

Home Ownership Report

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Abstract

In the United States, owning a home is part of the national dream. Historically, the government has encouraged home ownership as a method of accumulating wealth for all Americans. Extensive research has been done on U.S. home ownership. This research has been accompanied by a range of visualizations.

The goal of our team's research is to expand upon the existing literature and visualizations. We review U.S. home ownership from several perspectives. We examine national trends, review factors that may constrain home ownership, and assess whether home ownership remains an important way to build wealth for most Americans. Our national trend review examines a variety of historical legislative, physical, economic, and financial metrics. Our constraint factor analysis reviews geographic, demographic, and income metrics. This analysis looks at current correlations and touches upon machine learning methods that may provide further insights.

We have primarily based our research on information readily available to the public or through subscription, with the U.S. Census as our primary source. We have created a variety of visualizations to improve understanding about factors that influence this piece of the American dream.

Overview

1 Introduction

1.1 The American Dream

For centuries, American residents and immigrants have dreamed of improving their families' and their own conditions. The conditions they aspired to improve have included refuge from persecution and starvation, and freedom to worship, to speak, and to seek prosperity.

1.2 Accumulating Wealth

A key path to achieving the prosperity embodied in the American Dream has been home ownership. Since its founding, the United States has had a high rate of home ownership in comparison to many other countries. Even after the decrease in home values and home ownership rates after the recession of 2008-2009, three studies have found that home ownership continues to be one of the best paths to accumulating wealth in the United States (Neal, 2013; Herbert et al., 2013; Swanson, 2019). One study from 2017 did find that investing may be a better path to building wealth than home ownership, yet the authors noted that many Americans may not have the discipline to invest in risky enough assets to make this a better option for them (Hellegaard, 2017). Moreover, since a low in United States home ownership rates in 2016, home ownership rates have begun to rise, especially since the beginning of the COVID-19 pandemic.

1.3 Home Ownership Generates Wealth

There are several reasons home ownership can be so effective in building wealth in the United States (Hecht, 2017; Herbert et al., 2013). First, the home can appreciate in value, increasing the owner's equity, sometimes substantially. Second, potential appreciation can offset inflation, as the value of homes often increase during inflationary periods, unlike many other assets. Third, the owner's investment can be leveraged, providing an accelerant to building equity as home mortgages or loans are paid off. Fourth, home ownership can force the owner to save; the owner must pay any mortgages/loans monthly rather than spending their income on other disposable items. Finally, taxpayers who itemize their taxes can sometimes increase their tax deductions, saving on tax payments.

1.4 The Vital Asset

For many Americans, their equity in their home is also their largest asset: “Not only is homeownership the key component of the American Dream, the home is the largest store of wealth for the majority of American families” (Jones, 2019). Two studies, one by the National Association of Home Builders and the other by the U.S. Census Bureau have found that their equity in their home is the single largest asset for many Americans. The Census Bureau study from 2014 and 2015 highlighted that at 34.1% to 34.5%, equity in owned homes is the largest class of Americans’ overall net worth with retirement accounts second at 28.9% to 29.1%. For middle and low-income Americans who are homeowners, the equity in their home often accounts for 40% to 60% of their wealth (Neal, 2013).

1.5 Secondary Benefits

Finally, home ownership provides several secondary benefits as noted by the Urban Institute:

“The benefits of owning a home in the United States are well documented. Homes can create wealth for their owners that in turn can benefit families for generations.

Homeownership can also reduce economic risk by protecting families from rising rent prices. Owning a home has also been associated with better psychological health and greater stability for homeowners’ children” (Lee et al., 2020).

1.6 Visualization Objective

Visualization can be used to illustrate factors raising or reducing home ownership rates. Our efforts will focus first on national trends that may affect these rates. As many influences on ownership are both more granular and localized, our second focus will examine specific factors constraining home ownership rates, such as demographics and locality. Finally, our report will review the circumstances in which an individual or household should seek to own a home.

2 Background

Since the end of the fifteenth century, European settlers immigrating to North America often became homesteaders. This historical anomaly was enabled by four unusual factors. The first was sparsely populated land. The first European settlers had survived a set of deadly Asian, European, and African diseases in the two previous centuries, and their deadly viral load swiftly killed more than 90% of the exposed indigenous American populations. The second was the limited presence of feudal aristocracy. The settlers in North America did not include many aristocrats unlike those in South America, where the Spanish and Portuguese aristocratic settlers swiftly seized ownership of large tracts of land, preventing widespread homesteading. The last two were a combination of the English Common Law system and establishment of locally representative government, both of which inhibited seizure of land by the politically connected or wealthy from smaller homeowners.

The result of these four factors, which also occurred in Canada and Australia, was the embedding of the concept of home ownership in the set of national aspirations called the American Dream by the middle of the nineteenth century. This begins to explain the significantly higher home ownership rates at the beginning of the twentieth century in the United States, also Canada and Australia, in comparison to developed European and Asian countries, even those also under the English Common Law system, as illustrated in **Figure 2-1**.

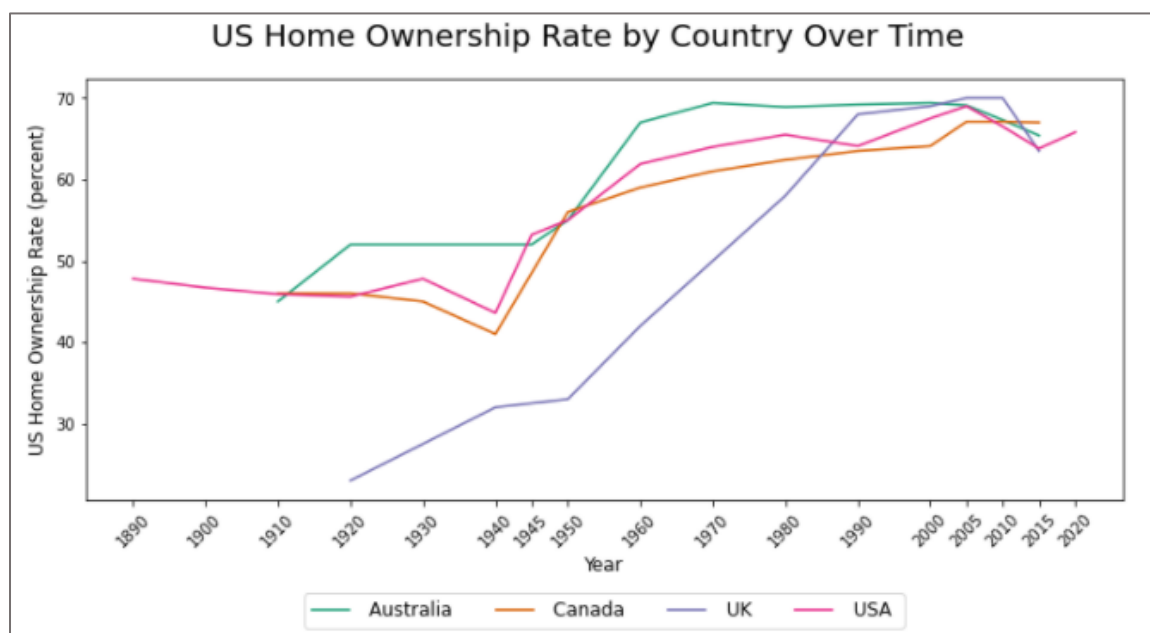


Figure 2-1 Home Ownership Rates by Country Over Time.

(Pollock, 2014; Reserve Bank of Australia 2015; Trading Economics; U.S. Census Bureau).

Almost from its inception, the United States government encouraged this homesteading and home ownership. This is first evident in government encouragement of settlers in the Ohio valley and upper Midwest in the early 1800s, although this effort also had objectives in subverting English treaty limits and countering slave state growth in the American South. After the American Civil War, these efforts accelerated with a series of laws and regulations that explicitly emphasized increased home ownership.

Given the American interest and encouragement of home ownership, extensive research has been conducted in this area. The most active researchers can be found in government, policy institutes, industry, and academia. They include government officials at the U.S. Census Bureau, Department of Housing and Urban Development, Federal Reserve Bank, and Bureau of Economic Analysis. The policy institutes include the American Enterprise Institute, the Manhattan Institute, the Pew Research Center, and the Urban Institute. Industry groups include the National Association of Home Builders (NAHB). University professors and scholars also have produced a variety of studies.

Recent studies from these sources have focused on federal trends at both the national and state levels, home ownership differences, and home ownership in comparison to renting. Several studies have significant relevance to our investigation. These include the following:

- A 2019 Pew Research study, that reviewed household size since 1790 and found the first slight increase in number of people per household in the last 160 years with an increase from 2.58 in 2010 to 2.63 in 2018 (Fry, 2020).
- A 2014 American Enterprise Institute analysis, that illustrated that home square foot space per person has doubled while the number of persons in a household has declined by more than 16% in the last 50 years (Perry, 2014).
- A 2013 Harvard University study, that examined whether home ownership was still a good wealth-building method for low-income households and concluded that it was (Herbert et al., 2013).
- A 2017 Urban Institute study, that highlighted that African American and Young Adult households were falling behind in home ownership compared to other groups (Lee et al., 2020).

- A 2021 Manhattan Institute study, that assessed the limits that inadequate housing placed on urban growth and concluded that excessive land use regulation constrained home building (Kober, 2021).
- A 2013 U.S. Census study, that examined Home Ownership affordability in 2009 and highlighted what challenges were faced by first time home purchasers [citation].
- A 2013 National Association of Home Builders (NAHB) study, that analyzed household wealth and the key role of home ownership in that wealth (Neal, 2013).
- A 2017 Florida Atlantic University study, that assessed whether home ownership or equity investing was a better approach to building wealth. This study concluded that, if the household could invest wisely and regularly in somewhat risky equities, that path would lead to the highest returns. However, if the household did not have sufficient willingness to make investments containing sufficient risk, then home ownership was the better approach (Hellegaard, 2017).

Existing Visualizations

Given the attention paid to U.S. home ownership, both as a policy subject and as an economic statistic, there are many existing visualizations on this subject. As with this report, the visualizations can be categorized into three groups: national, factor analysis, and purchase decision.

2.1 National

The first group is national in scope and often includes a time element. Two examples of these are static charts describing long-term and contemporary home ownership trends. The American Enterprise Institute provides a surprisingly powerful visualization comparing U.S. and Canadian home ownership rates over time (**Figure 2-2**). This visualization adeptly shows a similar hundred-year trend in home ownership in both countries, with potential current divergence. The author goes on to compare these rates with those of the United Kingdom, which does not have open frontiers or substantial empty land, employing effective single comparison time series line graphs. An even more powerful and efficient visual image could have been prepared had the author composed a visual with all three of the countries' trends.

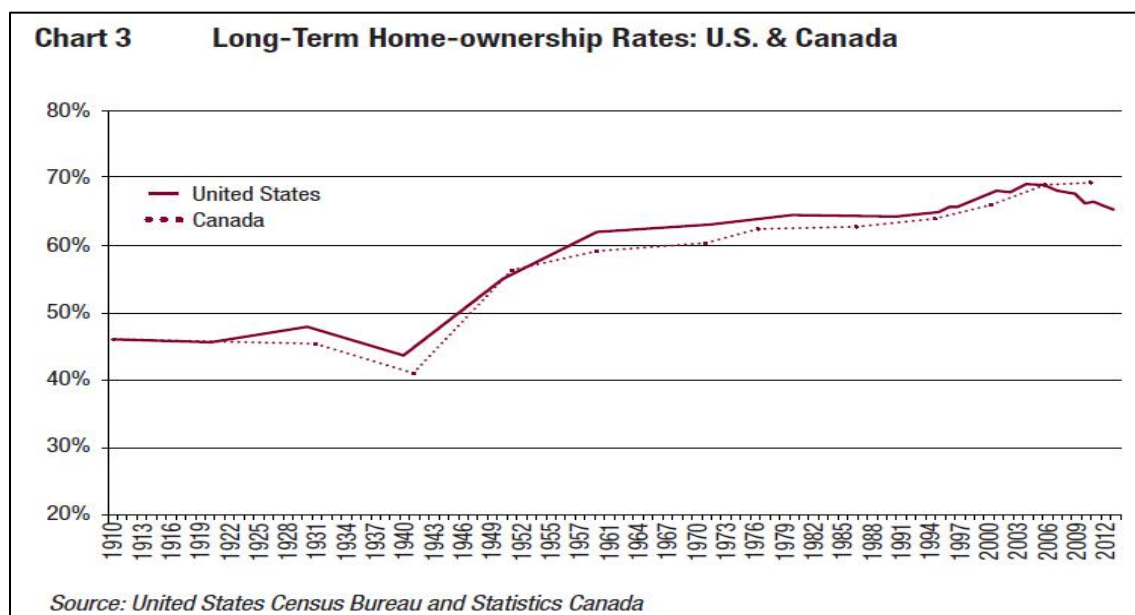


Figure 2-2 Static Chart of home ownership rates in the U.S. and Canada (Pollock, 2014)

Another good visualization is a comparison of U.S. home ownership rates with recessions provided by Advisor Perspectives (**Error! Reference source not found.**). This visualization provides a comparison of current U.S. home ownership rates with trends over the last half-century with distinct comparative emphasis on prior trends and peaks. The singular weakness of this image is a lack of explanation as to why the impact of recessions has been so varied. It should be noted that this weakness may be intentional: the author's comments and other images are intended to encourage exploration of other visualizations and commentary on the website.

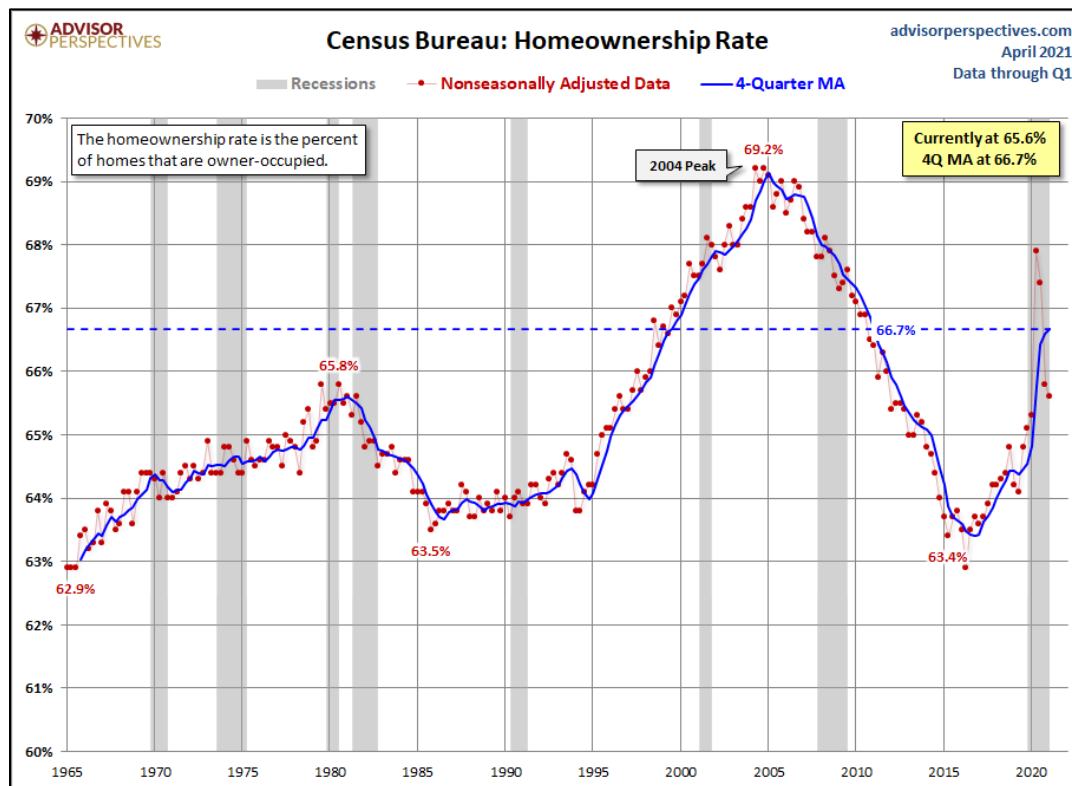


Figure 2-3 Static Chart of U.S. home ownership trends with recessions (Misliniski, 2021)

A third national visualization provides another perspective that may illustrate a more current constraint on increasing home ownership rates (**Figure 2-4**). This 2019 visualization from Pew Research examines the number of persons in households historically, highlighting the considerable decline in persons per household from 5.5+ two centuries ago to 2.63 currently. This visualization requires some additional context, which Pew Research provides in the accompanying commentary. Otherwise, it is powerful in its simplicity.

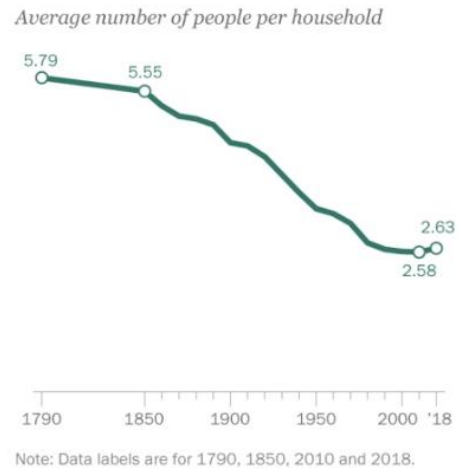


Figure 2-4 Static average household occupants (Fry, 2019).

2.2 National – Economics Statistic

A sub-category in this national group review U.S. home ownership as an economic statistic, often for use in financial analysis and investment decisions. Trading Economics provides an excellent, but potentially overwhelming, interactive visualization (**Figure 2-5**) in support of trading and other investment decisions.

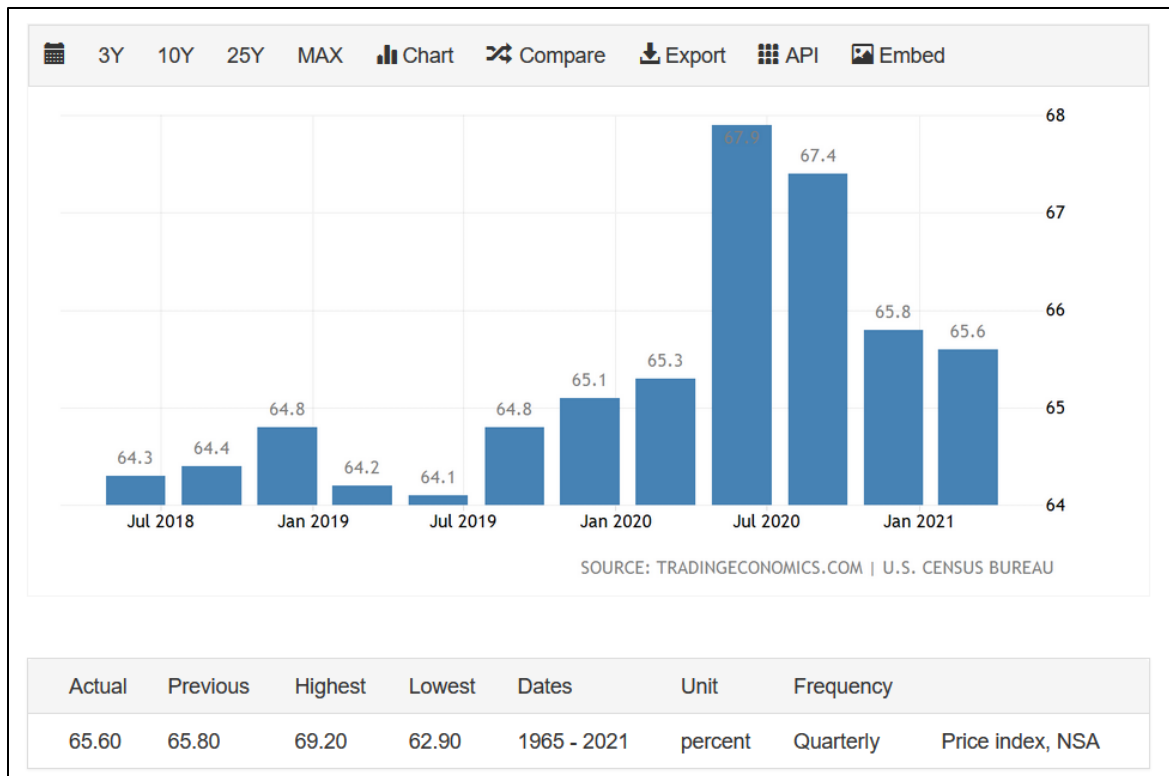


Figure 2-5 Interactive Chart combining economic statistics (Trading Economics 2021).

This interactive chart facilitates rapid time series analysis of U.S. home ownership rates with one selected economic statistic, such as GDP or Unemployment Rate. It supports comparisons with economic statistics of many other countries and commodity prices. Both underlying data and selected comparisons can be displayed in more than five different formats, ranging from lines to bars to pie charts, with more than five key trends/points highlighted. The data is also available for analysis directly or through APIs. The great strength of this visualization is its flexibility, but it challenges the audience to have some understanding of the underlying relationships, as a comparison of U.S. home ownership trends with, for example, Bahamian GDP is visually interesting but potentially misleading (**Figure 2-6**).

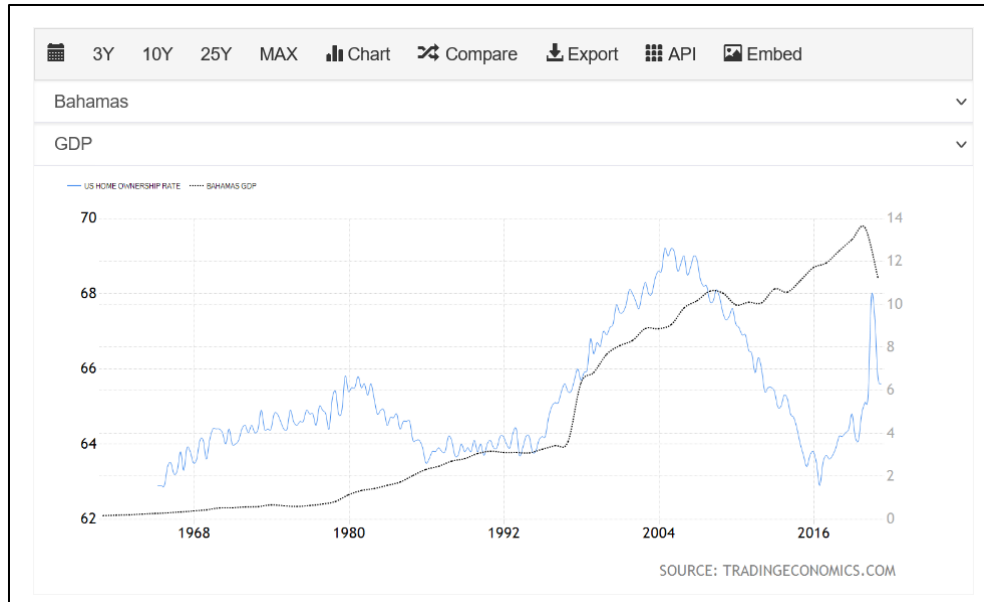


Figure 2-6 U.S. Home Ownership v. Bahamian GDP (Trading Economics 2021)

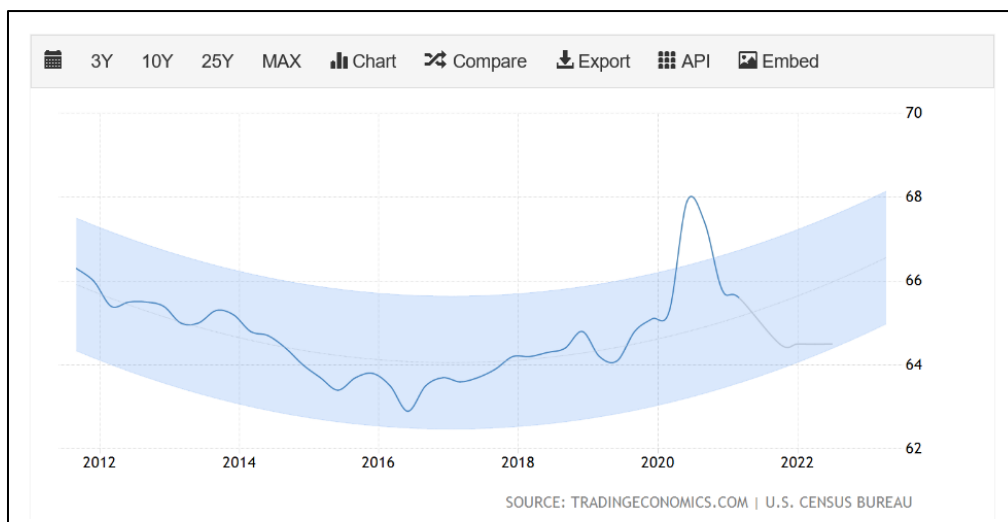


Figure 2-7 U.S. Home Ownership forecast (Trading Economics 2021).

