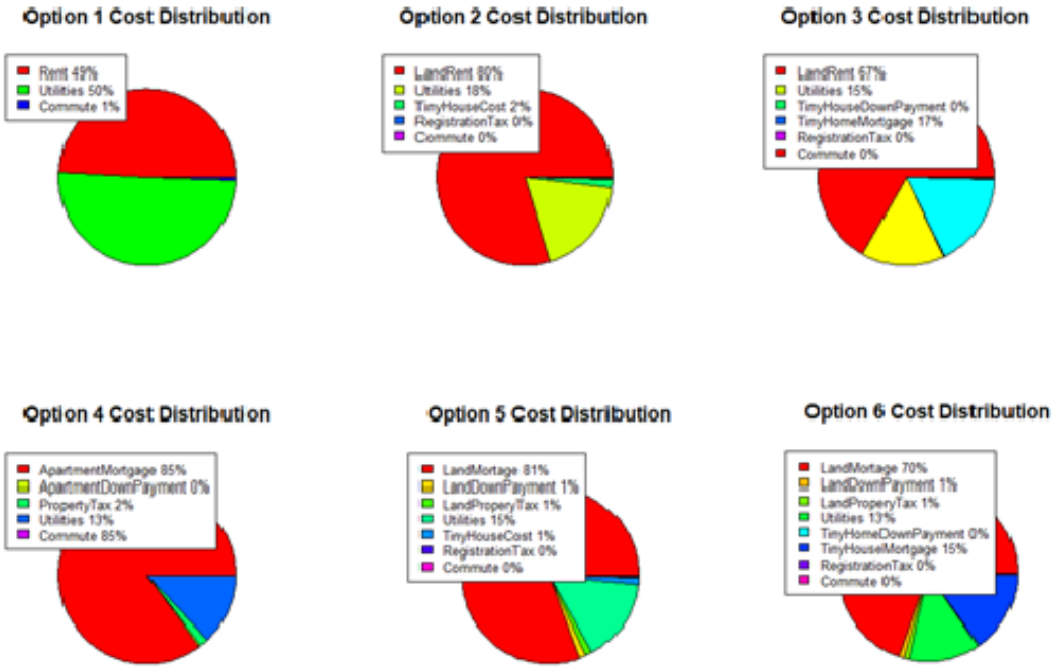


Fig. 2: Cost distributions for housing alternatives.

differences between these alternatives: (1) the number of expenses, and (2) the percentage of which rent/loan payments make up the total cost. Even though living in a tiny home has a greater number of expenses, in some cases the cost of living in a tiny house is cheaper than renting or purchasing an apartment. This signals that the number of costs does not correlate into a higher overall cost.

Figure 2 further indicates the price of land is the greatest contributer to the cost of living in a tiny house. The cost of living in a tiny house could be decreased by finding an alternative cheaper plot of land or location to park the tiny home. Further observe how after the cost of rent/loan payments, the cost of utilities is typically the second largest contributer to the overall cost. In all housing alternatives, young adults could seek to save money through reducing their utility usage through awareness of use and other methods, such as improved insulation.

Figure 3 shows that the predicted benefits are typically smaller than the estimated costs for each housing alternative. Interestingly, the options and regions with the greatest and least benefits do not correlate to those with the greatest and lowest costs. Figure 3 also gives a visual

representation of the great range in costs and benefits between ranges and between housing alternatives. On average, it appears as though renting an apartment has the lowest cost, but notice renting an apartment also has no benefits like the other housing alternatives. Hence, it is important to explore the benefits, as Figure 3 hints the benefits could cause another housing alternative to be the best housing option.