Even more flexible visualization tools are available to Trading Economics subscribers, such as comparisons of three or more statistics and forecasts (**Figure 2-7**). These interactive visualizations can adeptly aid in trading and investment decision-making.

2.3 Factor Analysis

The second group of existing visualizations portray different factors of U.S. home ownership. This group is perhaps the most extensive, as there are many different perspectives from which to examine U.S. home ownership. A good example of this is a flexible visualization is provided by the U.S. Census Bureau (**Figure 2-8**).

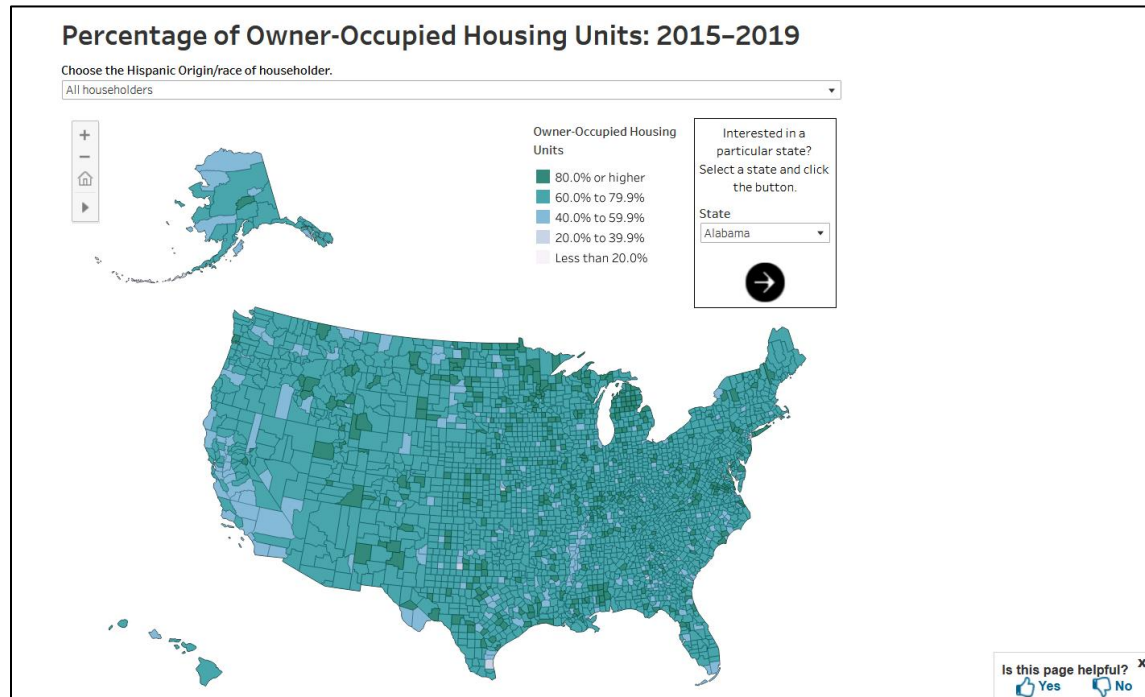


Figure 2-8 Interactive Chart from U.S. Census Data by Race and State (Percentage of Owner-Occupied Housing Units: 2015-2019 2021)

This interactive chart provides geographic summary and filterable data of U.S. home ownership by race and geography. While the data can be filtered by race and geography, it can also be examined on a much more detailed level using a zoom feature. It can also be annotated for presentations. This is a powerful visualization for a specific purpose. However, it does not realize its full potential since it only supports comparisons in a geographic dimension but not in a racial dimension. Nevertheless, its zoom feature is quite powerful as seen in this portrayal of the very low U.S. home ownership rates in New York City's populous Bronx, Manhattan, and Brooklyn counties and New Jersey's Hudson County (**Figure 2-9**).

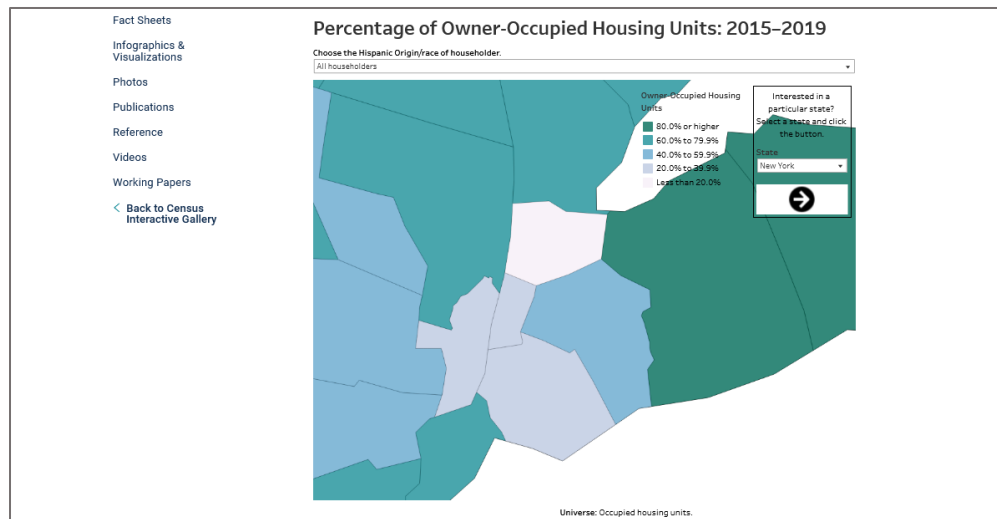


Figure 2-9 U.S. Census: home ownership in New York City and surrounding counties
(Percentage of Owner-Occupied Housing Units: 2015-2019 2021).

As all real estate ownership has local factors, a number of these different perspective visualizations follow the U.S. Census visualization by illustrating further differences by state, often including a historical aspect. An interactive chart prepared by Harvard Business School is one example (**Figure 2-10** Figure 2.9).

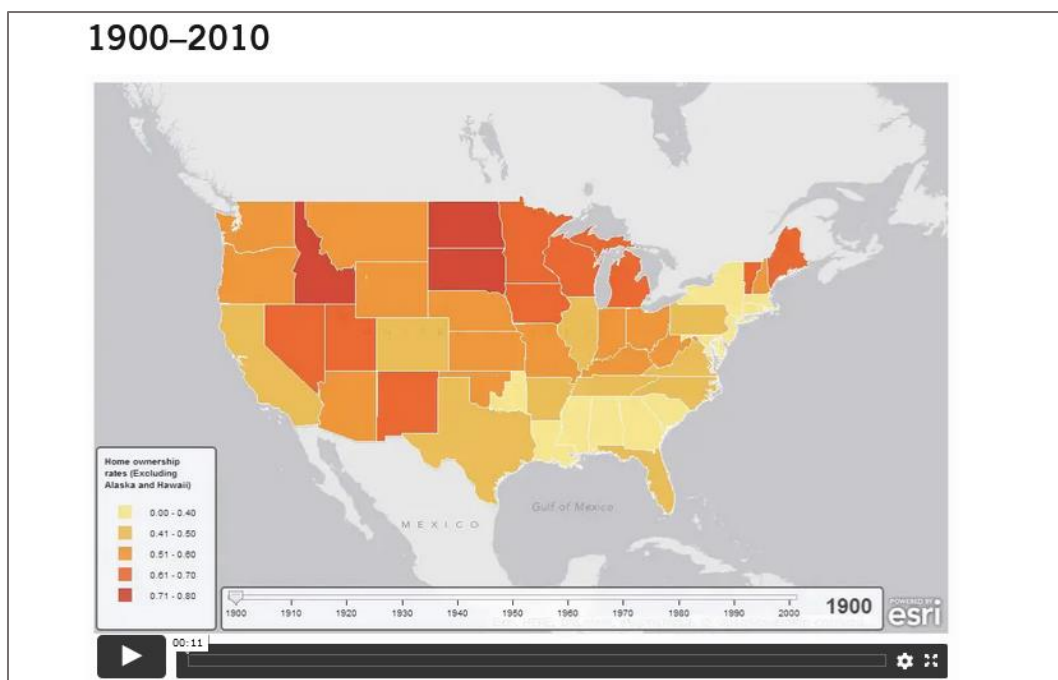


Figure 2-10 Interactive chart of U.S. Historical home ownership rates by state (HBS, Historical Data Visualization 2011)

This chart is an excellent visualization of the gradual increase in U.S. home ownership by state during the twentieth century and provided inspiration for one of this report's visualizations. The only challenging aspect of this visualization is the red scale as deeper red hues are often used to indicate greater concern. Another approach to state home ownership comparisons, this from the early twenty-first century, used the small multiple method (**Figure 2-11** Figure 2.10). This visualization uses multiple area charts to highlight state changes in home ownership over the volatile period from 2000-2013. It adeptly shows the low rates of California, Hawaii, and New York. It also highlights the declines in Florida, Georgia, and Nevada because of the housing mortgage crisis of 2008. The considerable challenge with this approach, however, is the need to shrink each chart due to the number of states involved, which can reduce legibility.

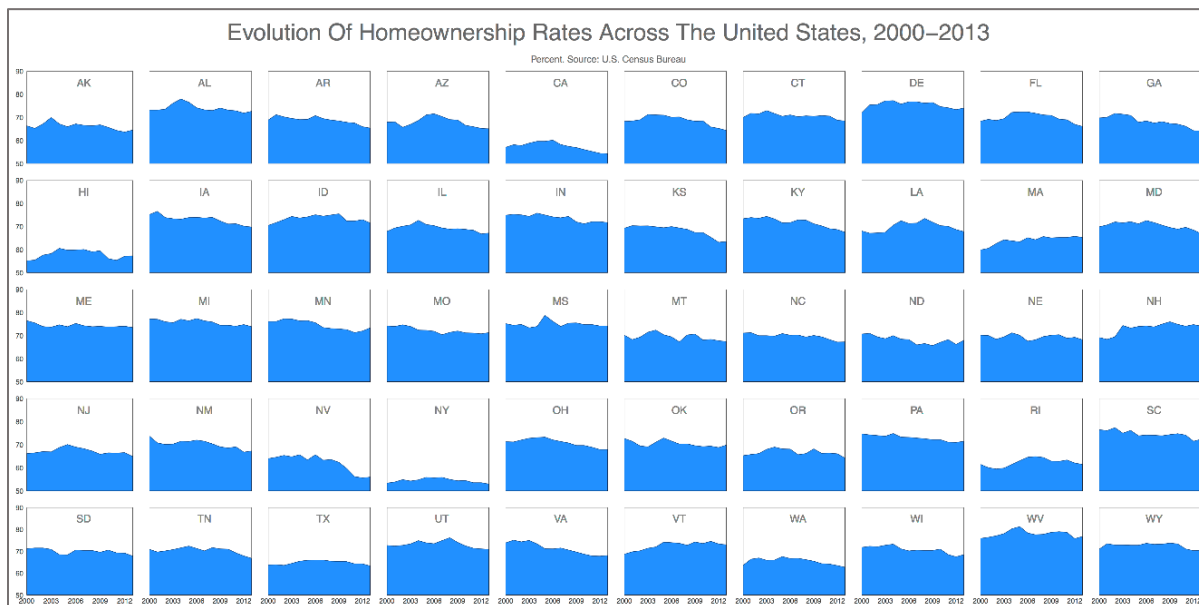


Figure 2-11 Static small multiple of state home ownership rates from 2000-2013 (Sánchez Chinchón, 2015)

These different perspective visualizations need to be carefully prepared with respect to message. A comparison of two visualizations from the Public Resource Bureau illustrate this conundrum (**Figure 2-12 Static comparison of home ownership at different ages over time** (Lee et al., 2020) **Figure 2-13**). The PRB analysis contains two powerful messages: that young adults and African Americans are falling behind in U.S. home ownership rates. The first analysis (**Figure 2-12 Static comparison of home ownership at different ages over time** (Lee et al.,

2020)) is an excellent comparison of ownership rates by different age groups over time, highlighting generational changes in home ownership.

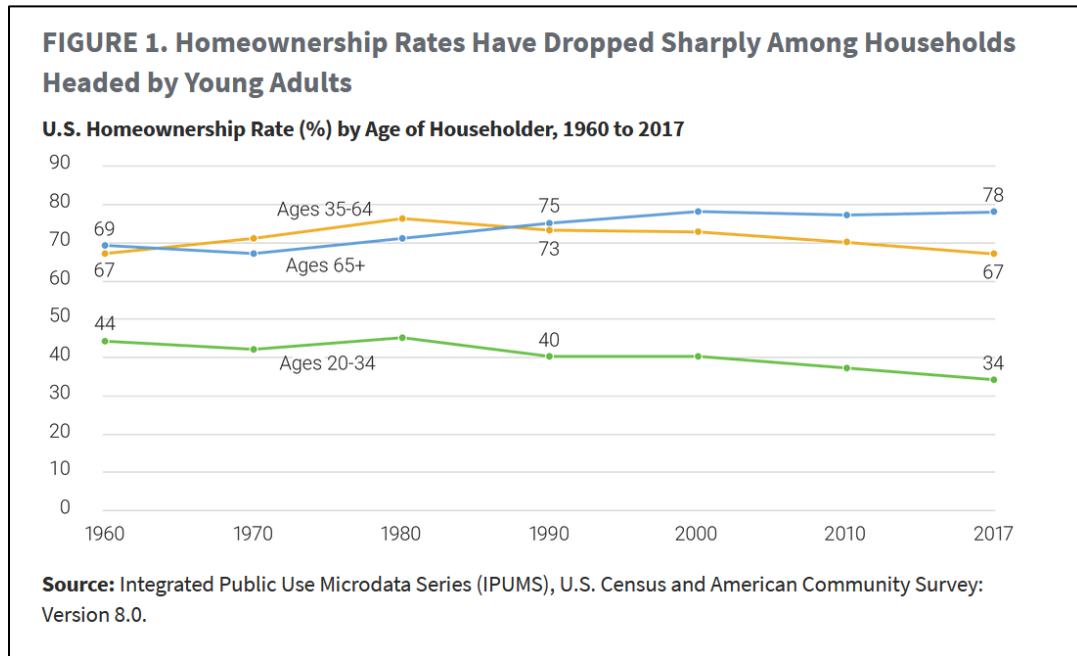


Figure 2-12 Static comparison of home ownership at different ages over time (Lee et al., 2020)

The other analytical image (**Figure 2-13**) highlights the different ownership rates by race over nearly two decades. The challenge of this visualization is that the authors' message is muddled by the visualization. The authors want to emphasize that African American home ownership rates are falling behind those of other racial groups: the visualization clearly demonstrates this decrease. However, it also raises a countervailing question: why have Asian and Hispanic ownership rates increased, and White and Native American rates remained constant, when African American rates have declined? This comparison is not addressed in the analytical commentary.

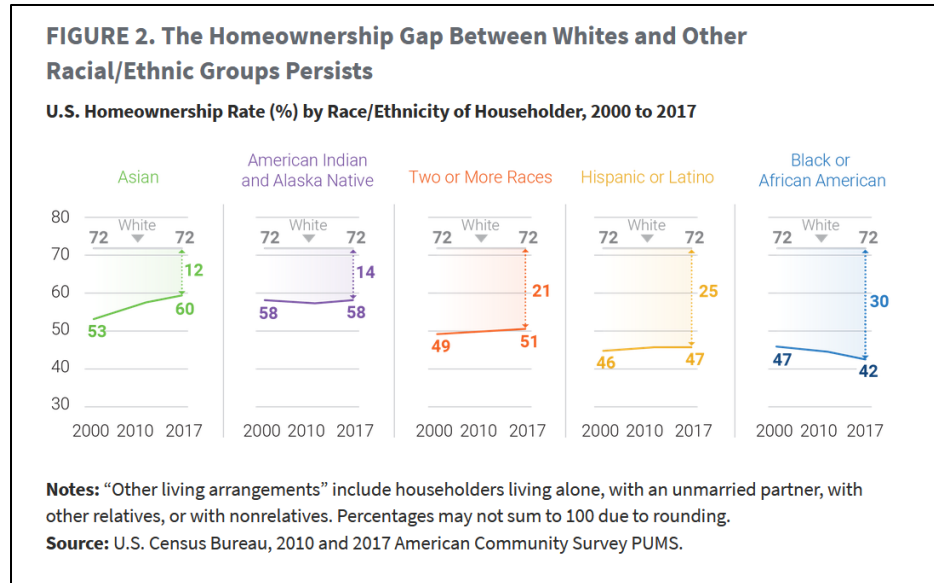


Figure 2-13 Static comparison of ownership rates by race over time (Lee et al., 2020).

Therefore, this excellent, accurate visualization may not have been the most useful choice for this message.

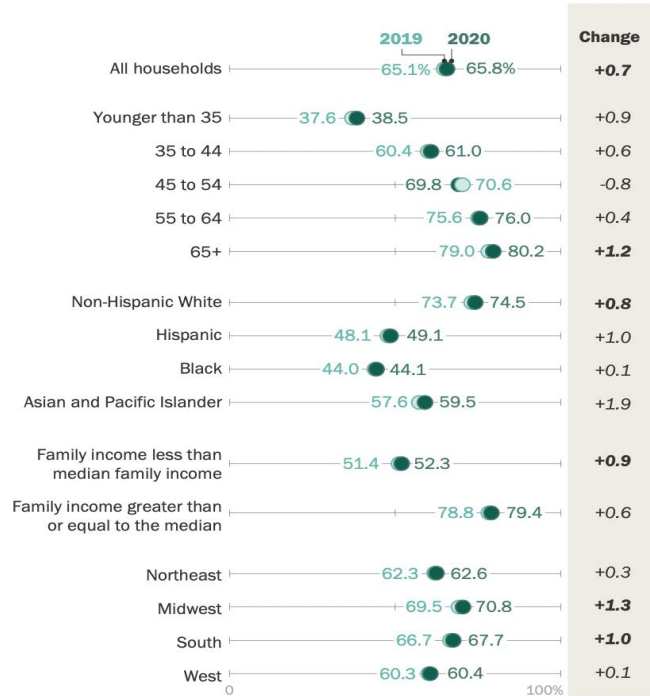
An alternate approach to illustrating ownership rates by race over time can be found in a 2021 Pew Research study (**Figure 2-14**).

This visualization highlights changes in home ownership by several different groupings, including race, from the fourth quarter of 2019 to the fourth quarter of 2020. This visualization is more neutral in its messaging than **Figure 2-13**. Like **Figure 2-13**, it provides a clear visual summary of changes, albeit in a more tabular form.

Either approach is useful, but the authors of **Figure 2-13** included their key messaging in the image, while the authors of **Figure 2-14** provided much of their messaging in associated commentary.

Increase in homeownership greater among households headed by those 65 and older and in Midwest, South

Homeownership rate (%), fourth quarter, nonseasonally adjusted



Note: The homeownership rate is the share of households who own their home. For demographic breaks, the homeownership rate reflects the characteristic of the householder. White householders include those who report being only one race and are not Hispanic. Black and Asian householders include those who report being only one race and include the Hispanic portion of those groups. Hispanics are of any race. Statistically significant changes in **bold**.

Source: Quarterly Residential Vacancies and Homeownership, fourth quarter 2020 press release, U.S. Census Bureau.

PEW RESEARCH CENTER

Figure 2-14 Static chart of ownership rate changes by group in 2020 (Fry, 2021)

2.4 Purchase Decision

The third group of visualizations focus on comparing home ownership to renting. An example is an interactive visualization/decision support algorithm provided by Nerd Wallet (**Figure 2-15 Interactive rent versus buy calculator with break-even visualization** (Rent vs Buy Calculator: Should I Rent or Buy? 2021)). This is a powerful tool and visualization. As with all models/algorithms, it contains many variables that affect the calculation. NerdWallet places many significant secondary variables, such as tax rates and income thresholds on a supporting more options section, where the audience can adjust them to fit their own circumstances. The challenge with this tool and visualization lies with the default values for these secondary variables: unless the audience adjusts those variables appropriately, the algorithm may provide incorrect advice and results. For example, the default value for home and rent appreciation in the tool is 3%, regardless of location. If the consumer manually increases the home appreciation value to 10%, in many cases, the graph tells the user that buying is always cheaper. A customer may make this mistake because it reflects the recent market, but not the long-term market. This tool can be improved by estimating accurate defaults that vary based on location and reflect the past 30 years. Another fault of this tool is that it requires the consumer to input both a home purchase price and a monthly rent price. We believe a more useful tool would be one that allows the customer to input a monthly price that they are willing to pay whether it be on rent or a mortgage payment, along with how much of a down payment they could comfortably make, and let the tool use that information to determine if renting or buying is the better option as well as the breakeven point.

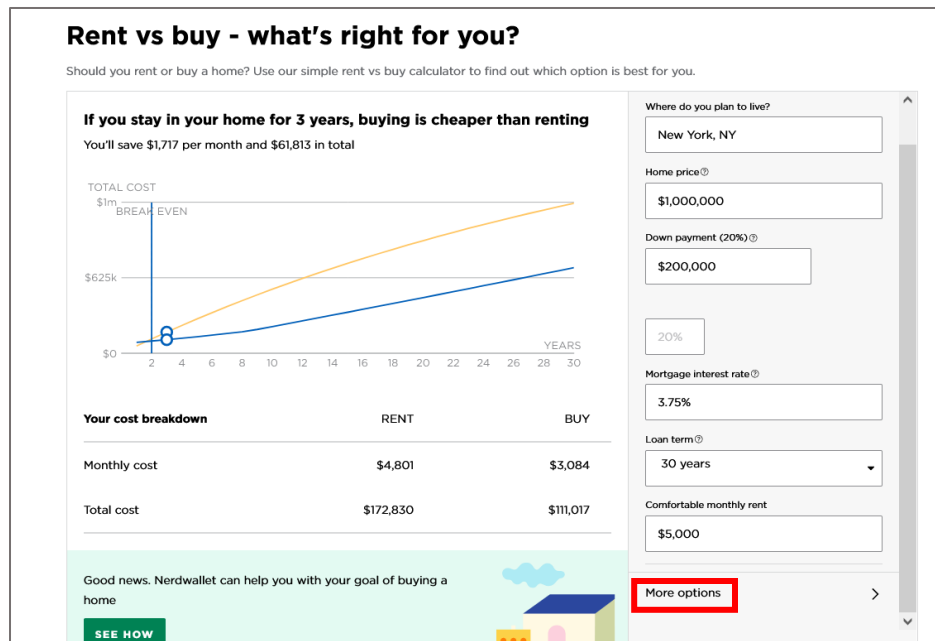


Figure 2-15 Interactive rent versus buy calculator with break-even visualization (Rent vs Buy Calculator: Should I Rent or Buy? 2021)

The U.S. Census periodically produces national housing affordability visualizations related to this purchase decision. Their report on 2009 conditions during the middle of the 2008-2009 recession included two representative visualizations (Figure 2-16 and Figure 2-17). The first compares the affordability of differently priced homes among four cohorts using a somewhat complex bar chart. It highlights the different purchasing capabilities of owners in comparison to renters and of families in comparison to unrelated individuals, indirectly reflecting how smaller households are less able to purchase homes. The second Figure 2-17 looks at one aspect of the first visualization over time, clearly indicating a decrease in affordability. This figure is much simpler and clearer than the first, which requires significant context in the accompanying commentary. This second visualization shows the clear impact of the 2008 financial crisis on home affordability, which had remained remarkably constant until that point. Indeed, that is the only issue with the second chart, as it references a historical decrease that was later reversed somewhat over the next decade.

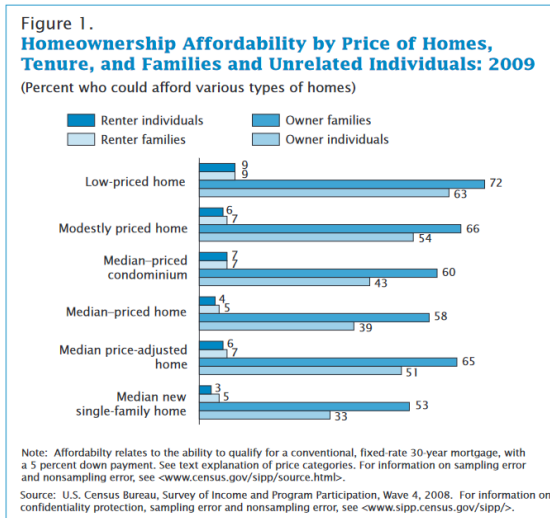


Figure 2-16 Affordability by home price
(Wilson & Callis, 2013)

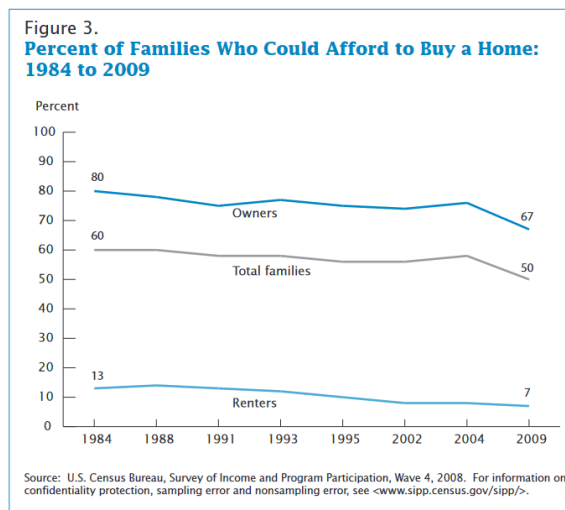
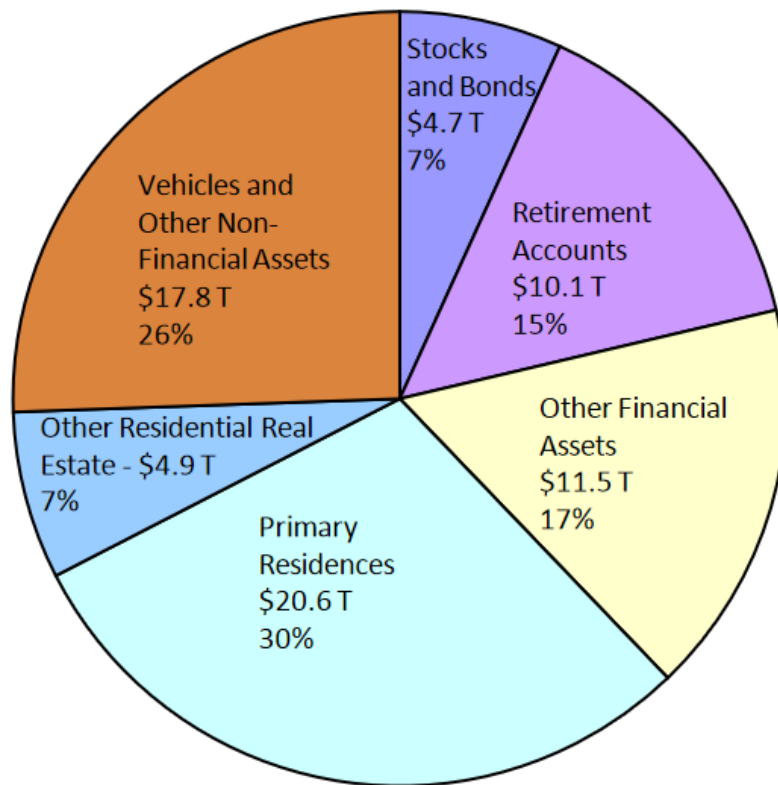


Figure 2-17 Affordability over time
(Wilson & Callis, 2013)

Another approach to examining home ownership focuses on how it impacts household wealth. This approach is reflected in a 2013 visualization from the National Association of Home Builders (Figure 2-18). The 2010 wealth visualization pie chart displays U.S. household wealth by asset category. This simple visualization has several challenges. In addition to the standard chart challenge of representing wealth divisions by area rather than length, it also provides the data itself in two unnecessarily complicated aspects. The first complication is placing the descriptive legend within each division: the legend would be more legible as a list outside the filled circle. The second complication comes from the first. To fit the descriptive legend, such as Primary Residences, into the chart slices, the author had to reorder the slices so that they do not progress in the usual largest to smallest order. This makes the chart less quickly comprehensible and adds to the visual confusion of comparative area sizes.

Figure 1. Major Assets on Household Balance Sheets, 2010

Note: Percentages may not sum to 100% due to rounding.
Source: Federal Reserve Board, Survey of Consumer Finances.

Figure 2-18 Static chart of wealth category distribution (Neal, 2013).

3 Data and Methods

3.1 Objectives

Visualization can be used to illustrate and understand factors raising or reducing home ownership rates. We will review these factors in three ways:

1. First, our report will focus on national or macro trends and constraints.
2. Second, our review will examine specific factors constraining ownership, such as demographics and geography, as many influences on ownership are both more granular and localized.
3. Finally, our report will review home ownership at the household level, how home ownership creates wealth, and the circumstances in which an individual or household should seek to own a home.

3.2 Data

Our team used a variety of datasets for our metrics and visualizations. The primary data sources for most of our report were obtained from the U.S. Census, the Census' American Community Survey, St. Louis Federal Reserve Economics Data (FRED), Trading Economics, and the Federal Reserve Survey of Consumer Finances.

While we mostly used existing databases, we needed to construct custom datasets for several of our initial visualizations, including the historical home ownership rate by country chart and our timeline charts. In the case of the historical country comparison, we used U.S. Census, Trading Economics, American Enterprise Institute, and Reserve Bank of Australia data, cross-checked against Statistics Canada and Schrodgers Insurance data (U.S. Census; Trading Economics; Pollock, 2014; Reserve Bank of Australia, 2015, Government of Canada, 2021; Lamont, 2021). For the timeline charts, we combined U.S. Census data with two historical narratives to generate our mixed dataset (Ancestry, 2017; Lebergott, 1966; Roth, 2020; U.S. Census). We also added several pivotal events to this mix, such as Nixon's taking the U.S. dollar off the gold standard in 1971.

In Results and Visualizations section 4.1, focusing on national trends, we started with home ownership rates over time sourced from the Federal Reserve Economic Data (FRED), which had derived its data from the U.S. Census. We used linear interpolation to fill some

missing rates prior to 1965. We also obtained the median home sales price and median home size from FRED. The average persons per household was pulled directly from the U.S. Census. Various economic statistics were obtained from Trading Economics, including GDP, unemployment, labor force participation, and inflation metrics. Finally, we obtained the 30-year mortgage rates from Macrotrends.

In Results and Visualizations section 4.2, focusing on factor and component analysis, we built upon the national information gathered for the prior section. We also gathered U.S. Census metrics at more granular levels, including by state and county. These measures included home ownership rates by state, county, race/ethnicity, age, and several income groups.

In Results and Visualizations section 4.3, focusing on individual household home ownership and building wealth through owning a home, we used data from the U.S. Census and several other sources, including the Bureau of Labor Statistics, Business Insider, the Department of Numbers, and the Survey of Consumer Finances. The U.S. household asset distribution metrics were obtained from the Survey of Consumer Finances 2010, 2013, 2016 and 2019. We explicitly used the data from Survey of Consumer Finances 2019 for the data pertaining to the net worth of homeowners and renters. We obtained the data for median monthly mortgage payments from Business Insider's calculations of 2018 data from the Bureau of Labor Statistics. In this section we also used data from Census Bureau's 2018 American Community Survey and Department of Numbers, U.S. Residential Rent and Rental Statistics.

3.3 Methods

3.3.1 Data Manipulation

We used several methods to complete and transform the data into more useful information. As historical U.S. and other country home ownership rates were often intermittent as surveys were conducted every 5 to 10 years, we used linear interpolation to fill in the missing intervals. In the case of certain national measures, including inflation and 30-year mortgage rates, we averaged monthly statistics to create annual metrics. The national and factor metrics were combined into several tidy Pandas data frames for visualization creation. The household metrics were combined from the various data sources using Python melt methods to create tidy data frames.

3.3.2 Visualization

We used a variety of Python data frame-based methods to visualize the U.S. home ownership rates and other metrics. We used Matplotlib and Seaborn to create time series visualizations for the national and factor analyses. Altair was the engine for our interactive timeline visualizations. We utilized Plotly to create interactive geographic and time series visualizations, including the historical maps of the United States and selectable time series charts. We used both Matplotlib and Altair to create the household analysis visualizations. The Word Cloud library was used to create the word cloud.

To ensure all visualizations delivered the message we intended, we avoided colors that inhibit the understanding by colorblind individuals. We also varied lightness to ensure our graphics would still be readable when printed in grayscale, except for divergent/contrasting color schemes for the variation from mean and heatmap visualizations.

4 Results and Visualizations

4.1 National Home Ownership Trends

4.1.1 Legislative Trends

Our investigation of U.S. home ownership began with a review of nationwide trends and metrics that may have impacted the overall national home ownership rate. As noted previously, from its first incarnation as the Congressional Congress, the U.S. government has encouraged home ownership. To better understand this encouragement, we reviewed legislative and regulatory actions taken in support of home ownership. We then built a hybrid comparison of these actions and other notable events to the historical U.S. home ownership rate (Figure 4-1).

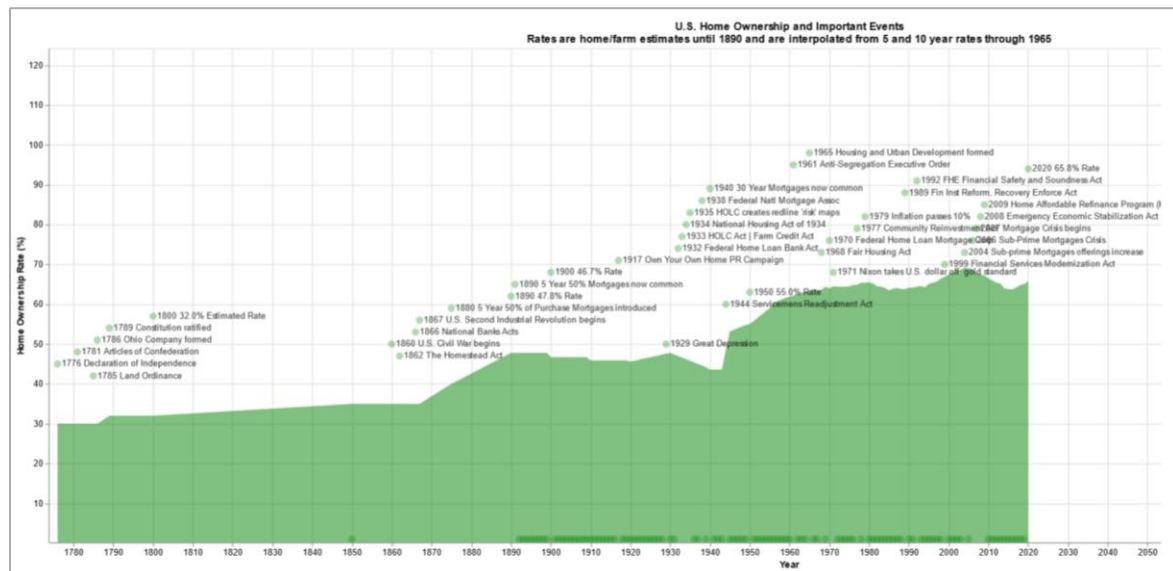


Figure 4-1. Historical U.S. Home Ownership and Important Events (Ancestry, 2017; Lebergott, 1966; Roth, 2020; U.S. Census).

In constructing this interactive hybrid comparison, we considered whether it was best presented as a vertical or horizontal timeline. Ultimately, we chose the horizontal form as the vertical form (Figure 4-2) would have required several frames to display in a report and radical time compression prior to 1890. These charts were built using Altair as multiple interactive layers of inter-connected area, scatter, and text plots based on the information from our historical research. The missing values for certain years were interpolated linearly.

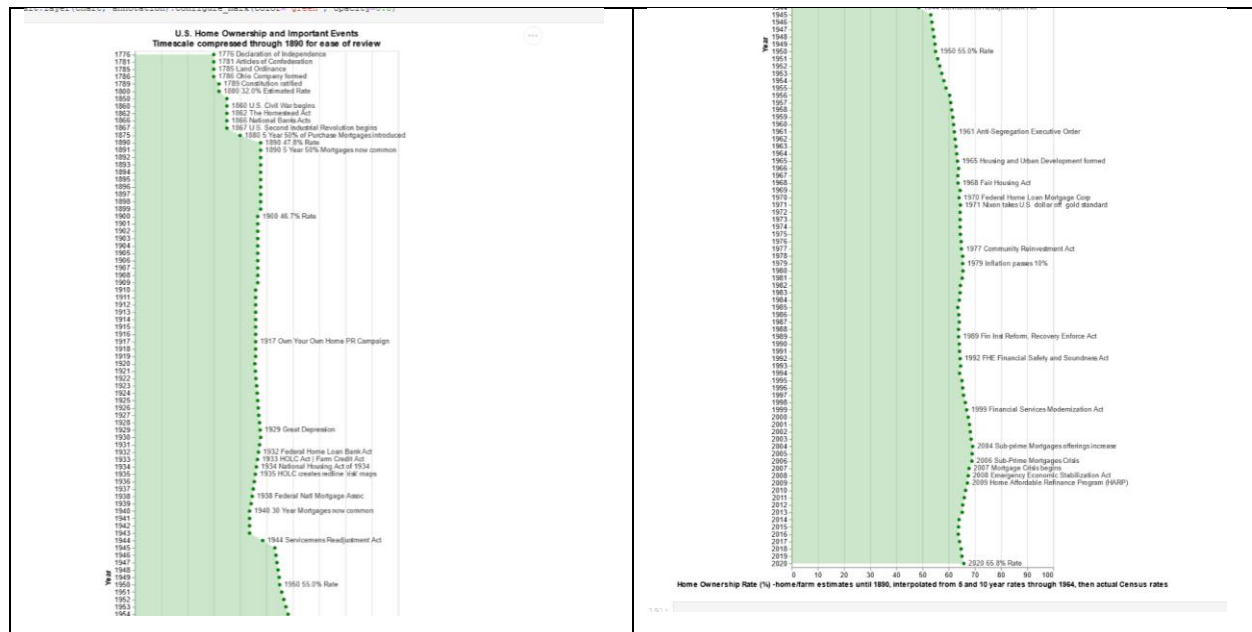


Figure 4-2 Vertical Timeline of Important Events (Ancestry, 2017; Lebergott, 1966; Roth, 2020; U.S. Census)

These comparisons demonstrate several clusters of legislative efforts to bolster U.S. home ownership over U.S. history. The first effort may have been the most critical: the Land Ordinance, sponsored by Thomas Jefferson in 1785, established laws protecting small farmers and homeowners' property rights against seizure by government or wealthy groups. The second cluster of legislative efforts occurred in the later nineteenth century. The most consequential of these was the Homestead Act, sponsored by Abraham Lincoln in 1862, opening government lands west of the Mississippi for small homesteaders. This period also saw the first introduction of mortgages, albeit with terms of only 5 years and 50% of the purchase price. The real estate brokerage industry formed and began marketing home ownership in 1917.

The last three legislative clusters occurred in the last century. The third legislative cluster coincided with the great depression of the 1930s, working to limit foreclosures, improve mortgage terms, create mortgage focused bankers with Savings and Loan Banks, and allow banks to sell mortgages to the government. The most consequential law of this period was passed in 1944: The Servicemen's Readjustment Act or G.I. Bill that provided discount mortgages for veterans of World War II, leading to a substantial increase in home ownership. The fourth legislative cluster focused on the financial sector, rescuing Savings and Loan Banks in 1989 from the effects of nearly twenty years of high mortgage and inflation rates, and modernizing the sector in 1999, permitting the entrance of mostly unregulated mortgage lenders.

These steps led to a dramatic increase in both prime/regular and subprime loans, which both increased home ownership to its highest ever levels and led to the 2007-2010 financial crisis. The final legislative cluster responded to that financial crisis, working primarily to limit foreclosures.

4.1.2 Physical Composition Trends

We next looked at inherent aspects of home ownership, including number of persons per household and physical home size. According to Pew Research Center (Fry, 2019), household size has decreased over the past 160 years until very recently (**Figure 2-4 Static average household occupants** (Fry, 2019)). The overall decline is due to social changes, including the rise in the nuclear family, meaning extended family no longer lives in the household, and the decrease in the number of children women have in their lifetime. We wanted to see if there was any relationship between household size and home ownership rates. To visualize this relationship, we created a time series plot using matplotlib with two y-axes. We put home ownership rate on the left y-axis and household size on the right y-axis. The information was sourced from the U.S. Census and FRED and covered the period from 1984-2020.

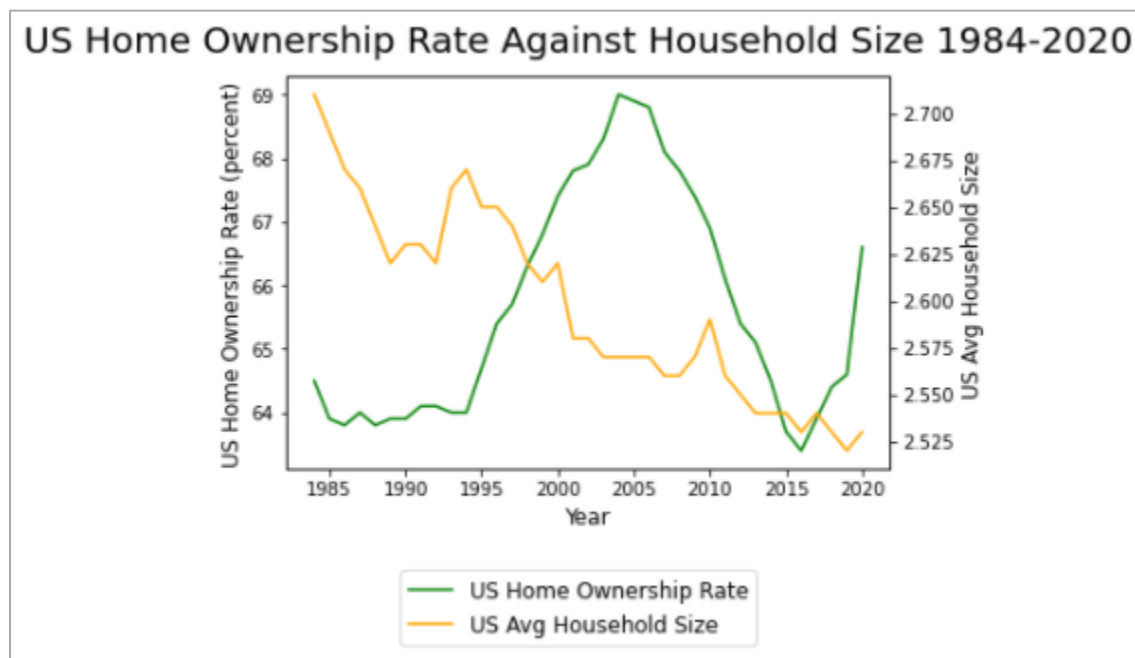


Figure 4-3 U.S. Home Ownership Rate Against Household Size 1984-2020 (U.S. Census, FRED).

As can be seen in the above graph, it appears that home ownership and household size do not trend together. However, there are some periods of time where they did. For example, both

trended downward from 1984 to 1986 as well as from 2010 to 2015. Both increased from 2019 to 2020. This chart indicates that there is no certain correlation between household size and home ownership. Our later research (below) did indicate a less evident correlation.

Our team's next area of interest was to study how house size has changed over time in relation to the home ownership rate. The following existing visualization (Perry, 2014) displays how house size has had an inverse relationship with household size from 1973 to 2013.

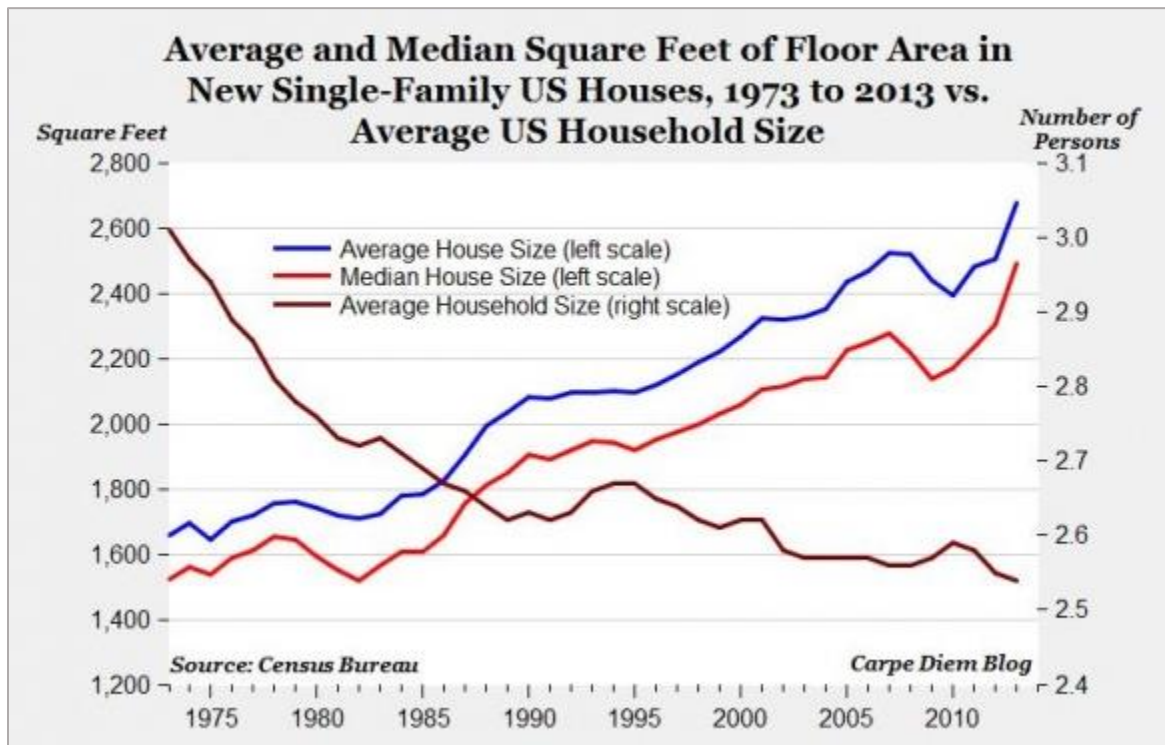


Figure 4-4 Average and median Square Feet of Floor Area in New Single-Family U.S. Houses, 1973 to 2013 vs. Average U.S. Household Size (Perry, 2014).