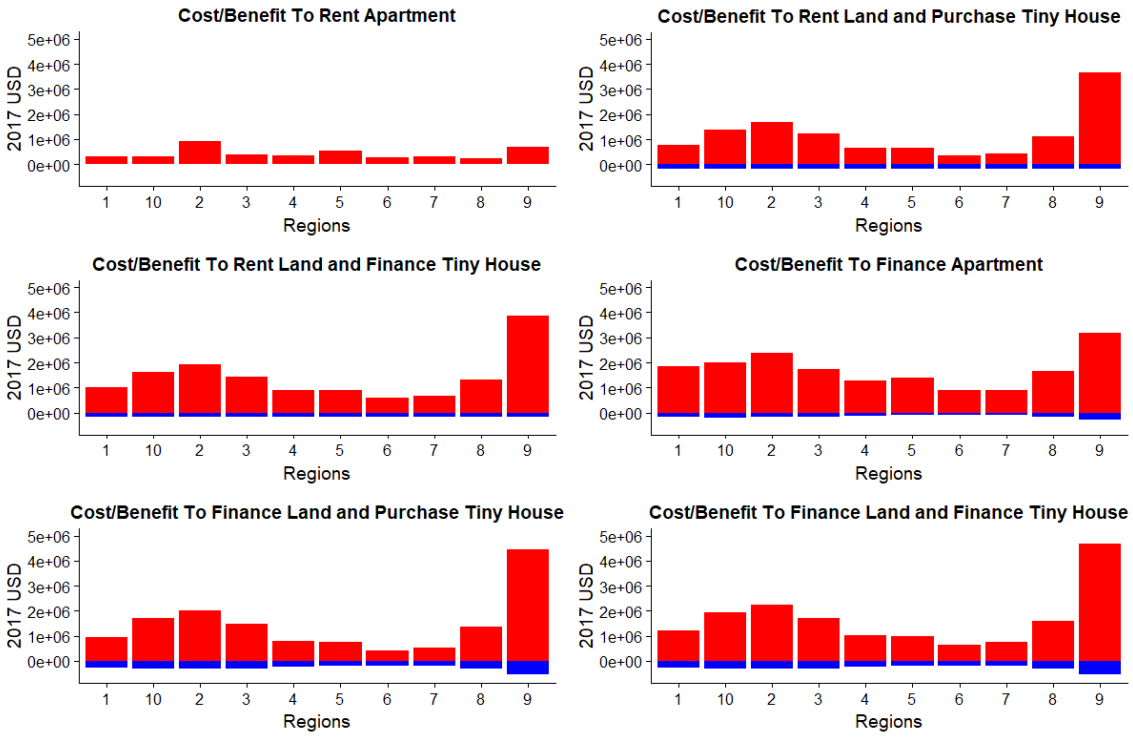


Fig. 3: Cost and benefits of housing options in GSA Regions.

## 5.2 Predicted Benefits

The predicted monetized benefits of each housing option in each region is shown in Table 5. Notice how the housing options pertaining to tiny houses have greater benefits. This is expected, as tiny home owners are outdoors more, save on moving costs, and have a smaller $CO^2$ emission footprint than their apartment dweller counterparts. Option 1 (the choice to rent an apartment) has no calculated benefits, as the renter does not receive equity, spend more time outdoors, reduce their $CO^2$ emission, or reduce their moving costs. Similarly, the only benefit from purchasing an apartment is equity. The calculated benefits signal that despite the equity earned on an apartment, living in a tiny home, whether renting or purchasing land, will always yield greater benefits.

In fact, a young adult can gain the most by living in a tiny home in Region 2. Notice how the greatest benefits from living in a tiny house come from reduced $CO^2$ emission and living a more active life style. This signals that the part of the final decision on housing depends upon the individuals value on a healthy life style and individual contribution to reduce pollution.

Figure 4 shows the distribution of benefits for each housing alternative. Notice Figure 4 follows the results seen in Table 5, as several of the alternatives have the same benefits. The avoided health costs make up the greatest proportion of the benefits for tiny home owners. In fact, the qualitative benefit is the most influential benefit of the cost-benefit analysis.

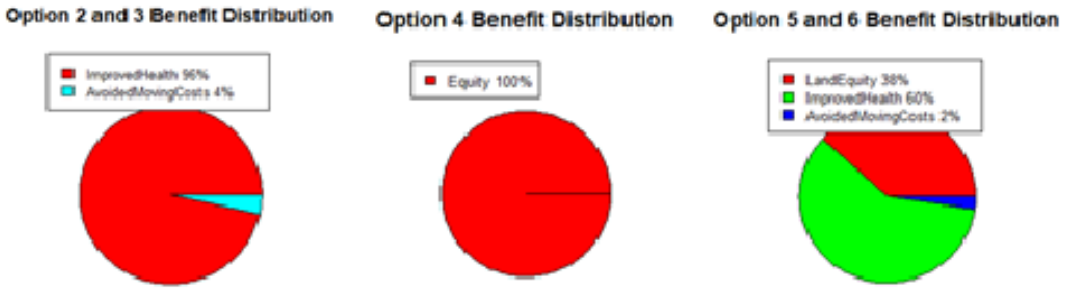


Fig. 4: Benefit distributions for housing alternatives.