As house size and household size seem to be related, we were unsure if we would find a relationship between house size and home ownership rate since household size did not appear to be related to home ownership rate in the period from 1984 to 2020. First researching house size alone, we learned that for the most part, house size has increased over time nationwide. The following existing visualization (Muresan, 2016) portrays how house size has changed in major cities between 1910 and 2010.

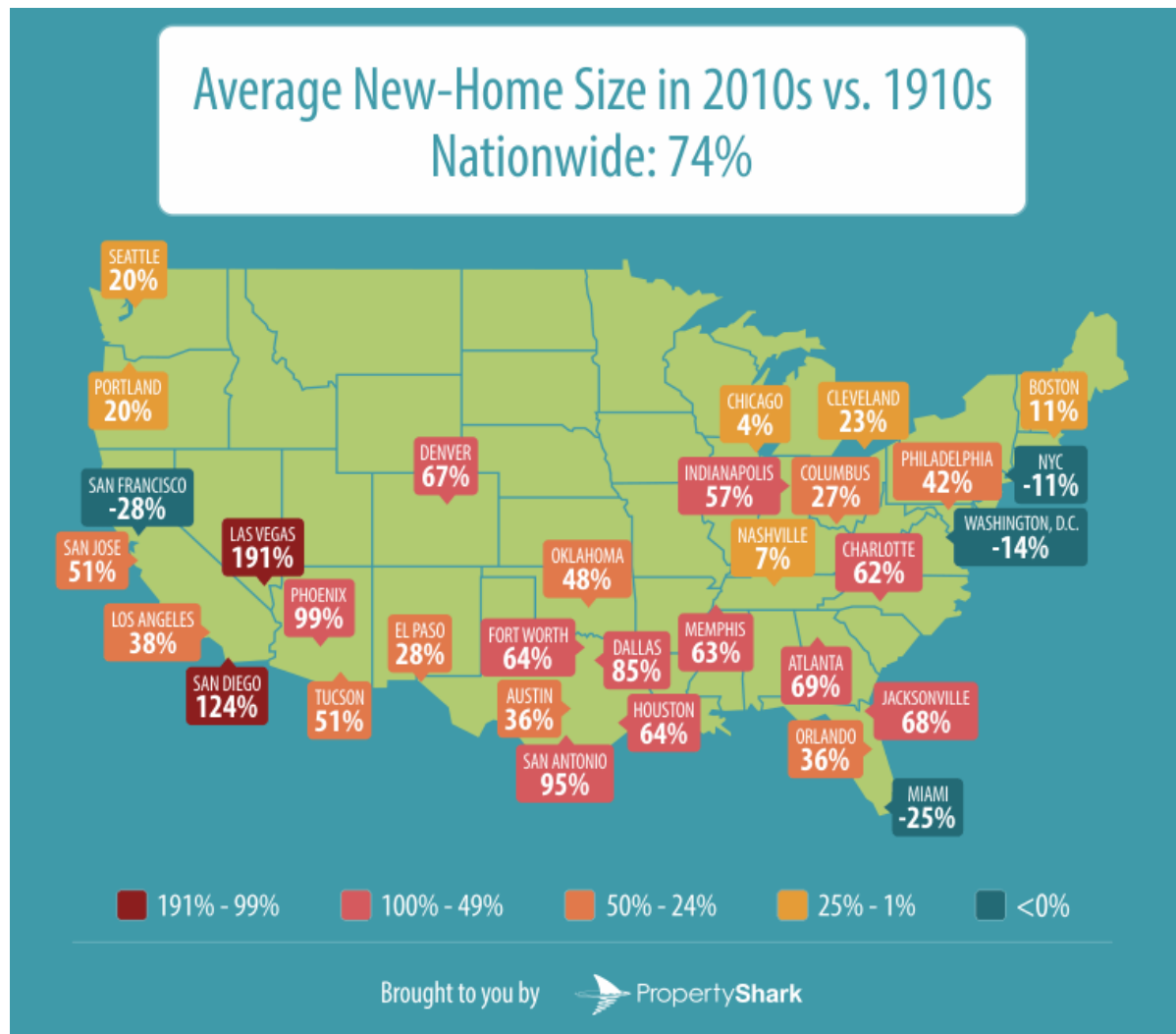


Figure 4-5 Average New-Home Size in 2010s vs. 1910 nationwide: 74% (Muresan, 2016)

As can be seen above, the house sizes for all cities in this visualization except for San Francisco, NYC, DC, and Miami have increased in size over the 100-year time span. Next, we used Python to plot the home ownership rate against house size. Like the comparison with household size, we created a time series plot with year on the x-axis, home ownership rate on the left y-axis, and median home size on the right y-axis. Unfortunately, our data was much more limited, only covering four years.

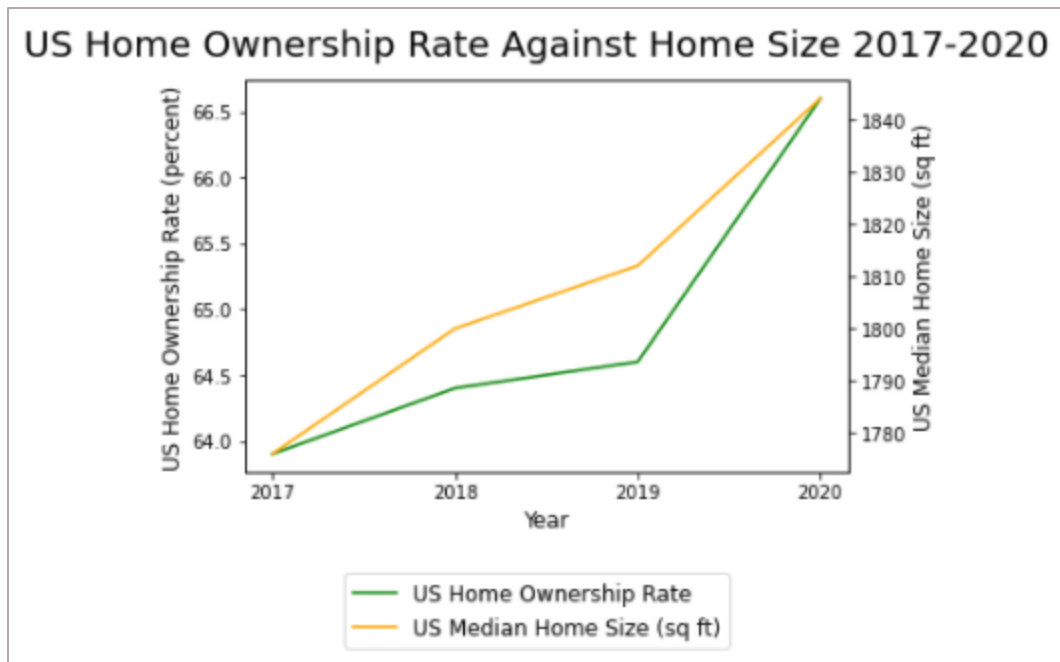


Figure 4-6 U.S. Home Ownership Rate Against Home Size 2017-2020 (U.S. Census, FRED).

Over this four-year time span, it seems that there is a relationship between home ownership rate and median home size. Not only do both lines in the graph increase over time, but they increase at similar rates year-over-year. While this seems promising that a relationship between the two exist, our data is lacking in depth. We previously saw that the home ownership rate waxed and waned over time, so without additional years for comparison, it is difficult to understand if a similar waxing and waning trend exists for median home size. Despite this lack of recent visual proof, the century long combined trends of increasing home size and mostly decreasing numbers of persons per household, as seen in the existing visualizations, have been constraints on increasing U.S. home ownership rates.

4.1.3 Home Ownership Economic Trends

Home ownership accounts for a significant portion of GDP. In 2019, it accounted for 14.7% (Dietz, 2019). According to Valadez (2010), a relationship existed between home ownership and GDP in the years following the 2007 recession. Our research led us to several plots comparing GDP and the housing price index, but none comparing GDP against the home ownership rate. Therefore, we decided to create one ourselves. We pulled both GDP and GDP per capita from Trading Economics. Utilizing matplotlib, we created two more time series plot, looking at both GDP and GDP per capita against the home ownership rate.

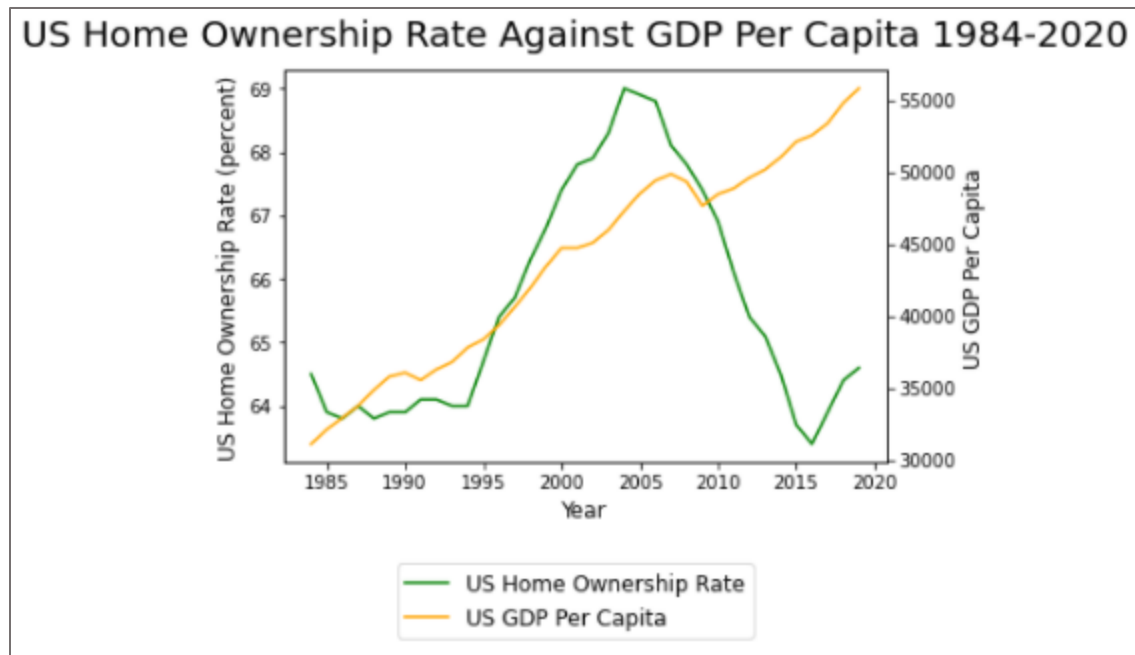


Figure 4-7 U.S. Home Ownership Rate Against GDP Per Capita 1984-2020 (U.S. Census, Trading Economics).

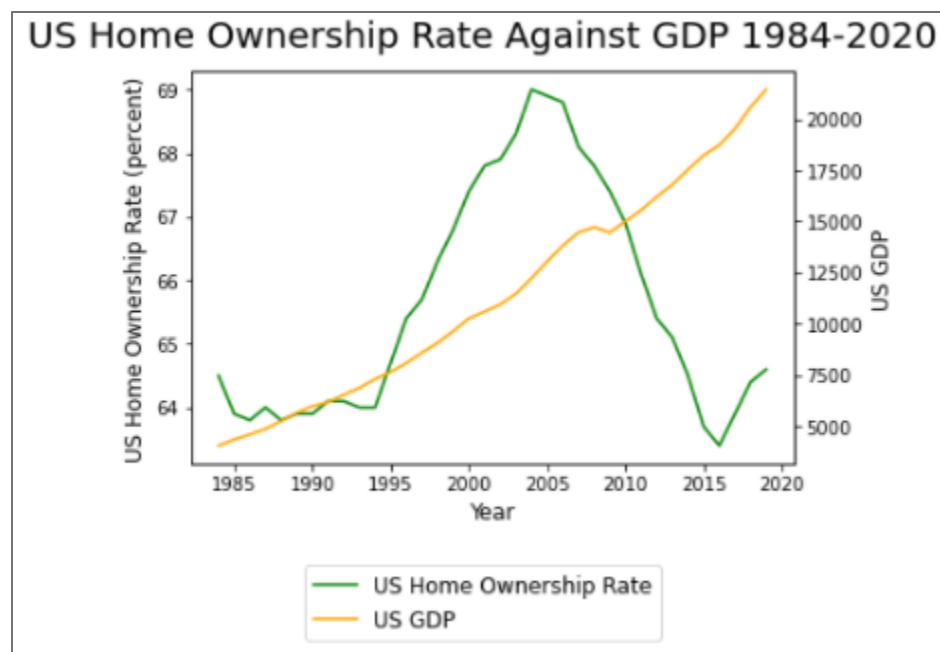


Figure 4-8 U.S. Home Ownership Rate Against GDP 1984-2020 (U.S. Census, Trading Economics).

Over the period depicted in the above plots, we can see that both GDP and GDP per capita increased over time. However, the home ownership rate saw a large increase beginning in 1995

followed by a large decrease beginning in 2004. While all measures move in sync over short time spans, there does not seem to be a correlation between the two.

Our next area of research was to uncover if a correlation between home ownership and unemployment as well as the labor force participation rate. According to Oswald (2013), the two are correlated although he cannot verify causation. Using data from Trading Economics, we plotted the home ownership rate against both the unemployment and labor force participation rates from 1984 to 2020.

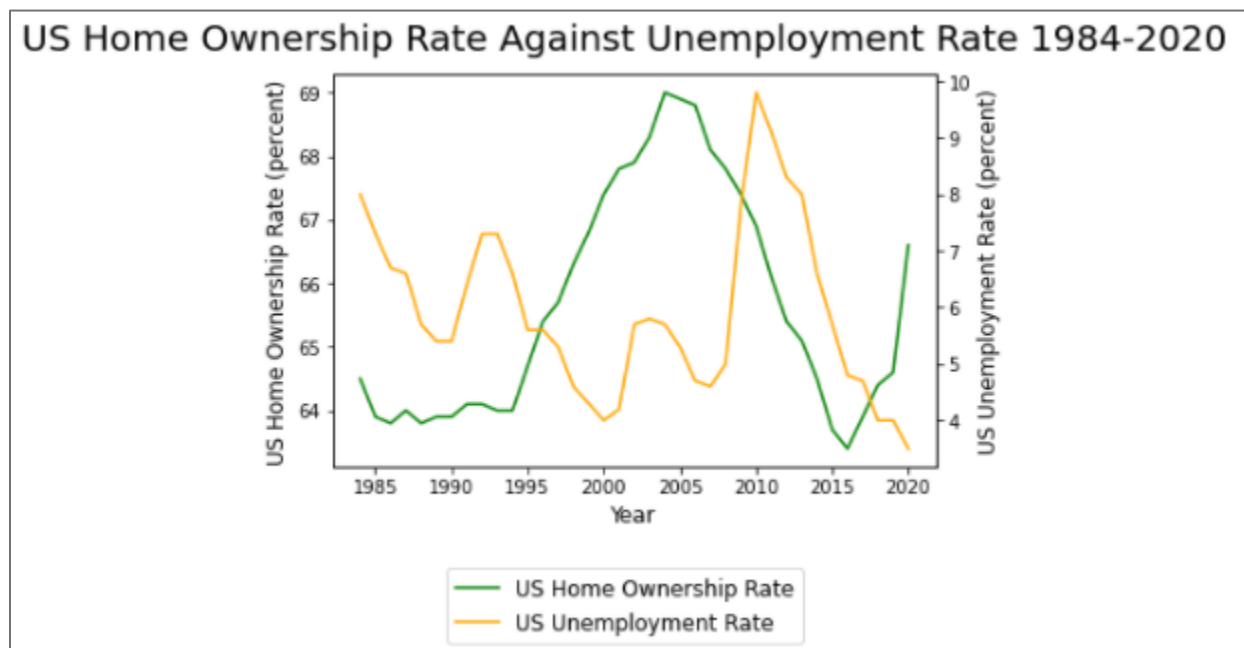


Figure 4-9 U.S. Home Ownership Rate Against Unemployment Rate 1984-2020 (U.S. Census, Trading Economics).

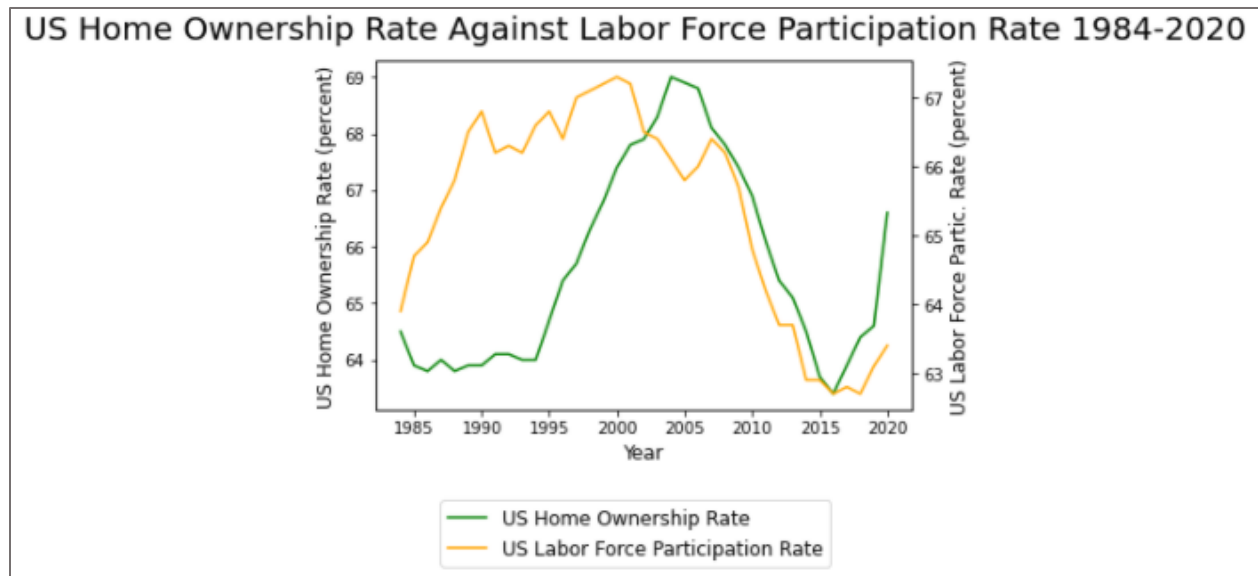


Figure 4-10 U.S. Home Ownership Rate Against Labor Force Participation Rate 1984-2020
(U.S. Census, Trading Economics).

First looking at unemployment, it seems that both the home ownership and unemployment rates were in sync during the decline from 2007 to about 2016. Prior to that, they did seem to move in the same direction most of the time, just at different rates. For comparison with the labor force participation rates, the two seemed to remain relatively constant at the beginning of the period followed by a slight increase in the labor force participation rate and a major increase in the home ownership rate. Starting around 2005, they both fell and subsequently increased around 2017. It appears that there may be a relationship between owning a home and unemployment. An increase in people working from home might substantially reduce this potential correlation from 2020 onward.

4.1.4 Home Ownership Financial Trends

Subsequently, we decided to look at how home ownership has changed over time in relation to home prices and other financial metrics. Our research illustrated that these two measures have for the most part moved in sync. The below plot offers an existing visualization over time from 1987 to 2014 (Garriga, 2014).

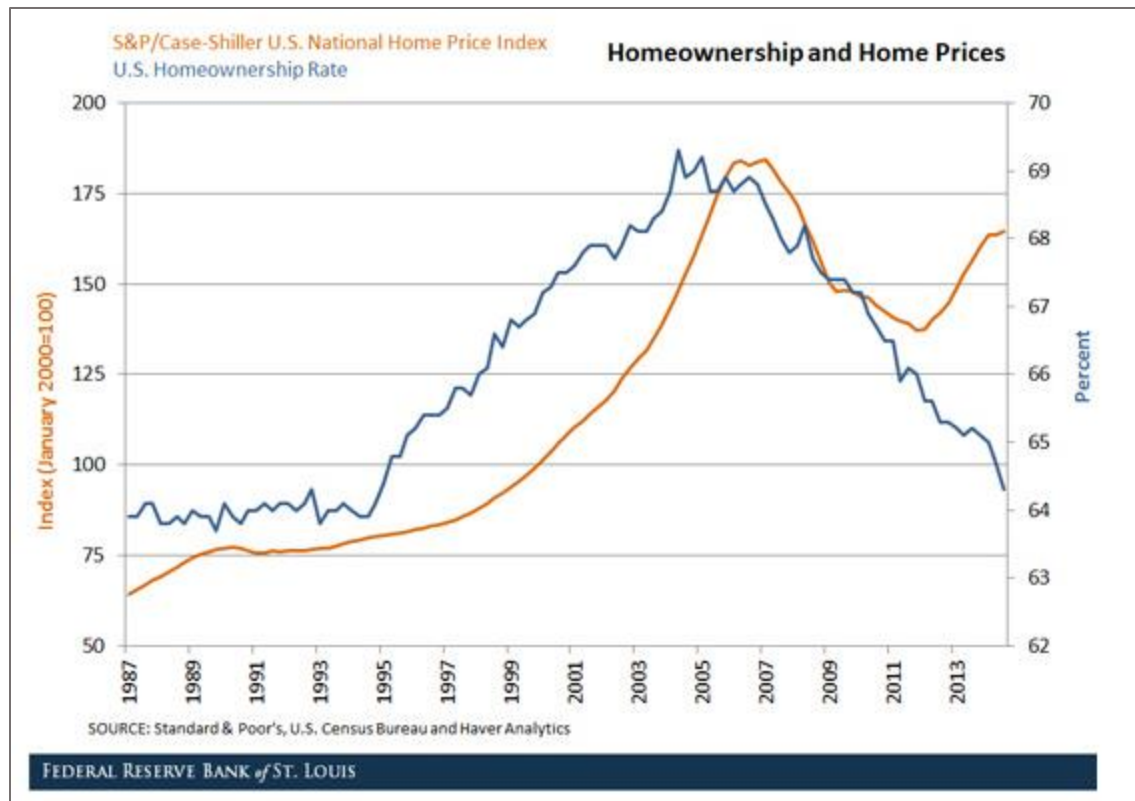


Figure 4-11 Home Ownership and Home Prices (Garriga, 2014).

Throughout the period depicted on the graph, the two measures moved in sync until the financial crisis. While both measures dropped beginning in 2007, home prices recovered and rebounded in 2012 while home ownership rates continued to decline until rebounding in 2017 (see Figure 4-12 below).

Our next national comparison was to review home ownership trends against inflation rates and mortgage rates. The two graphs we created can be seen below.

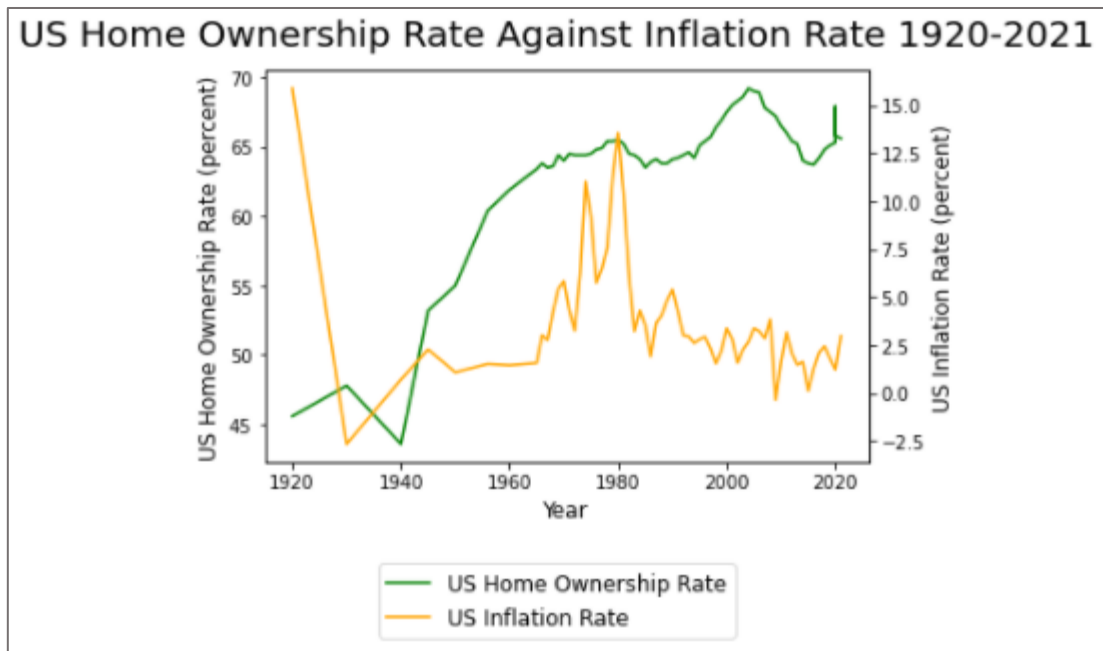


Figure 4-12 U.S. Home Ownership Rate Against Inflation Rate 1920-2021 (U.S. Census, Trading Economics).

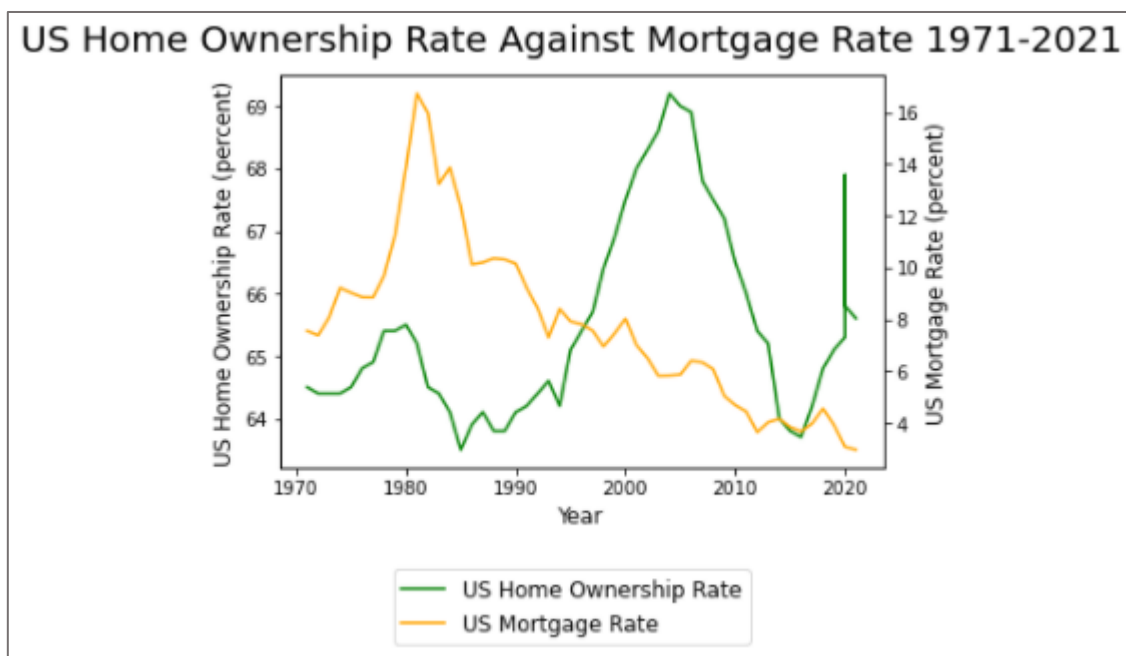


Figure 4-13 U.S. Home Ownership Rate Against 30 Year Mortgage Rate 1971-2021 (U.S. Census, Macrotrends).

First, regarding the inflation rate, it appears that the home ownership rate shifted in the same direction but on a lag to the inflation rate from 1945 and prior. From there, the two metrics

did not always travel in stride although there were some similarities around 2010. First, regarding the inflation rate, it appears that the home ownership rate shifted in the same direction but on a lag to the inflation rate from 1945 and prior. From there, the two metrics did not always travel in stride although there were some similarities around 2010. Mortgage rates, however, seemed to be much more in sync. The two aligned from 1970 to about 1995, at which point the home ownership rate spiked but the mortgage rates did not. Both declined with the financial crisis around 2008, but then home ownership rates spiked again around 2017 and mortgage rates did not follow suit.

Elevated 30-year mortgage rates and the plateauing of home ownership rates from 1971 through the early 1990s are likely not only inversely correlated but the first is also a cause of the latter. When Nixon took the United States dollar off the gold standard, the decoupling drove inflation and the related mortgage rates to consistently elevated levels for nearly 20 years. These elevated mortgage rates caused severe funding mismatch problems for the then largest source of mortgage financing, the Savings and Loan Banks (Robinson, 2013). They were funding their long-term mortgages with short-term deposits, limiting their ability to offer mortgages. Therefore, the high mortgage rates and these banks' funding problem reduced a key driver of home purchases in this period. This situation was not remedied until the passage of the Financial Institution Reform and Recovery Enforcement Act (FIRREA) in 1989.

4.1.5 Key Historical Trends

Through the combination of our analysis and our review of existing research, we were able to distinguish a series of key national/macro trends that both boosted and limited historical U.S. home ownership rates. These trends are illustrated in the Historical Trend Timeline visualization below (Figure 4.14). Prepared in Altair, this interactive visualization is composed of three layers, a scatter plot of event labels, a line chart of key trends with a color-coded legend, and an area plot of the underlying U.S. home ownership rates. The circles prior to the key events and those at the base of the chart can be selected to obtain a more detailed description of the related event.

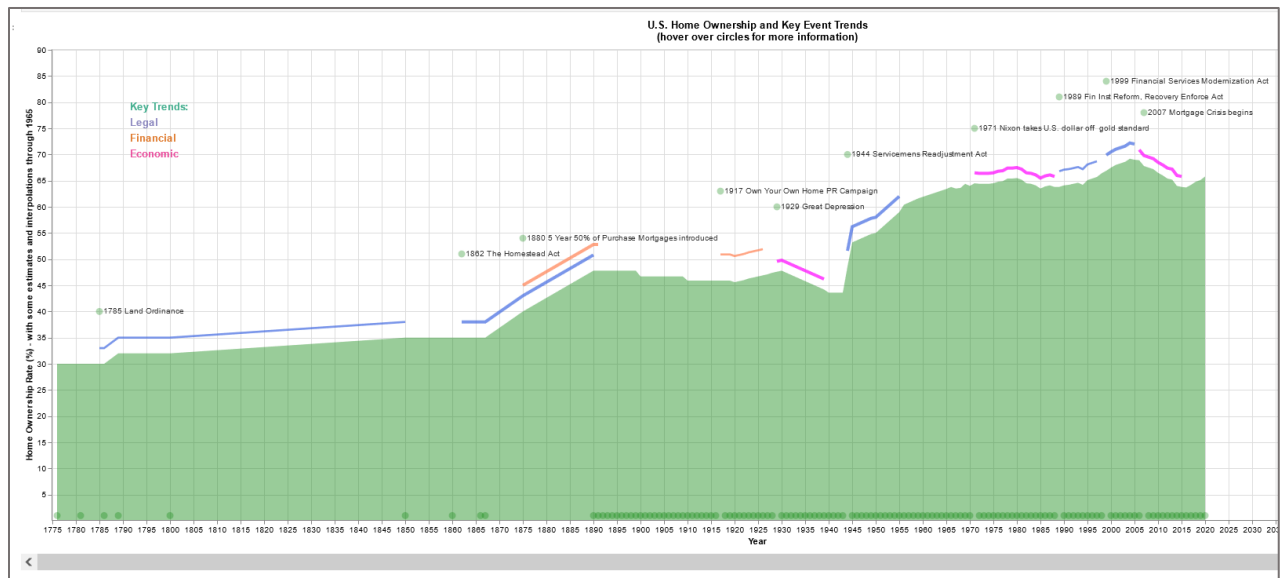


Figure 4-14 Historical Key Trend Timeline (Ancestry, 2017; Lebergott, 1966; Roth, 2020; Trading Economics, U.S. Census).

The chart highlights the key legal/legislative, financial, and economic trends that had the most significant impact on changing U.S. national home ownership rates. The legislative events included the Land Ordinance, Homestead Act, G.I. Bill, FIRREA, and the Financial Services Modernization Act. The non-legislative financial events include the introduction of 5-year mortgages and the emergence of real estate brokers. The economic events include the 1929 Great Depression, the decoupling of the U.S. dollar from the gold standard, and the 2007-2008 financial crisis. Both the legislative and financial events had mostly positive impacts on U.S. home ownership rates, while the economic events either limited or decreased those rates.

4.2 U.S. Home Ownership Constraint Analysis

The home ownership rates can be influenced by varying number of factors. The rates vary by state, age group, ethnicity, family income, etc. In addition, these rates have varied over the period, as seen earlier, which in turn have been influenced by various other factors. In the following section, we study the influence of these factors on home ownership.

4.2.1 Home Ownership by State

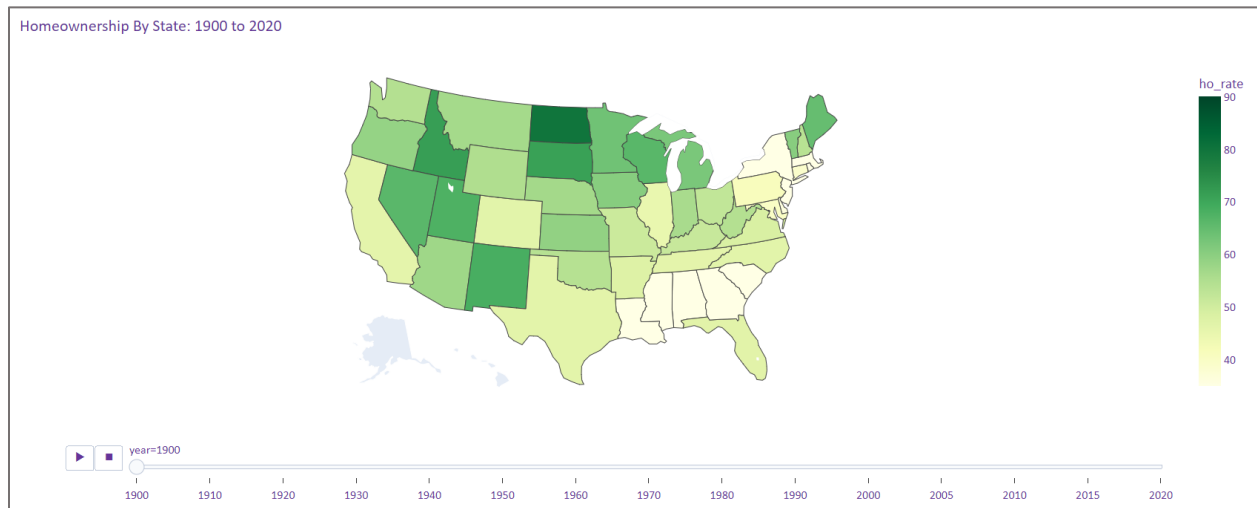


Figure 4-15 Variation of home ownership rates by state from 1900 to 2020 (U.S. Census).

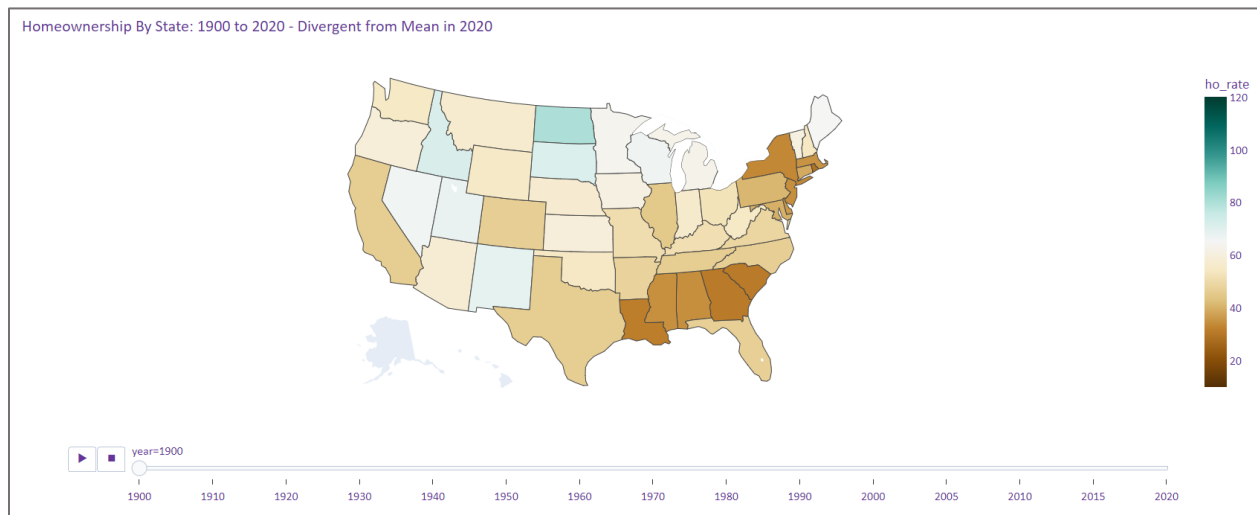


Figure 4-16 Variation from mean of home ownership rates by state from 1900 to 2020 (U.S. Census).

The above plots in **Figure 4-15 Variation of home ownership rates by state from 1900 to 2020** and **Figure 4-16 Variation from mean of home ownership rates by state from 1900 to 2020** have been prepared using the data from U.S. Census. These plots have been generated using Plotly Express to show the time series trend across all U.S. states from 1900 to 2020. In the first plot, the color scheme of yellow and green have been used for visualization, wherein green depicts the top end of home ownership rate and yellow depicts the bottom end of home ownership rate. Further, in the second plot, deviation from the mean 2020 home ownership rate of 65.8 (per census.gov) is studied across all U.S. states for the same period. A color scheme of brown and green have been used for visualization in the second plot, wherein green depicts the portion over the mean home ownership rate and brown depicts the portion under the mean home ownership rate. Finally, in both these plots, the trend has been studied for every 10 years, except from 2005, wherein the trend has been studied for every 5 years.

In both the plots, it has been seen that the home ownership rate of California, New York, and Hawaii have had the lowest home ownership rate compared to rest of the country. In addition, they have continued to be on the lower side from 1900s, and the increase in the home ownership rate has not been significant. They continue to be under the mean U.S. home ownership rate. We further wanted to study the home ownership rate on a yearly basis, to understand the trend across all U.S. states. Hence, the plots in **Figure 4-17 Variation of home ownership rates by state from 1984 to 2020** and **Figure 4-18 Variation of home ownership rates by state from 1984 to 2020 w.r.to mean rate** have been generated.

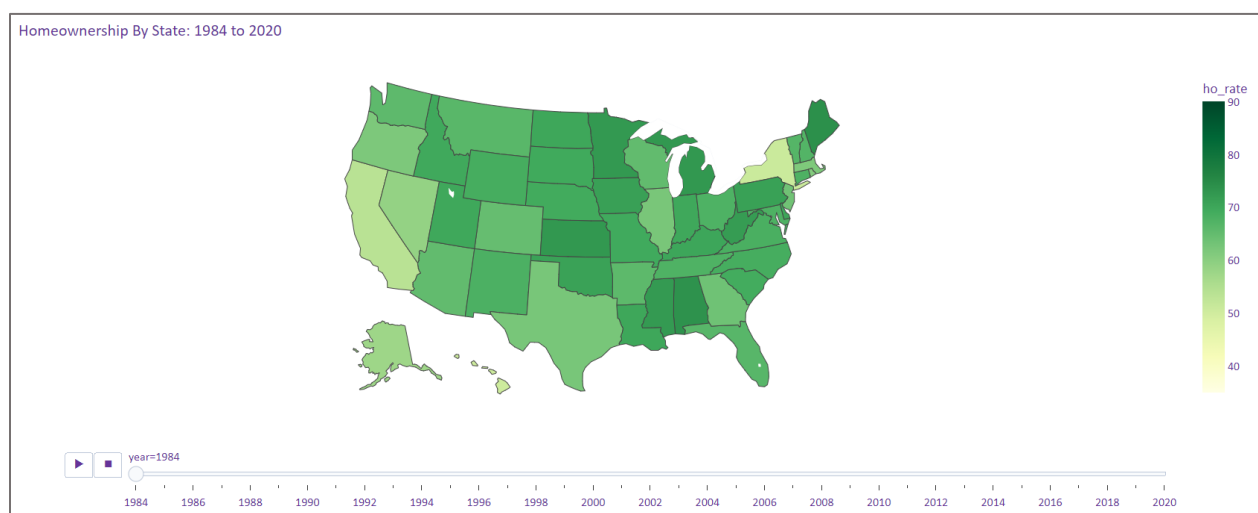


Figure 4-17 Variation of home ownership rates by state from 1984 to 2020 (U.S. Census).

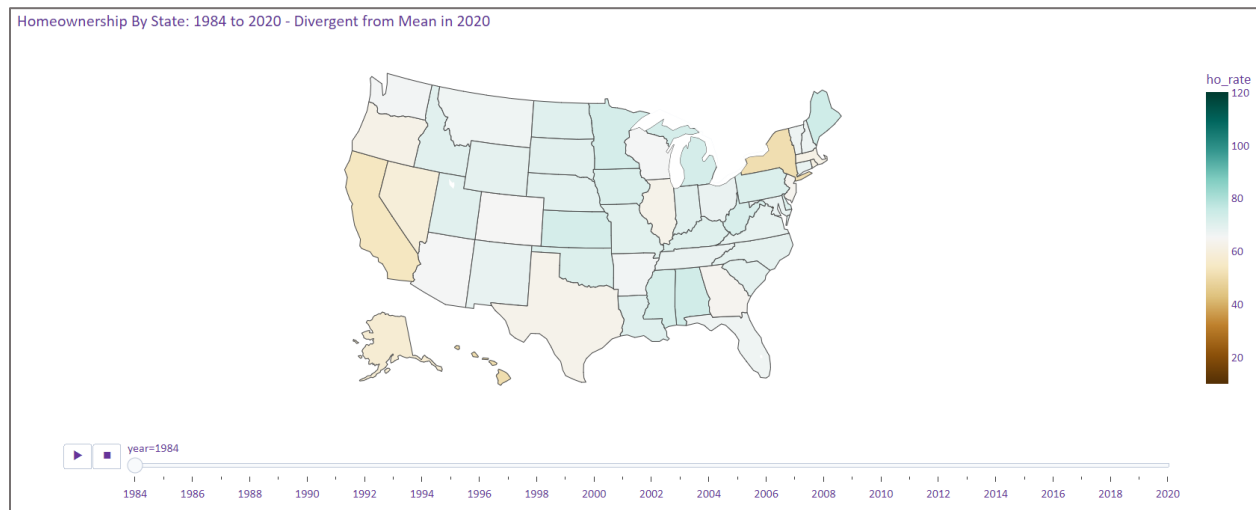


Figure 4-18 Variation of home ownership rates by state from 1984 to 2020 w.r.to mean rate (U.S. Census).

The above plots in **Figure 4-17 Variation of home ownership rates by state from 1984 to 2020 (U.S. Census).** and **Figure 4-18 Variation of home ownership rates by state from 1984 to 2020 w.r.to mean rate (U.S. Census).** have been prepared using the data from U.S. Census. These plots have been generated using Plotly Express to show the time series trend across all U.S. states from 1984 to 2020. In the first plot, the color scheme of yellow and green have been used for visualization, wherein green depicts the top end of home ownership rate and yellow depicts the bottom end of home ownership rate. Further, in the second plot, deviation from the mean 2020 home ownership rate of 65.8 (per census.gov) is studied across all U.S. states for the same period. A color scheme of brown and green have been used for visualization in the second plot, wherein green depicts the portion over the mean home ownership rate and brown depicts the portion under the mean home ownership rate. Finally, in both these plots, the trend has been studied for every year from 1984 until 2020.

It is seen from the visualization in **Figure 4-17 Variation of home ownership rates by state from 1984 to 2020 (U.S. Census).** that the states of California, New York and Hawaii have the lowest home ownership rate, and it has been the case from 1984 to 2020. Similarly, the states of West Virginia, Maine and Delaware have the highest home ownership rate. Further another interesting pattern, which has been observed using this visualization is that the states of Alaska, Delaware, Hawaii, New Hampshire, Vermont, West Virginia, and Wyoming have had an increase in home ownership rate from 1984 to 2020 by over 5 points. Finally, it is observed that

the states of North Dakota and Kansas have had a decrease in home ownership rate from 1984 to 2020.

In 2020, there were 12 states, namely Alaska, California, Colorado, Hawaii, Massachusetts, Nevada, New Jersey, New York, North Dakota, Oregon, Rhode Island, and Washington, where the home ownership rate was lower than the mean. This can be visualized from the **Figure 4-18 Variation of home ownership rates by state from 1984 to 2020 w.r.to mean rate** (U.S. Census).. One of the interesting patterns observed here is that the state of New Jersey and Colorado had a higher home ownership rate until 2008, and it had been increasing steadily prior to 2008. Post 2008, the rate has decreased in these states. Similarly, other states which are currently over the mean home ownership rate have also had an impact around the year 2008. The major factor here was the 2007-2008 U.S. financial crisis and recession. In several of these states, the decline in home ownership rates only began to reverse in 2019 and 2020. However, it can also be interestingly noticed that the states of Alabama, Florida, Delaware, Michigan, South Carolina, and West Virginia have had a healthy home ownership rate prior to and post 2008.

4.2.2 Home Ownership by Region

The other constraint which has been studied as part of this paper is the region-wise home ownership trend. To do this study, the data from U.S. Census has been used, where the data for various regions such as Midwest, Northeast, South and West are available from 1984 to 2021. In the **Figure 4-19 Variation of home ownership rates by different U.S. regions from 1984 to 2021**, we can see the time series trend for the home ownership in various U.S. regions from 1984 to 2021, along with the overall home ownership rate trend in U.S. for the same period. Various interesting observations can be seen from this visualization. The first one is that the Midwest and South regions have always had higher home ownership rate compared to U.S. home ownership rate, whereas the Northeast and West have always had lower home ownership rates. These differences may be influenced by the comparably lower rates in New York and California, the most populous states in those regions.

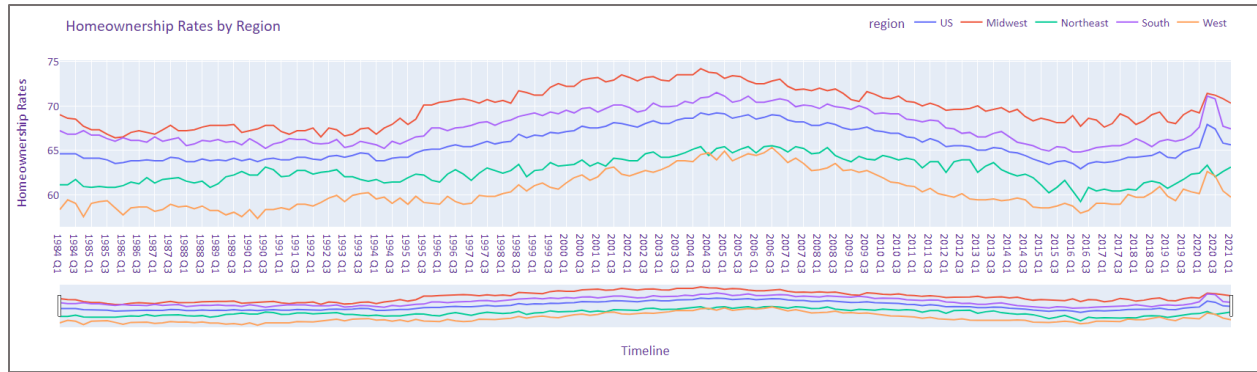


Figure 4-19 Variation of home ownership rates by different U.S. regions from 1984 to 2021 (U.S. Census).