## 5.3 The Best Choice

The goal of the recent college graduate is to reduce the total cost of housing. The differing best options identified by cost and benefit signals the cost of housing is not necessarily correlated to the benefits. Therefore, a benefit to cost ratio shows the option and region in which a young adult will receive the greatest benefit per one dollar of cost. The benefit to cost ratios shown in Table 5 are below one, leaving all alternatives as unappealing to a young adults. However, it is important to remember the recent graduate must reside somewhere, therefore, the best alternative has the highest benefit to cost ratio.

Table 5 shows the highest benefit to cost ration occurs in renting land and purchasing a tiny home in Region 6. As expected from the results of benefits, the lowest ratio occurs in renting an apartment in all Regions. In fact, the benefit to cost ratios of living in a tiny house are in some cases ten times larger than that of living in an apartment. Like the total benefits, the benefit to cost ratio of living in a tiny home, whether renting or purchasing land, is higher than apartment

living. This is due to the benefit of living a healthier lifestyle.

## 5.4 Sensitivity Analysis

Sensitivity analysis was completed on the estimated constant values of the equations. Each constant was varied by 20% of its estimated value. Figure 5 shows the estimated impact on the total cost with the variance of each single predictor. This model is most sensitive to the probability of moving and the cost per move, meaning the avoided cost of moving has the greatest impact in determining which housing option is most beneficial. Furthermore, notice the variables of highest impact are those associated with the qualitative benefits monetized in this study. This further suggests the non-monetary benefits of housing options play a large role in deciding upon a housing option, as the benefit placed on each one of these variables varies by person.

Furthermore, because the costs of living in a tiny home are higher than renting an apartment, increasing or decreasing the value associated with the qualitative benefits will ultimately affect the net cost of each housing alternative. The benefit to cost ratio of tiny homes is directly correlated to these values. Meaning, as these values increase or decrease, the benefit to cost ratio of tiny houses will increase and decrease, respectively. Therefore, if the qualitative benefits are thought to be insignificant, then the benefit to cost ratios of living in a tiny home would be comparable, if not smaller, than that of financing an apartment. Overall, the existence and value placed on the qualitative benefits is a primary cause in tiny house living yielding higher benefit to cost ratios.

# 6 Conclusion

Until now, the costs and benefits of housing alternatives for recent college graduates and young adults were not modeled or discussed in order to determine the most cost effective housing alternative. This analysis shows the best housing alternative does not remain constant through regions. Therefore, the best housing alternative ultimately depends on where the young adult lives and places the young adult would be willing to move. Reducing total cost of housing depends upon the young adult's ability to reduce their housing costs in all regions in which they live during the 13 year span. Given current trends, the cost of housing will continue to increase, increasing the concern for affordable housing for all people, especially young adults.

Tab. 5: Quantified Costs and Benefits of Each Housing Option Listed in Table 3.