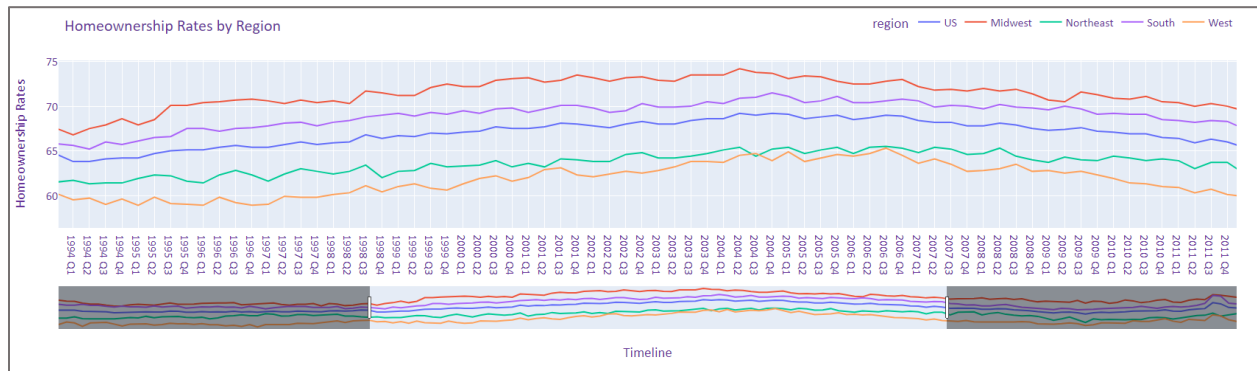


Figure 4-20 Variation of home ownership rates by different U.S. regions from 1994 to 2011 (U.S. Census).

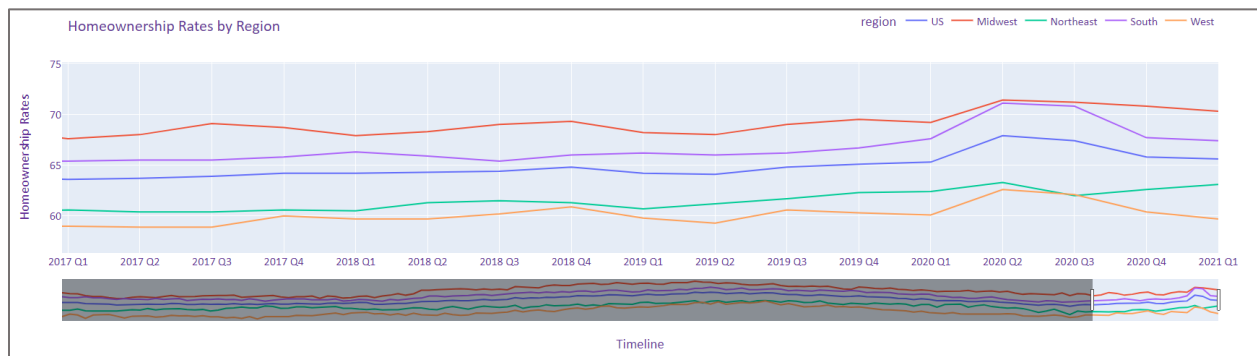


Figure 4-21 Variation of home ownership rates by different U.S. regions around 2020 (U.S. Census).

The above plots in **Figure 4-19 Variation of home ownership rates by different U.S. regions from 1984 to 2021**, **Figure 4-20 Variation of home ownership rates by different U.S. regions from 1994 to 2011** and **Figure 4-21 Variation of home ownership rates by different U.S. regions around 2020** have been prepared using the data from U.S. Census. These plots have been generated using Plotly Express to show the time series trend across all U.S. regions from 1984 to 2021 as a line chart. Plotly Express has been chosen, since it allows splicing of data using horizontal bar in a simple way.

In the **Figure 4-20 Variation of home ownership rates by different U.S. regions from 1994 to 2011** (U.S. Census), it is seen that the home ownership rate steadily increased from 1994 to 2004. After 2004, the rate seemed to be steady until 2008, except for Midwest region. In this interesting pattern, it is seen that the rate started to decline in Midwest region alone from 2004 itself, whereas in other regions the rate declined from 2008, which coincides with recession. Furthermore, it is also observed that during the recession, in fact the rate increased in Midwest region, slightly in 2009.

In the **Figure 4-21 Variation of home ownership rates by different U.S. regions around 2020** (U.S. Census), it is seen that the home ownership rates increased for all the four regions between Q1 and Q2 of 2020. At this point, the Midwest and South region rates overlapped, as did the rates for the Northeast and West. This was followed by a steep dip for South and West regions between Q3 and Q4 of 2020. However, during this same period it was steady for Midwest and Northeast regions. It will be interesting to study the reason for this period, which coincides with the timeframe when COVID-19 peaked in the United States.

4.2.3 Home Ownership by Ethnicity

The trend of home ownership rates in U.S. by ethnicity has been studied next. In the **Figure 4-22 Variation of home ownership rates by different ethnicities in U.S. from 1994 to 2021** the timeseries trend of the rates per ethnicity has been visualized from 1994 to 2021 using the data from U.S. Census. It is interestingly seen from the visualization that the home ownership rate amongst the non-Hispanic white population has always been high compared to the national home ownership rate. The difference has fluctuated between 5 and 8 points. The least rate has been observed amongst the African American population. Further, it is seen that the home ownership rate amongst the Hispanic and African American population has been more or less the

same until mid of 2012. However, the difference in home ownership rate between the Hispanic and African American population widened from mid of 2012. Finally, it can also be observed that the home ownership rate had recovered from the 2007-2008 crisis for all ethnicities by 2016, except for African Americans. Their home ownership rate continued to dip until 2019, when it also began recovering.

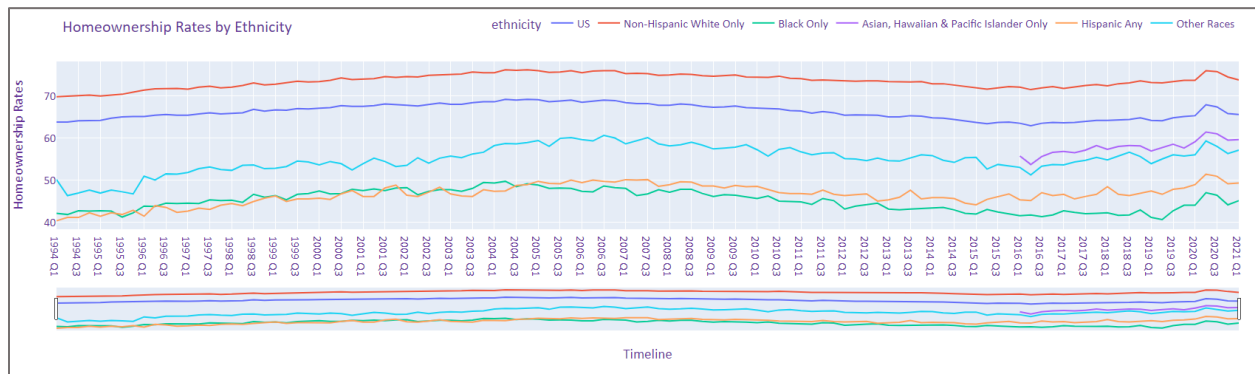


Figure 4-22 Variation of home ownership rates by different ethnicities in U.S. from 1994 to 2021 (U.S. Census).

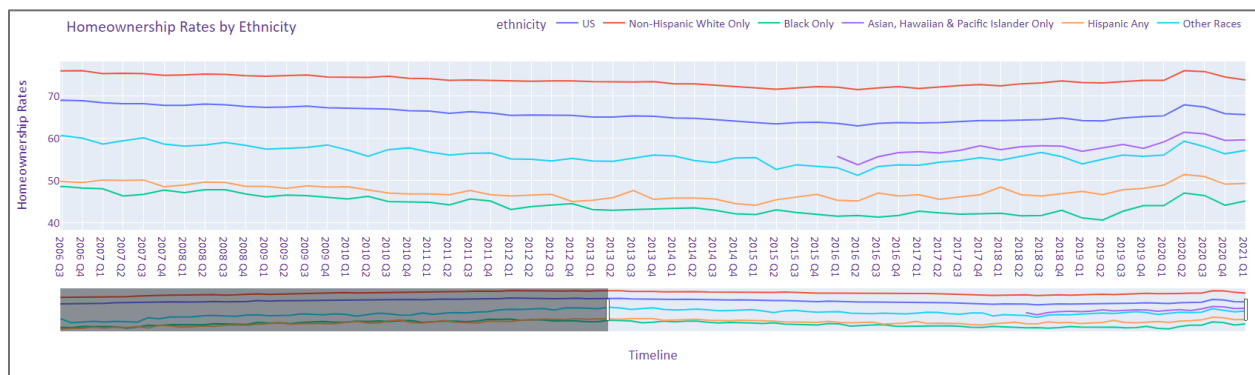


Figure 4-23 Variation of home ownership rates by different ethnicities between 2006 and 2021 (U.S. Census).

The above plots in **Figure 4-22 Variation of home ownership rates by different ethnicities in U.S. from 1994 to 2021 (U.S. Census).** and **Figure 4-23 Variation of home ownership rates by different ethnicities between 2006 and 2021 (U.S. Census).** have been prepared using the data from U.S. Census. These plots have been generated using Plotly Express to show the time series trend amongst different ethnicities from 1994 to 2021 as a line chart.

Plotly Express has been chosen, since it allows splicing of data using horizontal bar in a simple way.

The **Figure 4-23 Variation of home ownership rates by different ethnicities between 2006 and 2021** (U.S. Census)., which has been generated from the same visualization used in the **Figure 4-22 Variation of home ownership rates by different ethnicities in U.S. from 1994 to 2021** (U.S. Census).by doing a slice, shows that the home ownership rates have increased for all ethnicities, except African Americans, from 2016. However, for the African American population, the home ownership rates have started to increase only from 2019.

4.2.4 Home Ownership by Family Income

Next the trend of home ownership rates in U.S. by different family income has been studied. In the **Figure 4-24 Variation of home ownership rates by family income between 1994 and 2021**, it can be seen the families whose median income is greater than or equal to national median income have home ownership rates greater than the national rate. Similarly, the families whose median income is lower than that of the national median income have home ownership rates lower than the national rate. This is an expected result, since ability of a family to purchase a home depends on their income. The intermediary inclines and declines per income group has followed a same pattern in consistency with the reasoning as observed for the earlier analysis of the various constraints.

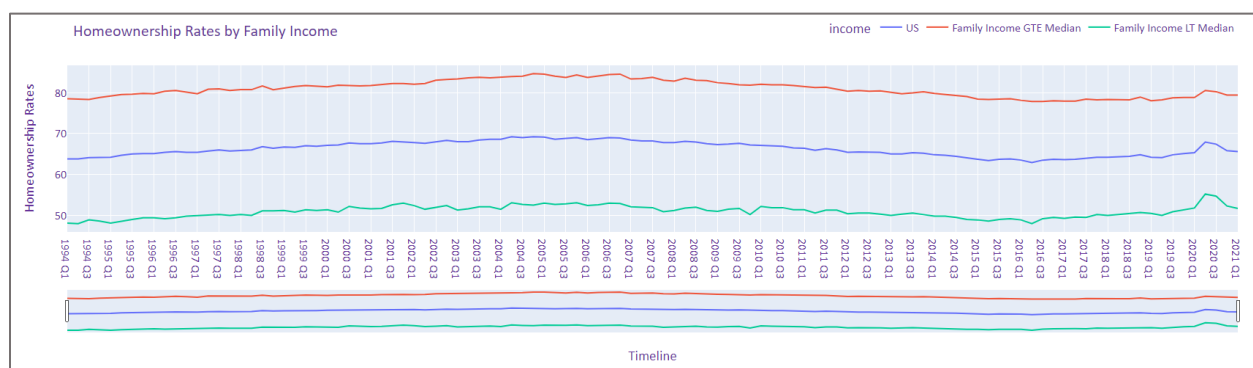


Figure 4-24 Variation of home ownership rates by family income between 1994 and 2021 (U.S. Census).

The above plot has been prepared using the data from U.S. Census. The plot has been generated using Plotly Express to show the time series trend across family income groups from

1994 to 2021 as a line chart. Plotly Express has been chosen, since it allows splicing of data using horizontal bar in a simple way.

4.2.5 Home Ownership by Age of the Householder

Finally, the trend of home ownership rates in U.S. by different age group has been studied. From the **Figure 4-25 Variation of home ownership rates in different age groups in U.S. between 1994 and 2021**, it can be observed that the people of age 45 and above have home ownership rate greater than the national rate from 1994, and similarly, the people of age less than 35 have home ownership rate way below the national rate from 1994. A similar pattern is observed for people of age group between 55 and 64 against the people of age group greater than or equal to 65.

Another interesting observation, as seen in **Figure 4-26 Variation of home ownership rates by different age groups between 2008 and 2021**, is that the people between age 35 and 44 used to have almost the same home ownership rate as that of the national rate until 2008. However, since then the home ownership rate for people between 35 and 44 have fallen below the national rate. From 2012, the gap has been consistent. Finally, it is also interesting to observe that the home ownership rate for people of age greater than or equal to 65 has been consistent from 1994, and this age group's home ownership rate alone was not impacted even during and after recession.

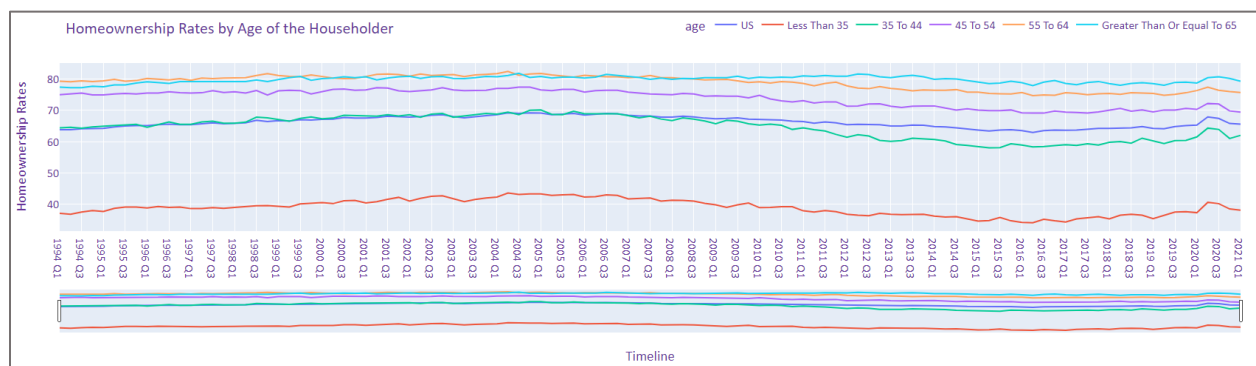


Figure 4-25 Variation of home ownership rates in different age groups in U.S. between 1994 and 2021 (U.S. Census).

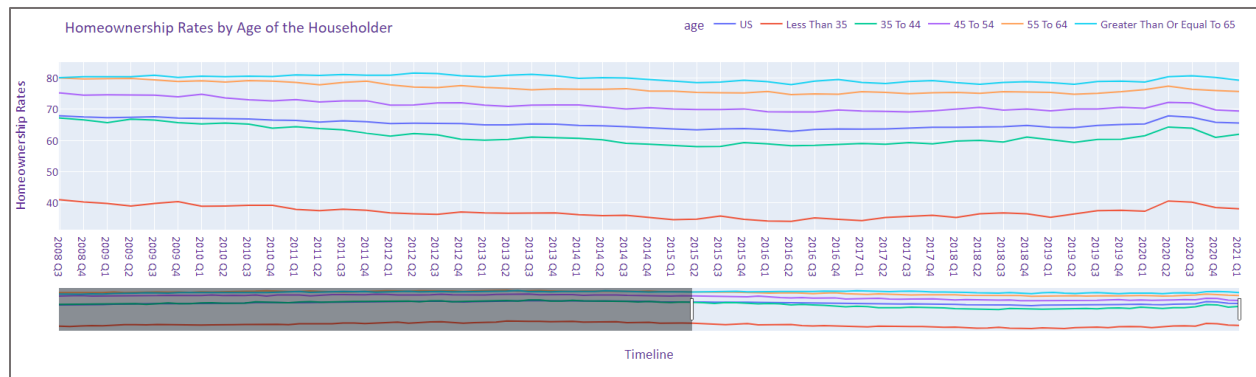


Figure 4-26 Variation of home ownership rates by different age groups between 2008 and 2021 (U.S. Census).

The above plots have been prepared using the data from U.S. Census. These plots have been generated using Plotly Express to show the time series trend amongst different age groups from 1994 to 2021 as a line chart. Plotly Express has been chosen, since it allows splicing of data using horizontal bar in a simple way.

4.2.6 Correlation & Dimensionality Reduction

Next, we wanted to study the correlation pattern amongst the various factors which were seen to have potential impact on the U.S. home ownership rates. We combined these factors using the data obtained from U.S. Census, FRED, Trading Economics, and Macrotrends and generated the Correlation Matrix seen in the **Figure 4-27 Correlation matrix amongst various factors against home ownership rate** using seaborn heatmap for the data from 1984 to 2020. Color scale of green and pink has been used, wherein green represents positive correlation value and pink represents negative correlation value.

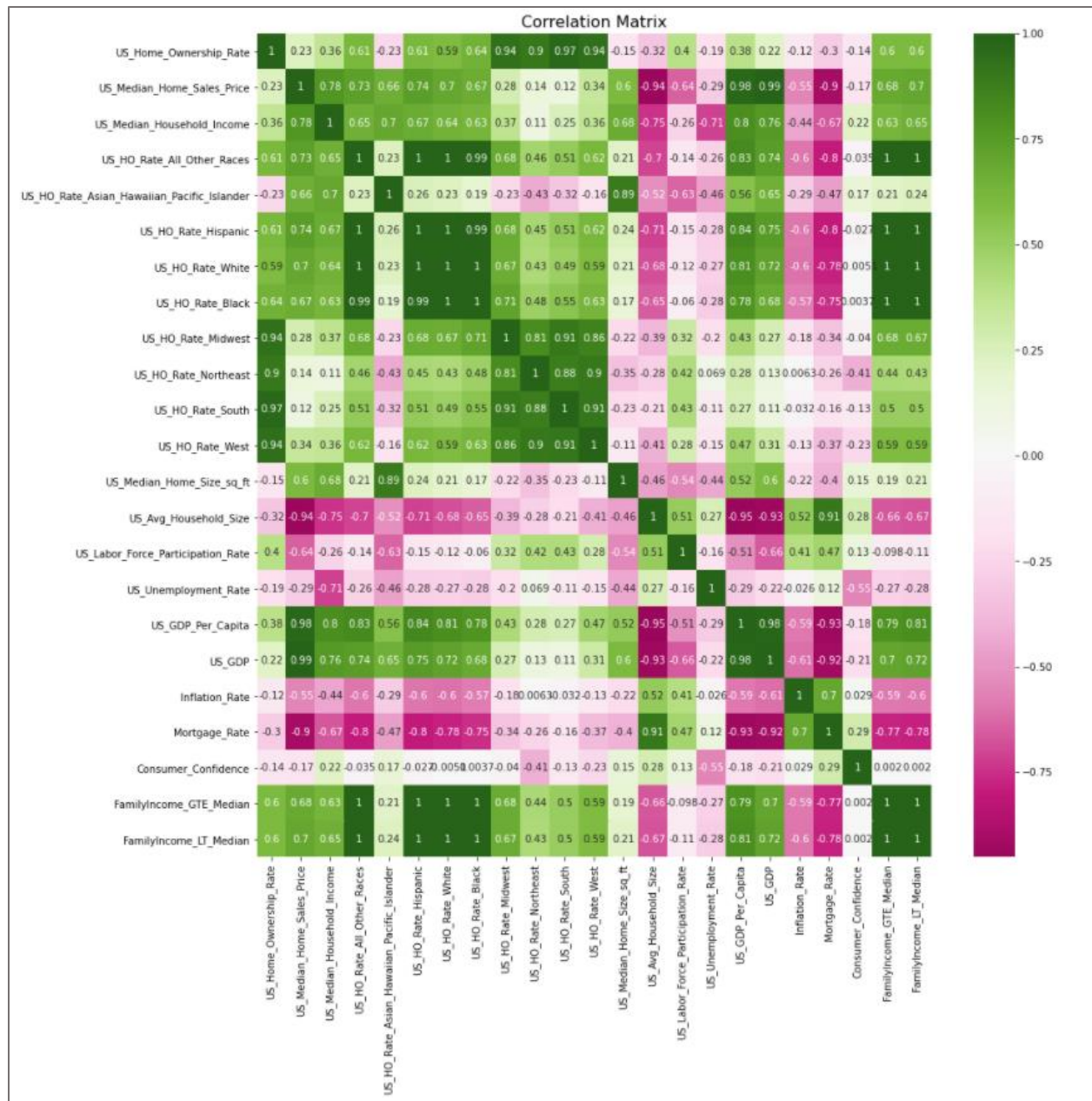


Figure 4-27 Correlation matrix amongst various factors against home ownership rate (U.S. Census, FRED, Trading Economics, and Macrotrends)

US_Home_Ownership_Rate	1.000000
US_HO_Rate_South	0.969752
US_HO_Rate_West	0.943930
US_HO_Rate_Midwest	0.937834
US_HO_Rate_Northeast	0.903468
US_HO_Rate_Black	0.642369
US_HO_Rate_All_Other_Races	0.609847
US_HO_Rate_Hispanic	0.608973
FamilyIncome_GTE_Median	0.599823
FamilyIncome_LT_Median	0.598615
US_HO_Rate_White	0.591359
US_Labor_Force_Participation_Rate	0.397083
US_GDP_Per_Capita	0.382939
US_Median_Household_Income	0.359623
US_Median_Home_Sales_Price	0.231158
US_GDP	0.217086
Inflation_Rate	-0.121833
Consumer_Confidence	-0.136152
US_Median_Home_Size_sq_ft	-0.148230
US_Unemployment_Rate	-0.194058
US_HO_Rate_Asian_Hawaiian_Pacific_Islander	-0.232192
Mortgage_Rate	-0.295119
US_Avg_Household_Size	-0.324599
Name: US_Home_Ownership_Rate, dtype: float64	

Figure 4-28 Correlation table amongst various factors against home ownership rate (U.S. Census, FRED, Trading Economics, and Macrotrends).

It has been seen from the plot in **Figure 4-28 Correlation table amongst various factors against home ownership rate** that all regions have the highest correlation value against the U.S. home ownership rate. No appreciable difference is seen amongst these factors, and its movement is sync with the national average. Next, it is observed there is a high correlation between home ownership rates of African Americans and U.S. home ownership rate. This was due to the introduction of sub-prime mortgages between 1997 and 2006, which increased the home ownership rate amongst the African Americans. Further, we can see that the correlation is high between greater than or equal to median household income and U.S. home ownership rate, as that category of household income increased higher compared to lower than median income. Finally, it is seen that the average household size has a negative correlation with U.S. home ownership rate, and it is due to decrease in person per household 3 to 2.6 person per household during this period as seen in the section 4.1.

After combining the data from various sources, we had 22 factors which had an influence on home ownership rate. We wanted to study the dimensionality reduction on these 22 factors to determine the number of dimensions which could explain the variance against the U.S. home ownership rate. To do this, we performed Principal Component Analysis (PCA) and Non-negative Matrix Factorization (NMF).

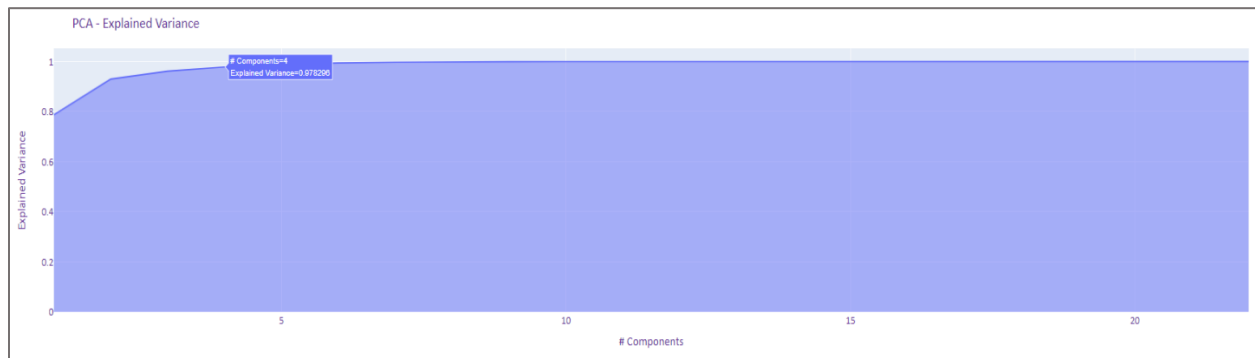


Figure 4-29 Explained variance using PCA

The **Figure 4-29 Explained variance using PCA** has been plotted using Plotly Express. It is seen that with 4 components, an explained variance of 97.83% could be explained. So, we decided to reduce the 22 factors into 4 components for PCA. We have not yet been able to determine the exact structure of each of the 4 components.



Figure 4-30 Scatter matrix against the PCA dimensions

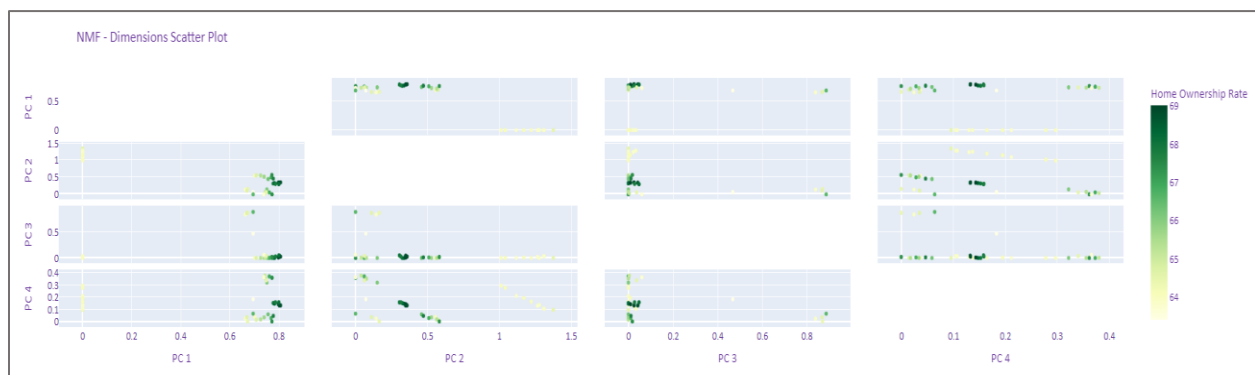


Figure 4-31 Scatter matrix against the NMF dimensions

PCA was performed on the data, and the data was reduced to four dimensions. These four dimensions could explain most of the variance in the data. We then plotted scatter matrix for these four dimensions generated from PCA. The scatter matrix is seen in the **Figure 4-30 Scatter matrix against the PCA dimensions**. Further, we then did the NMF on the data by assuming the needed components to be four. However, we could notice that amongst these four dimensions, two dimensions had mostly zero when compared to other two dimensions. Similar to PCA, we then plotted scatter matrix for these four dimensions generated from NMF. The scatter matrix is seen in the **Figure 4-31 Scatter matrix against the NMF dimensions**.

4.3 Household Analysis: Home Ownership and increment in wealth

4.3.1 Status of U.S. household asset distribution

According to the Survey of consumer finances done by the Federal Reserve in 2010, 2016 and 2019, compared to all other liquid and non-liquid assets, primary residence represents the largest asset category for households in the US. Although the share of primary residence amongst other asset categories was seen to decline from 2010 to 2016 it was seen to rise once again from 2016 to 2019.

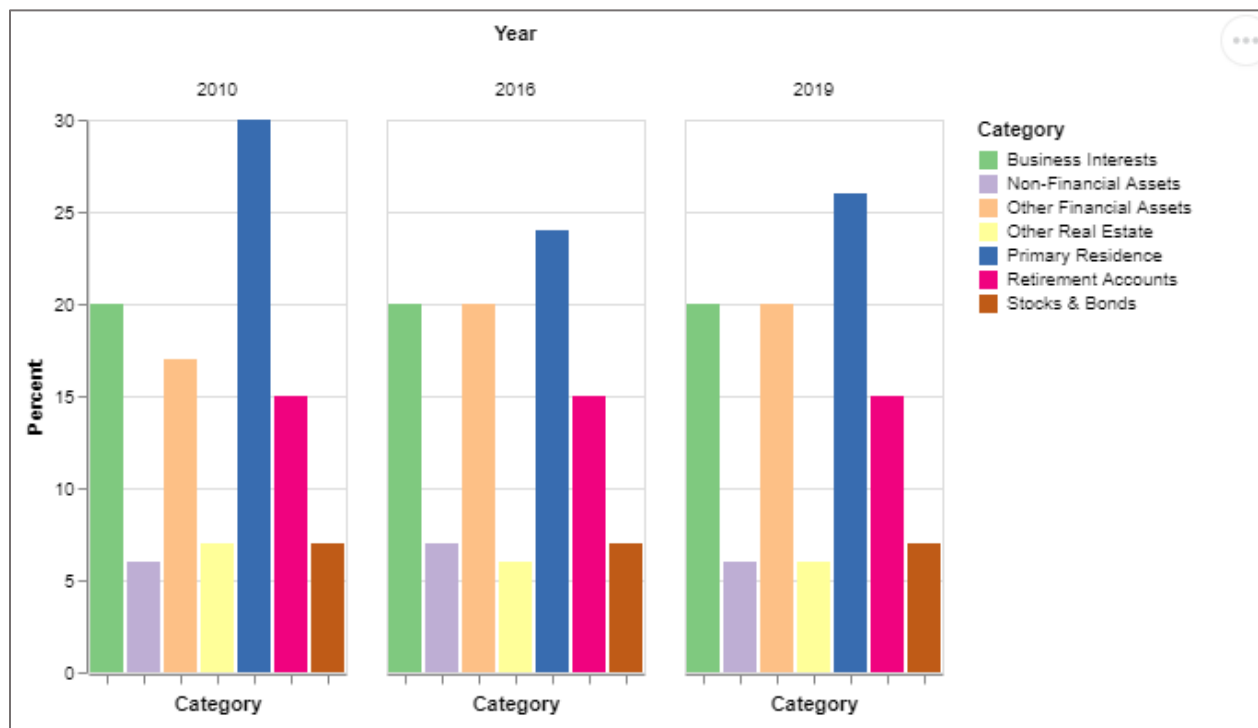


Figure 4-32 Distribution of household assets in 2010, 2016 and 2019 (Survey of Consumer Finances)

All existing visualizations for this distribution are as individual pie charts (**Figure 2-18**). We chose to show this visualization as column charts and for all the 3 survey years in the same chart because:

- Bar charts visualize data using length as compared to area in a pie chart and difference in lengths can be better perceived than difference in areas,
- Putting bar charts of the three periods in the same axis lets us not only see the per survey year asset distribution but also compare the asset distribution for the all the survey periods at a glance,

- We further created a grouped bar chart with the individual categories grouped by years to facilitate the comparison of change in each category over the years.

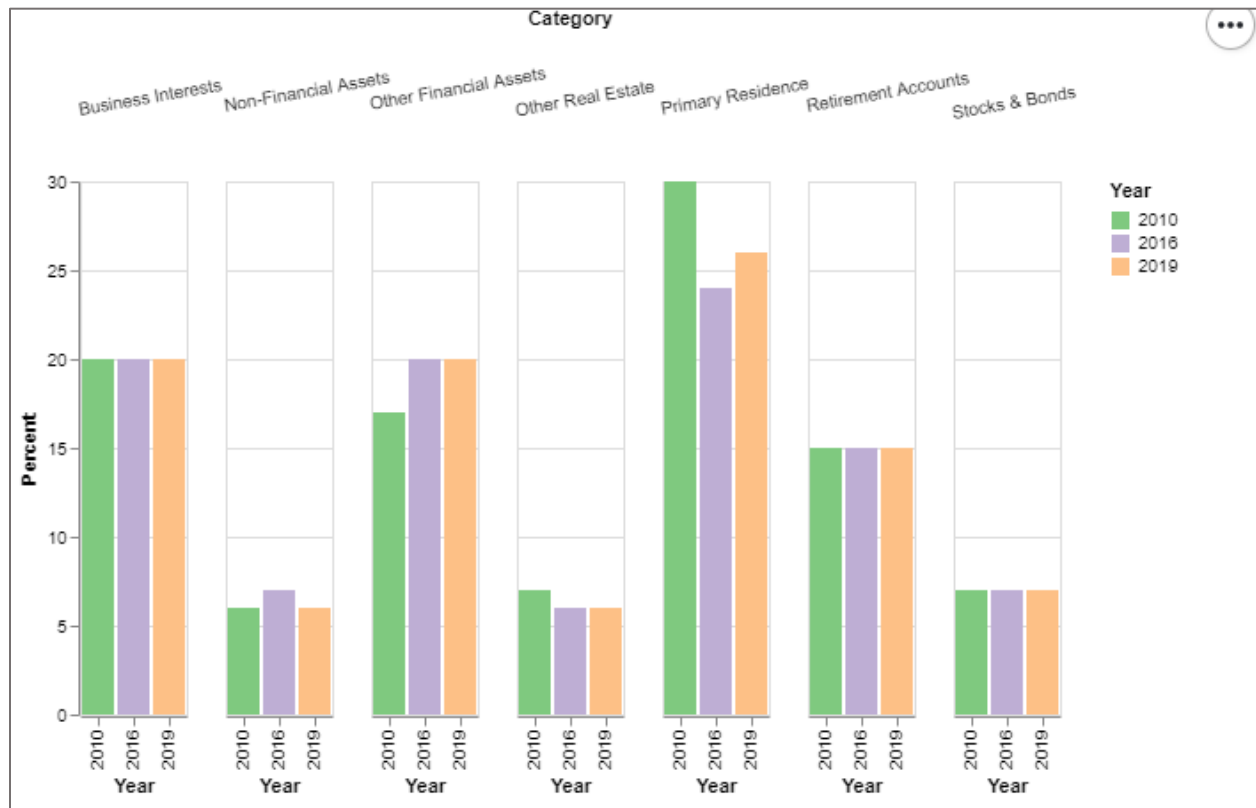


Figure 4-33 Distribution of household assets in 2010, 2016, and 2019; Grouped by Year
(Survey of Consumer Finances)

We used Altair to plot this visualization. Further looking into the asset distribution by category amongst homeowners and non-homeowners based on the Survey of Consumer Finances done in 2016, it can clearly be seen that homeowners have substantially more of each kind of asset compared to families that rent.

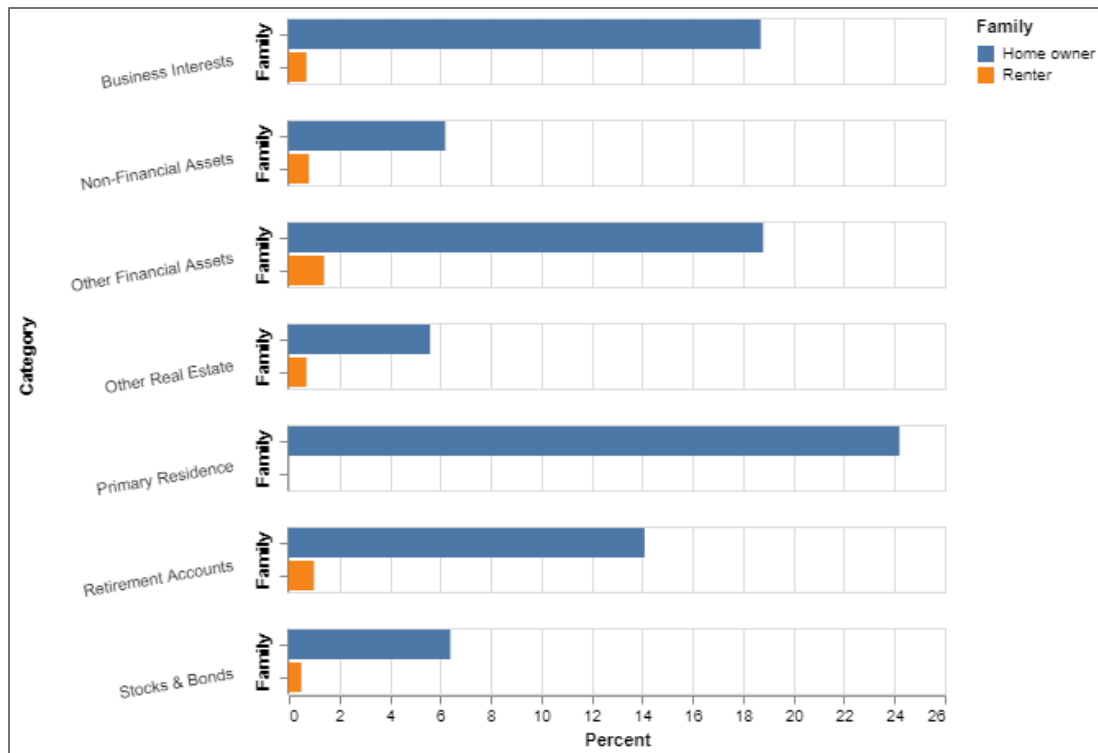


Figure 4-34 Asset distribution comparison between homeowners and non-homeowners
(Survey of Consumer Finances)

We used Altair to plot this visualization. We chose to show the above visualization with a horizontal bar chart, because we were comparing two categories across different fields and there was a huge difference between the numbers in these categories. We used a clustered horizontal bar chart with the categories plotted side by side to compare and contrast the difference

4.3.2 Comparing net worth of homeowners and non-homeowners

According to the same survey done in 2019, the average net worth of a family owning a home in the U.S. is \$1,102,100 compared to the \$95,600 of a typical family not owning a home (i.e., renting a home). However, averages are often skewed by the presence of outliers and so we need to look at the median for a better comparison. The median net worth for families owning a home is \$255,000 and that of a family renting a home is \$6,300. This is a vast difference; more than 40 times. On exploring the data more, we can see that this difference in between the median net worth of families owning a home and renting one has been on the rise i.e., the rate at which

the net worth of homeowners is increasing is also higher than the rate at which the net worth of renters is increasing.

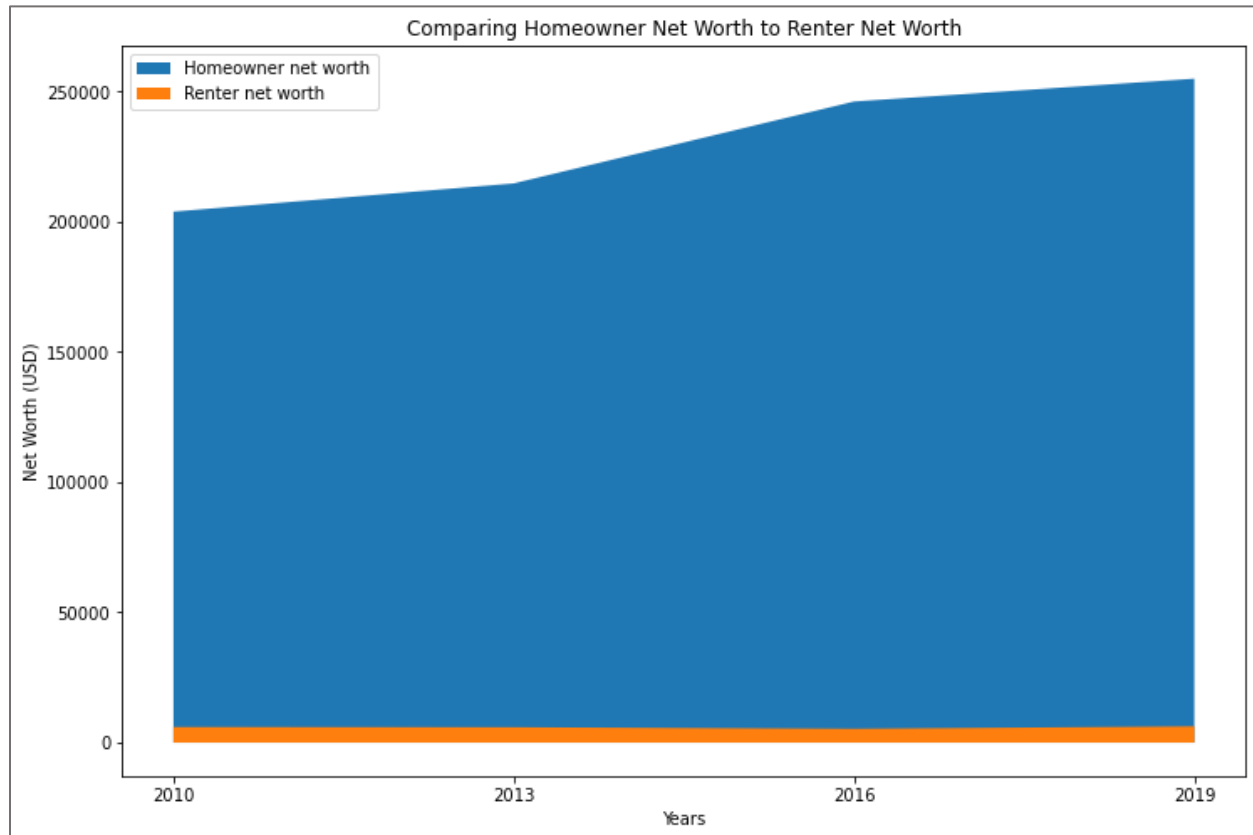


Figure 4-35 Median net worth of homeowners compared to non-homeowners or renters
(Survey of Consumer Finances)

We used Matplotlib to plot this visualization. Like **Figure 4-31, Error! Reference source not found.** here too we compared two categories with vast difference in numbers. We chose an area chart because:

- We specifically wanted to contrast the difference in between the median net worth of homeowners and the renters in the given period
- The thin strip at the bottom which shows the net worth of renters was used to emphasize how negligible the net worth of renters is compared to that of the homeowners

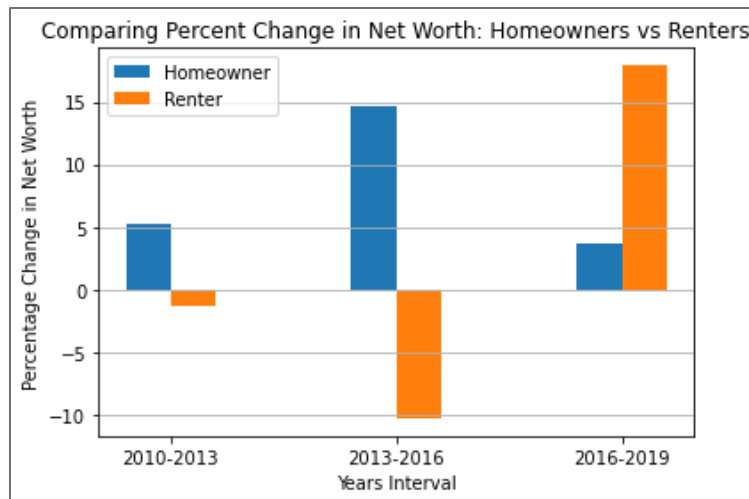


Figure 4-36 Percentage change in average net worth of homeowners compared to non-homeowners from 2010 to 2019 in 3-year intervals

We used Matplotlib to plot this visualization. We ourselves extracted this data from the data used to create **Figure 4-32Error! Reference source not found.** We intend this visualization to supplement **Figure 4-32**. Not only did we want to contrast the net worth of homeowners and renters, using the visualization in **Figure 4-33Error! Reference source not found.** we further wanted to put forward the fact that the net worth for renters was decreasing over 2 of the 3 periods compared.

4.3.3 Comparison of owning vs renting expenses

Unlike renting owning a home comes with some significant costs of its own. Some of the major costs that homeowners incur on a monthly basis which the renters do not are:

- Trash
- Water & Sewer
- Property taxes
- Homeowner's insurance
- Mortgage payments



Figure 4-37 Visualizing expenses of homeowners(left) and renters(right) – Word cloud

Data from Survey of Consumer Finances from 2010 to 2018 shows that although the difference between the median monthly cost of owning a home and cost of renting has been decreasing, the median cost of owning a home has always been higher than renting. We can therefore make an impromptu prediction that owning a home is costlier than renting it. But would that assumption be true?

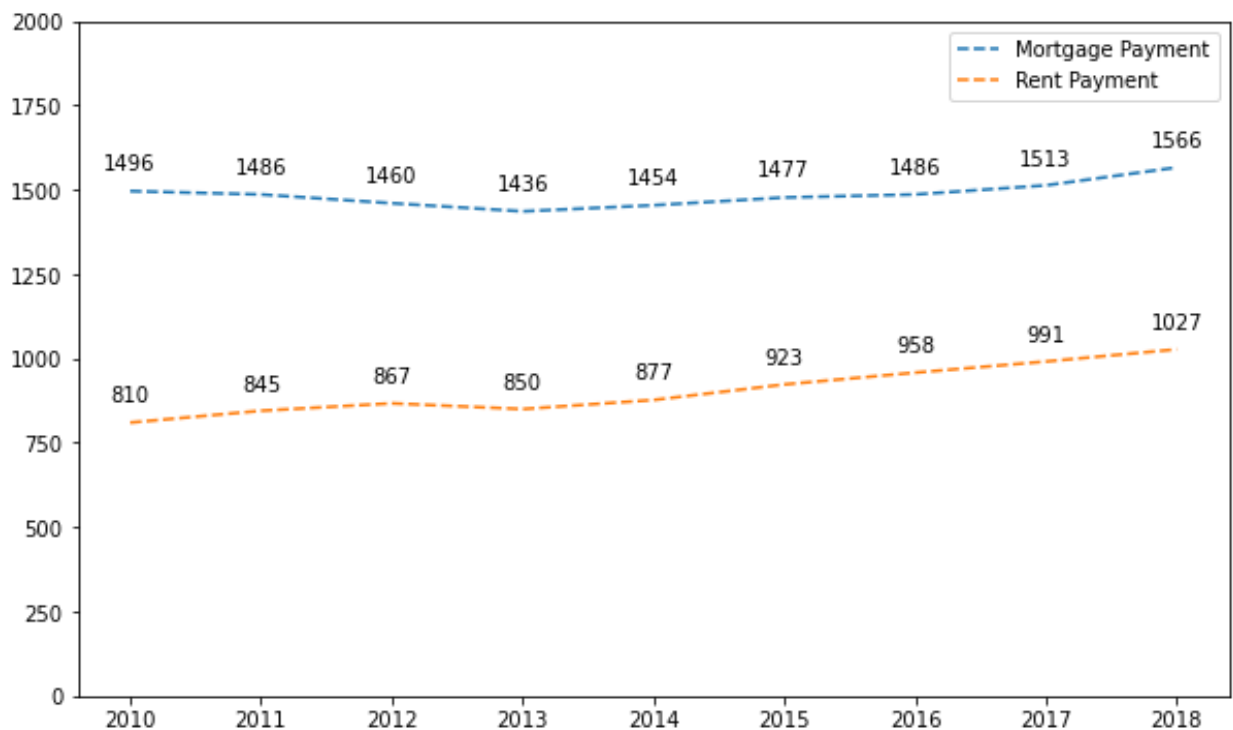


Figure 4-38 Median monthly cost for homeowners and renters (Mortgage is inclusive of homeowners insurance and property taxes and common expenses like utilities have been ignored) (Survey of Consumer Finances)

We used Matplotlib to plot this visualization. In this section we wanted to compare and visualize the median monthly expenses for homeowners and renters. We used a line graph because:

- It is very effective at showing comparisons over a period of time
- Although the data numbers are given, the difference in elevations of the lines are alone enough to convey the information. The visualization at a glance provides the information that home ownership is more expensive.