| Region | Option1 | Option2 | Option3 | Option4 | Option5 | Option6 |
|---|---|---|---|---|---|---|
| **COSTS ($)** | | | | | | |
| Region 1 | $322,900.58 | $754,182.58 | $1,065,333.36 | $1,997,211.76 | $1,056,503.18 | $1,367,653.95 |
| Region 2 | $916,041.08 | $1,633,677.38 | $1,944,828.15 | $2,493,460.16 | $2,141,214.82 | $2,452,365.59 |
| Region 3 | $390,114.38 | $1,156,827.56 | $1,467,978.34 | $1,840,934.31 | $1,600,400.09 | $1,911,550.86 |
| Region 4 | $332,940.99 | $636,119.92 | $947,270.70 | $1,344,709.57 | $857,049.81 | $1,168,200.58 |
| Region 5 | $516,161.29 | $651,678.48 | $962,829.25 | $1,446,530.10 | $788,337.23 | $1,099,488.00 |
| Region 6 | $253,859.97 | $352,992.17 | $664,142.94 | $971,859.79 | $451,760.99 | $762,911.77 |
| Region 7 | $314,920.67 | $429,726.47 | $740,877.24 | $955,467.50 | $551,898.46 | $863,049.23 |
| Region 8 | $237,516.64 | $1,051,195.89 | $1,362,346.66 | $1,770,538.40 | $1,491,952.79 | $1,803,103.57 |
| Region 9 | $675,814.78 | $3,470,326.12 | $3,781,476.89 | $3,396,601.97 | $4,858,854.45 | $ 5,170,005.23 |
| Region 10 | $302,646.70 | $1,317,988.89 | $1,629,139.66 | $2,142,768.28 | $1,877,365.61 | $2,188,516.38 |
| **BENEFITS ($)** | | | | | | |
| Region 1 | $0.00 | $213,728.90 | $213,728.90 | $174,812.21 | $286,686.49 | $286,686.49 |
| Region 2 | $0.00 | $213,728.90 | $213,728.90 | $177,530.11 | $335,166.70 | $335,166.70 |
| Region 3 | $0.00 | $213,728.90 | $213,728.90 | $154,496.80 | $323,787.56 | $323,787.56 |
| Region 4 | $0.00 | $213,728.90 | $213,728.90 | $112,991.46 | $268,956.07 | $268,956.07 |
| Region 5 | $0.00 | $213,728.90 | $213,728.90 | $102,061.33 | $246,873.52 | $246,873.52 |
| Region 6 | $0.00 | $213,728.90 | $213,728.90 | $78,708.43 | $237,785.26 | $237,785.26 |
| Region 7 | $0.00 | $213,728.90 | $213,728.90 | $75,700.82 | $244,083.60 | $244,083.60 |
| Region 8 | $0.00 | $213,728.90 | $213,728.90 | $158,012.97 | $323,684.52 | $323,684.52 |
| Region 9 | $0.00 | $213,728.90 | $213,728.90 | $277,533.56 | $562,763.64 | $562,763.64 |
| Region 10 | $0.00 | $213,728.90 | $213,728.90 | $190,633.94 | $352,476.26 | $352,476.26 |
| **BENIFIT TO COST RATIO** | | | | | | |
| Region 1 | $0.00 | $0.28 | $0.20 | $0.09 | $0.27 | $0.21 |
| Region 2 | $0.00 | $0.13 | $0.11 | $0.07 | $0.16 | $0.14 |
| Region 3 | $0.00 | $0.18 | $0.15 | $0.08 | $0.20 | $0.17 |
| Region 4 | $0.00 | $0.34 | $0.23 | $0.08 | $0.31 | $0.23 |
| Region 5 | $0.00 | $0.33 | $0.22 | $0.07 | $0.31 | $0.22 |
| Region 6 | $0.00 | $0.61 | $0.32 | $0.08 | $0.53 | $0.31 |
| Region 7 | $0.00 | $0.50 | $0.29 | $0.08 | $0.44 | $0.28 |
| Region 8 | $0.00 | $0.20 | $0.16 | $0.09 | $0.22 | $0.18 |
| Region 9 | $0.00 | $0.06 | $0.06 | $0.08 | $0.12 | $0.11 |
| Region 10 | $0.00 | $0.16 | $0.13 | $0.09 | $0.19 | $0.16 |