4.3.4 Sample Calculation

Sure, tallying and comparing the monthly expenses between renters and homeowners shows that the homeowners are spending more. But tallying the expenses alone is not enough. Buying a home is a form of forced saving and compared to renting it also comes with various financial returns, the major ones of which are:

- Increasing equity in home
- Appreciation of home prices
- Savings on rent
- Tax deduction

These financial returns over the years add up to increase the net worth of homeowners compared to the renters.

Laurie S. Goodman and Christopher Mayer in their study “Home ownership and the American Dream” performed a study investigating the net returns from home ownership. They started with a home valued at \$134,200 bought in 2002 with a down payment of \$20,000. In this study they accounted for several financial returns from home ownership such as Imputed rental income, tax benefits along with the expenses of home upkeep, funds for capital improvements and mortgage payments. They concluded that a homebuyer in 2002 would have earned a higher rate of return on home equity than on bonds regardless of the holding period and a higher return than on the S&P 500 with a three-year holding period or more.

We chose to do a simple case study of a median U.S. household by assuming that a family buys a house worth 260,000 dollars at the end of third quarter of 2018 compared to a household that starts renting at the same time. The stats related to the study are:

House price: 260,000\$
 30-year fixed mortgage rate of 4.45% with monthly payments of 1260\$
 10,000 dollars down payment
 3% House value appreciation each year
 Private mortgage insurance: 1250\$ per year
 Homeowner's insurance: 1737\$ per year
 Repair and maintenance: 2500 \$ per year (Using the 1% rule)
 Property taxes: 2500 \$ per year

Assume another family rents an apartment at the same 1260 \$ per year.

Ignoring inflation and rent increase the yearly cost of the homeowner would be 23,107 \$ and for the renter it would be 15,120 \$. We can further assume that the family that rents, invests half of its monthly savings from not buying a house i.e., 4000\$ into the stock market which averages a 10% increase annually.

By the time the mortgage period of 30 years is over, the homeowner will have spent a total of 693,210 dollars compared to the 453,600 dollars of the family who rented. However, the amount the homeowner spends directly goes towards increasing assets as compared to the rent which is a periodical nonrefundable investment.

We calculated the net worth of the two families using the following formulae:

Net worth of homeowner:

$$\text{Net gain per year} = \text{Equity gained in the house} + \text{Appreciation of home value} - \text{Yearly expenses}$$

Net worth of renter

$$\text{Net gain per year} = \text{Stock market gains}$$

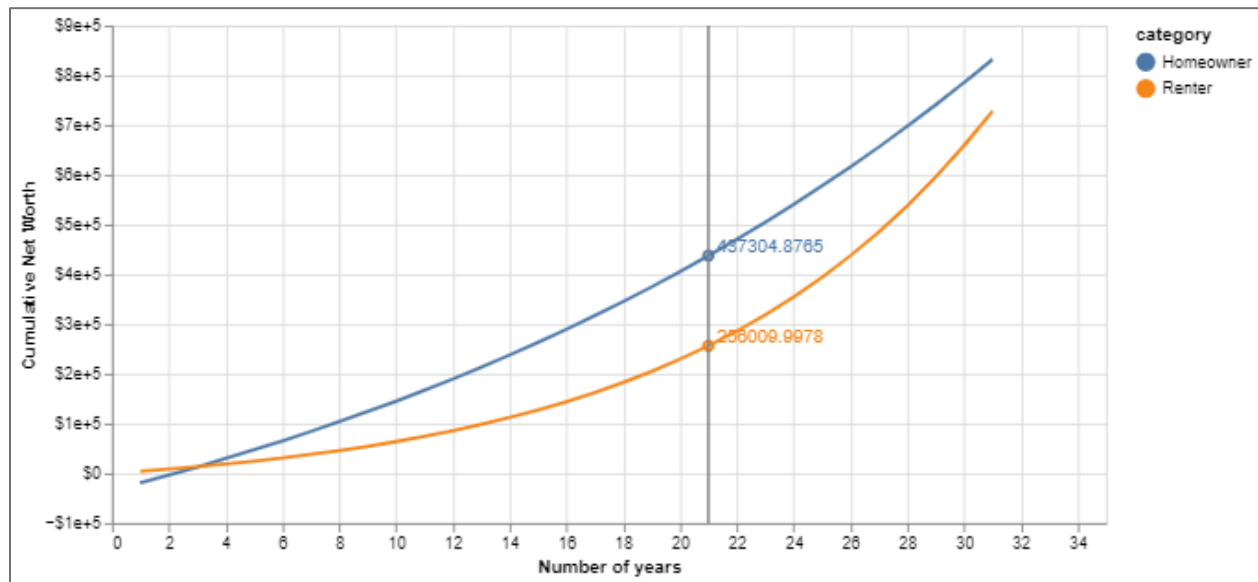


Figure 4-39 Cumulative net worth of homeowner vs renter over a period of 30 years

We used Altair to create this visualization. We used multiple line chart here because:

- We needed to compare the trend of two cumulative net worth over a period of 30 years
- A line chart is also very useful here because we can add a horizontal marker to show the exact values as we move along

As can be seen the forced savings and appreciation in home value contributes to a drastic increase in net worth of the homeowning family. At the end of the 30th year the family owning a home has a net worth of approximately \$10400 more than the family renting. The net worth of the family owning a home starts surpassing the net worth of a family sometime around the 4th year.

Limitations of the assumptions of the study

- Major home expenses have been ignored, this could significantly increase the cost of home ownership and would have to be deducted from the net worth
- Inflation has been ignored; this could affect the renters more as there is a tendency to increase rent annually to account for inflation.
- It is assumed that family that rents invest only half of the expenses difference between them and the family owning a home. This amount could fluctuate over the years.

- It is assumed that the family that rents does not utilize the invested funds throughout the 30-year period. If they periodically withdrew from it then their net worth would be a lot less
- It is assumed that for a similar sized home the mortgage payments and rent payments are equal. This however is not normally seen to be true. Monthly rent for a house similar to a house that one would buy usually is more than the monthly mortgage payments.

Although the initial costs are higher, not accounting for any uncertain situations the net worth of a homeowner starts exceeding that of a renter after about 4 years of home purchase. It can be concluded that even today with very general assumptions owning a home still is a reliable way of increasing wealth over a long period of time.

5 Discussion, Conclusion, and Further Work

5.1 Discussion

Our team learned several valuable lessons while preparing this report, in the technical, process, and subject categories. Technically, we learned the strengths and weakness of half a dozen different Python plotting libraries, particularly Altair and Plotly. In addition, we improved our understanding of recently acquired visualization concepts through their application. We also learned how to tell a compelling story through the use of visualizations.

From a process perspective, we came to recognize the critical need for subject matter expertise, especially when looking at exploratory results. We would have benefitted from communicating directly with government experts with respect to both the location and certain characteristics of extensive datasets. In addition, we did not consult soon enough or frequently enough with available subject matter experts in the Citibank and JP Morgan mortgage risk teams. Home ownership is a complex topic, and knowledge of the domain is crucial for effective analysis.

With respect to our subject, we have learned certain intriguing revelations. U.S. home ownership rates have recently been significantly affected by two events that do not seem to have yet been widely examined, specifically:

- The increase in the labor participation rate from 2017 to 2019 that drove a noticeable increase in the home ownership rate.
- The Covid-19 pandemic, which drove volatile changes in home ownership rates, led to migration from cities, and popularized the work-from-home model that could in turn accelerate further increases in home ownership.

Therefore, while extensive research on U.S. home ownership rates helped direct some of our exploration, at times even research from as recently as four years ago has been challenged by these two recent events. With a few notable exceptions, most research on this topic has allowed itself to be constrained to only the existing albeit extensive datasets, as was our research for the most part. There are several very fertile topics for research on this topic, including analysis by urban/non-urban cohorts, income cohorts, and generational cohorts that could illuminate understanding about constraints on home ownership. However, each would require some transformation of existing data that does not seem to have yet been done. We also did not

recognize the need for several data transformations until well into our research that would have informed our findings, some of which are noted above. We also found no machine learning based analyses of home ownership rates, yet our initial explorations suggested that this could also be lush ground for further research.

The topic of U.S. home ownership rates and constraints upon them may become even more vital if U.S. social security's financial basis becomes further eroded. At that point, building wealth through home ownership may become a long-term need for all Americans who are not wealthy.

5.2 Conclusion

Our study examined U.S. home ownership at the national, factor, and individual household levels. At the national level, we found certain legal, financial, and economic trends that significantly impacted home ownership rates. These trends, often noted separately in prior research, included household size, house footprint, inflation/mortgage rate, regulatory trends, and economic downturns. We were able to combine many of these findings into an interactive visual narrative.

Our work on the factor or component level analyzed geographic, ethnic, simple income, and age factors. It also looked at correlations between these factors and the national rate. We also began to dissect these elements using several deep learning techniques, although our analysis requires further work.

Finally, we examined home ownership's impact on individual households, highlighting the wealth building feature of home ownership. Using materials from Federal Reserve studies, we assessed different aspects of this wealth building. We concluded that home ownership remains an excellent method for building wealth for most Americans.

5.3 Further Work

In our preparation of this analysis and illustration of U.S. Home Ownership, we identified several areas for further research. These included:

I. National analysis of the impact of more distinct income categories on home ownership rates: The movement of more Americans from low and middle income to higher income cohorts is likely to have had an impact on rates. The underlying information needs to be transformed into appropriate cohorts to complete this analysis.

II. National and factor analysis of the status of home ownership rates by generational cohort: Our analysis, and prior research, suggested that younger generations have not achieved home ownership at rates of older generations. Such an analysis would require capture of further age statistics at the state/county level and some transformation of them into cohorts over time.

III. National and factor analysis of the impact of urbanization on home ownership rates: Our analysis suggested that urbanization could be a key constraint on home ownership, especially among ethnic groups clustered in cities, including Hispanic and African Americans. Such an analysis will require categorizing U.S. counties into urban, suburban, exurban, and rural categories, a grouping we were not yet able to find in existing datasets.

IV. Factor analysis of four key low home ownership rate states, California, Hawaii, Nevada, and New York: This analysis, which could be extended to other states, would require augmenting certain existing datasets with additional attributes such as income groupings, urbanization aspects, and numbers of persons per household. Given the historical evidence of persistently lower comparable home ownership rates in New York state and city, this research could provide insights into pervasive local constraints on home ownership.

V. Further use of machine learning component analysis of both national and state constraints on home ownership rates: Our work only began to apply these tools to identify these constraints. Given the high explanation rates of the resulting derived components, these tools could provide considerable insight into some of the other potential research noted above.

VI. Creation of a more reasoned visualization(s) to support the home purchase versus rent decision: Our work indicated several drawbacks with the most well-known calculator that a more insightful visualization might overcome with respect to this decision.

VII. Examination of building methods on home affordability: Certain earlier home ownership rate increases were fueled by more affordable building techniques, such as factory-built homes in the 1920s and common model suburban homes in the 1950s. Given the emergence of prefabricated rooms and 3d-printing capabilities, newer building methods may be able to produce more affordable homes. Historical data on building permits and similar elements could provide some insights into this possibility.

References

- Ancestry. (2017, March 23). *Homeownership Through the Ages: A Look at Ownership Then and Now*. Ancestry Corporate. <https://www.ancestry.com/corporate/blog/homeownership-through-the-ages-a-look-at-ownership-then-and-now/>.
- Dietz, R. (2019). *Housing affordability reducing housing share of GDP*. Eye On Housing. <https://eyeonhousing.org/2019/04/housing-affordability-reducing-housing-share-of-gdp>.
- DQYDJ. (2020, September 5). *US Historical Homeownership Rate: 1890 to Present*. DQYDJ | Don't Quit Your Day Job. <https://dqydj.com/historical-homeownership-rate-united-states/>.
- Federal Reserve Bank of St. Louis. (2021, June 8). *Housing / FRED / St. Louis Fed*. FRED | Federal Reserve Economic Data. <https://fred.stlouisfed.org/categories/97>.
- Federal Reserve Bank of St. Louis. (2020, September 16). *Real Median Household Income in the United States*. Federal Reserve Economic Data. <https://fred.stlouisfed.org/series/MEHOINUSA672N>.
- Fry, R. (2019). *The number of people in the average U.S. household is going up for the first time in over 160 years*. Pew Research Center. <https://www.pewresearch.org/fact-tank/2019/10/01/the-number-of-people-in-the-average-u-s-household-is-going-up-for-the-first-time-in-over-160-years>.
- Fry, R. (2021, March 8). *Amid a pandemic and a recession, Americans go on a near-record homebuying spree*. Pew Research Center. <https://www.pewresearch.org/fact-tank/2021/03/08/amid-a-pandemic-and-a-recession-americans-go-on-a-near-record-homebuying-sprees/>.
- Garriga, C. (2014). *Homeownership and house prices no longer in sync*. Federal Reserve Bank of St. Louis. <https://www.stlouisfed.org/on-the-economy/2014/december/homeownership-and-house-prices-no-longer-in-sync>
- Golden Oak Research Group. (2018, May 19). *Kaggle / Datasets / Income, Age, Marriage, Mortgage, Home Equity Loan & Demographics*. Kaggle. <https://www.kaggle.com/goldenoakresearch/us-acs-mortgage-equity-loans-rent-statistics>.
- Goodman, L., & Mayer, C. (2018, February 21). *Homeownership is still financially better than renting*. Urban Institute. <https://www.urban.org/urban-wire/homeownership-still-financially-better-renting>.

- Government of Canada. (2021, July 1). *Statistics Canada: Canada's national statistical agency*.
<https://www.statcan.gc.ca/eng/start>.
- Harvard University. (2011, July 1). *Historical Data Visualization*. US Home Ownership Rates -
Historical Data Visualization - Business History - Harvard Business School.
https://www.hbs.edu/businesshistory/courses/resources/historical-data-visualization/Pages/details.aspx?data_id=44.
- Hecht, B. (2017, April 11). *#BensTake: Homeownership as a Key Driver of Wealth*. *Living Cities*. <https://www.livingcities.org/blog/1183-benstake-homeownership-as-a-key-driver-of-wealth>.
- Hellegaard, J. (2017, November 16). *Homeowners Can't Count on Property Appreciation for Wealth*. FAU. <https://www.fau.edu/newsdesk/articles/homeowners-cant-count-on-property-appreciation-for-wealth.php>.
- Herbert, C. E., McCue, D. T., & Sanchez-Moyano, R. (2013, September 30). *Is Homeownership Still an Effective Means of Building Wealth for Low-income and Minority Households? (Was it Ever?)*. Harvard University, Joint Center for Housing Studies.
<https://www.jchs.harvard.edu/sites/default/files/hbtl-06.pdf>.
- History of Federal Minimum Wage Rates Under the Fair Labor Standards Act, 1938 – 2009*. (2021, June 10). U.S. Department of Labor.
<https://www.dol.gov/agencies/whd/minimum-wage/history/chart>.
- Home Price Trends*. (2021, June 10). Global Property Guide.
<https://www.globalpropertyguide.com/home-price-trends?ref=breadcrumb>.
- Howley, K. (2020, July 29). *U.S. homeownership rate soars to an almost 12-year high*. HousingWire. <https://www.housingwire.com/articles/u-s-homeownership-rate-soars-to-an-almost-12-year-high/>.
- Jones, T. C. (2019, November 5). *U.S. Homeownership Rate by State*. Stewart.
<https://blog.stewart.com/stewart/2019/11/05/u-s-homeownership-rate-by-state/>.
- Kober, E. (2021, July 7). *The Jobs–Housing Mismatch: What It Means for U.S. Metropolitan Areas*. Manhattan Institute. <https://www.manhattan-institute.org/jobs-housing-mismatch-what-it-means-metropolitan-areas>.
- Kushi, O. (2020, November 5). *Homeownership Remains Strongly Linked to Wealth-Building*. First American Blog - The First Word.

- <https://blog.firstam.com/economics/homeownership-remains-strongly-linked-to-wealth-building>.
- Lamont, D. (2021, March 15). *What does centuries of UK housing data tell us? What 175 years of data tell us about house price affordability in the UK*.
<https://www.schroders.com/en/insights/economics/what-174-years-of-data-tell-us-about-house-price-affordability-in-the-uk/>.
- Lebergott, S. (1966, January 1). *Labor Force and Employment, 1800–1960*. Output, Employment, and Productivity in the United States after 1800 | National Bureau of Economic Research. <https://www.nber.org/system/files/chapters/c1567/c1567.pdf>.
- Lee, A., Kilduff, L., & Mather, M. (2020, February 13). *U.S. Homeownership Rates Fall Among Young Adults, African Americans*. PRB. <https://www.prb.org/resources/u-s-homeownership-rates-fall-among-young-adults-african-americans/>.
- Macrotrends LLC. (2021, July 11). *30 Year Fixed Mortgage Rate - Historical Chart*. MacroTrends. <https://www.macrotrends.net/2604/30-year-fixed-mortgage-rate-chart>.
- Mazur, C. (2019, November 4). *A Decade After the Recession, Housing Costs Ease for Homeowners*. The United States Census Bureau.
<https://www.census.gov/library/stories/2019/11/decade-after-the-recession-housing-costs-ease-for-homeowner.html>.
- Mislinski, J. (2021, April 27). *Home Ownership Rate: 65.6% in Q1 2021*. Advisor Perspectives. <https://www.advisorperspectives.com/dshort/updates/2021/04/27/home-ownership-rate-65-6-in-q1-2021>.
- Muresan, A. (2016). *Who lives largest? The growth of urban American homes in the last 100 years*. Property Shark. <https://www.propertyshark.com/Real-Estate-Reports/2016/09/08/the-growth-of-urban-american-homes-in-the-last-100-years/>.
- Neal, M. (2013, September 30). *Homeownership Remains a Key Component of Household Wealth | September Special Study for Housing Economics*. www.nahbclassic.org.
<https://perma.cc/JF4Z-NER7>.
- NerdWallet. (2021, July 6). *Rent vs Buy Calculator: Should I Rent or Buy?* NerdWallet.
<https://www.nerdwallet.com/mortgages/rent-vs-buy-calculator>.
- Oswald, A. (2013). *High home ownership as a driver of high unemployment*. Vox EU.
<https://voxeu.org/article/high-home-ownership-driver-high-unemployment>

- Perry, M. (2014). *Today's new homes are 1,000 square feet larger than in 1973, and the living space per person has doubled over last 40 years*. AEI. <https://www.aei.org/carpe-diem/todays-new-homes-are-1000-square-feet-larger-than-in-1973-and-the-living-space-per-person-has-doubled-over-last-40-years/>.
- Pollock, A. J. (2014, March 26). *Long-term home ownership trends: The US, England, and Canada*. AEI. <https://www.aei.org/articles/long-term-home-ownership-trends-the-us-england-and-canada/>.
- Reserve Bank of Australia. (2015, June 1). *Home Ownership Rates: Submission to the Inquiry into Home Ownership June 2015: Housing and Housing Finance: Submissions*. Reserve Bank of Australia. <https://www.rba.gov.au/publications/submissions/housing-and-housing-finance/inquiry-into-home-ownership/home-ownership-rates.html>.
- Robinson, K. J. (2013, November 22). *Savings and Loan Crisis*. Federal Reserve History. <https://www.federalreservehistory.org/essays/savings-and-loan-crisis>.
- Roth, J. D. (2020, February 23). *A brief history of U.S. homeownership*. Get Rich Slowly. <https://www.getrichslowly.org/homeownership/>.
- S&P 500. (2021, June 10). Yahoo Finance. https://finance.yahoo.com/quote/%5EGSPC/history/?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xILmNvbS8&guce_referrer_sig=AQAAAHVgXiPHMbHlAXdVvLNbynDjokHAZK4Kxs0a4ihLnCFV_Owm9HBm6ROnPHzwWg7RU_-YXbFkZDVpxDPghtsSyNiFxEO4C0D1ibS5yj39JcjVIdB8onKENea-OwhnKahBfgziM-4QLcWOy9chJy0kg9DMn4kf0OxJmKLSKjn3HuNt.
- Sánchez Chinchón, A. (2015, January 10). *Visualizing home ownership with small multiples and R*. Data Science Blog by Domino. <https://blog.dominodatalab.com/visualizing-homeownership-in-the-us-using-small-multiples-and-r/>.
- Statista Inc. (2021, February 17). *U.S. homeownership rate 2020*. Statista. <https://www.statista.com/statistics/184902/homeownership-rate-in-the-us-since-2003/>.
- Swanson, J. (2019, August 28). *Homeownership is the Top Contributor to Household Wealth*. Mortgage News Daily. http://www.mortgagenewsdaily.com/08282019_homeownership.asp.
- Trading Economics. (2021, June 8). *United States Home Ownership Rate 1965-2021 Data: 2022-2023 Forecast: Historical*. United States Home Ownership Rate | 1965-2021 Data |

- 2022-2023 Forecast | Historical. <https://tradingeconomics.com/united-states/home-ownership-rate>.
- U.S. Census Bureau. (2020, December 15). *Housing*. The United States Census Bureau. <https://www.census.gov/topics/housing.html>.
- U.S. Census Bureau. (2021, March 25). *Homeownership in the United States: 2005 to 2019*. The United States Census Bureau. <https://www.census.gov/newsroom/press-releases/2021/homeownership.html>.
- U.S. Census Bureau. (2021, May 25). *New Residential Sales*. The United States Census Bureau. https://www.census.gov/construction/nrs/historical_data/index.html.
- U.S. Census Bureau. (2021, May 13). *Tables*. The United States Census Bureau. <https://data.census.gov/cedsci/all?d=ACS%201-Year%20Estimates%20Data%20Profiles&tid=ACSDP1Y2019.DP02>.
- U.S. Census Bureau. (2021, March 26). *Percentage of Owner-Occupied Housing Units: 2015-2019*. The United States Census Bureau. <https://www.census.gov/library/visualizations/interactive/acs-percentage-owner-hu-2015-2019.html>.
- U.S. Census Bureau. (2021, April 27). *QUARTERLY RESIDENTIAL VACANCIES AND HOMEOWNERSHIP, FIRST QUARTER 2021*. U.S. Census Bureau. <https://www.census.gov/housing/hvs/files/currenthvspress.pdf>.
- U.S. Housing and Urban Development | Office of Policy Development and Research (PD&R). (2021, June 8). *U.S. Housing Market Conditions*. USHMC Home | HUD USER. <https://www.huduser.gov/portal/ushmc/home.html>.
- U.S. Housing and Urban Development | Office of Policy Development and Research (PD&R). (1994, July 1). *Homeownership-Past, Present, and Future*. US Housing Market Conditions. <https://www.huduser.gov/periodicals/ushmc/summer94/summer94.html>.
- Valadez, R. (2010). *The housing bubble and the GDP: a correlation perspective*. Journal of Case Research in Business and Economics. <https://www.aabri.com/manuscripts/10490.pdf>.
- Vuleta, B. (2020, October 28). *26 Jaw-Dropping Home Ownership Statistics in 2020*. Movity. <https://movity.com/blog/home-ownership-statistics/>.
- Wilson, E., & Callis, R. R. (2013, May 1). *Who Could Afford to Buy a Home in 2009? Affordability of Buying a Home in the United States*. U.S. Census Bureau | Housing.

https://www.census.gov/content/dam/Census/library/publications/2013/demo/h121_13-02.pdf.

Appendices - provided separately

Jupyter Notebooks

Presentation