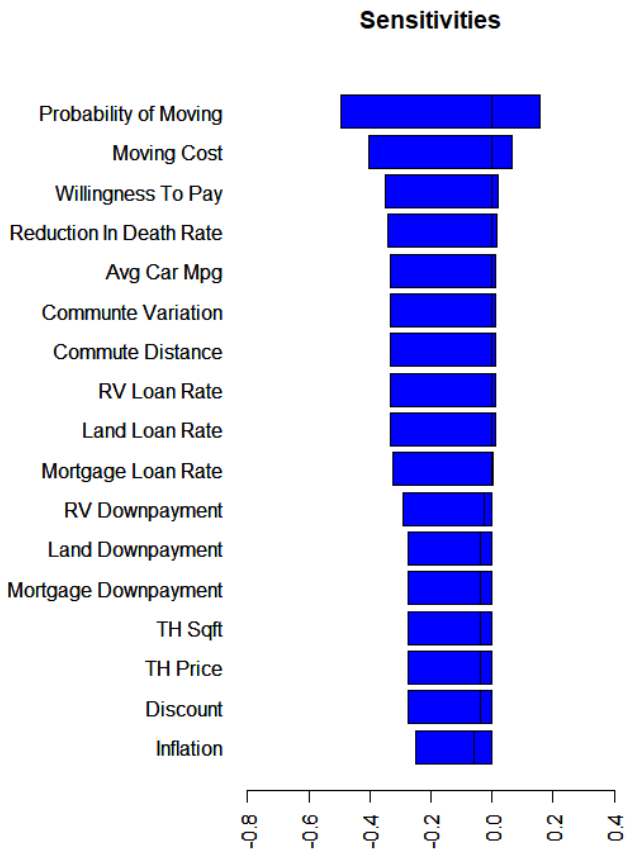


Fig. 5: Tornado plot of sensitivity analysis.

## 6.1 Model Improvement

Though this analysis models several costs and benefits of housing, there are several areas of improvement for this analysis in the future. The following are areas of improvement and development of this analysis.

- One important benefit of living in a tiny home is the reduced pollution through reduced use of utilities. Further work would include finding a method to accurately monetize the environmental impact of living in an apartment and a tiny home.
- This model is sensitive to moving costs; hence, further work would include more accurately modeling the probability a young adult moves and modeling the cost of moving as a function of how much stuff the young adults own and how far they intend to move.

- This model overestimates the benefit of equity. Future work would require the modeling of equity to account for possible housing market functions.
- There are other important costs associated with housing, such as the cost of insurance and maintenance. In many cases, the young adult will be required to insure their property and pay for maintenance, which vary greatly by housing alternative.
- The use of utilities is partially dependent upon the openness of a floor plan. Therefore, further work would include estimating utility costs and usage as a function of the floor plan openness.
- This model only accounts for the increased commute costs to and from the work place. However, tiny home owners would have to travel farther for all other amenities.

# Appendices

### Appendix A: Sources for Values in Models

Sources of values in models or data sets from which values in models were calculated. See Section 4.

| Variables | | Source |
|---|---|---|
| General | Avg Tiny Home Cost | (The Tiny House Life, 2018)[31] |
| | Avg Apartment Purchase Price Per Region | (Zillow, 2018)[33](exported values in 2017 dollars) |
| | Avg Land Purchase Price Per Region | Inflated from (Davis, 2007)[7] |
| | Avg Tiny Home Sq Ft | (Kilman, 2016)[18] and (The Tiny House Life, 2018)[31] |
| | Avg Apartment Sq Ft Per Region | Inflated from (Davis, 2007)[7] |
| Rent | Rent-Price Ratio | Inflated from (Davis,2008)[7] |
| Loan Payment | Apartment Mortgage | (Bankrate, 2018)[6] |
| | Land Loan Interest Rates | (Greenstone, 2018)[26] |
| | RV Loans Interest Rates | (USAA,2018)[25] |
| Down Payment | Mortgage Percentage | (cook, 2017)[5] |
| | Land Loans Percentage | (Dixon, 2018)[8] |
| | RV Loans Percentage | Inflated from (Swere, 2015)[27] |
| Property Tax | Rate Per Region | Inflated from (Logan, 2017)[20] |
| | Registration Fees | (NCSL, 2017)[30] |
| Utilities | Average Electric Use Per Region | (EIA, 2017)[9] |
| | Average Natural Gas Use Per Region | (EIA, 2017)[9] |
| | Average Electric Cost Per Region | (EIA, 2017)[9] |
| | Average Natural Gas Cost Per Region | (EIA, 2018)[9] |
| Commute | Average Distance | Inflated from (Kneebone, 2015)[19] |
| | Average Gasoline Cost Per Region | Discounted from (EIA, 2018)[9] |
| | Average Miles Per Gallon | Inflated from (FHA, 2015)[1] |
| Avoided Moving Costs | Probability of Moving | Inflated from (Benetsky, 2015)[2] |
| | Average Cost of Moving | ERC 2018[16] |
| Avoided Health Cost | Willingness to Pay for Reduction in Premature Death | Inflated from (Fields, 2008)[10] |
| Equity | House Price Index (HPI) | (FHFA, 2018)[29] |

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