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Fundamentals and affordability in the U.S. housing market: 1991-2015

A State-level analysis

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Housing market fundamentals have a strong correlation with house prices. In the past few decades, housing affordability in the United States has been a key topic of discussion as homes have become more expensive. The housing market is central to any country, as everyone is a part of the housing market either through homeownership or renting. This study aims to find how fundamentals of the U.S. housing market have impacted housing prices between 1991-2015. In addition, affordability of housing will be considered using a home price-income ratio, calculated using the home price index and per capita income data. The U.S. housing market is considered on a state-level due to the heterogeneity of housing markets across the country. Panel regression analysis will be used to analyse the correlation between housing market fundamentals and house prices. The study finds that during the whole period of 1991-2015, income and population have a strong positive correlation with house prices, whereas unemployment has a negative correlation. The period of 1991-2015 was also split into three separate periods to compare results. The correlation coefficients during and after the financial crisis, 2008-2015, differed from the previous results, with income having negative correlation and population having weak positive correlation with housing prices. Housing affordability measured by the home price-income ratio deteriorated in the mid-2000's prior to the financial crisis. Although a trend in the development of the home price-income ratio is found, there are states with clearly different outcomes. This study contributes to existing literature by emphasising the impact of housing fundamentals on the housing market and considering state-level differences in the United States.

Key words: housing markets, macroeconomics.

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Asuntomarkkinoiden perustekijöillä on vahva korrelaatio asuntojen hintojen kanssa. Asuntojen kohtuuhintaisuus on ollut keskeinen keskustelunaihe Yhdysvalloissa viime vuosikymmeninä asuntojen hintojen noustessa. Asuntomarkkinat ovat keskeisiä kaikissa maissa, sillä jokainen henkilö on osa asuntomarkkinoita joko omistamisen tai vuokrauksen kautta. Tämän tutkimuksen tavoitteena on selvittää kuinka Yhdysvaltojen asuntomarkkinoiden perustekijät ovat vaikuttaneet asuntojen hintoihin vuosina 1991–2015. Lisäksi asumisen kohtuuhintaisuutta tarkastellaan asunnon hinta-tulosuhteella, joka lasketaan asuntohintaindeksin ja asukaskohtaisten tulotietojen avulla. Yhdysvaltojen asuntomarkkinoita tarkastellaan osavaltiotasolla niiden heterogeenisyyden vuoksi. Paneeliregressioanalyysillä analysoidaan asuntomarkkinoiden perustekijöiden ja asuntojen hintojen välistä korrelaatiota. Tutkimus osoittaa, että vuosina 1991–2015 tuloilla ja väestönkasvulla oli vahva positiivinen korrelaatio asuntojen hintojen kanssa. Työttömyydellä oli negatiivinen korrelaatio asuntojen hintojen kanssa. Vuodet 1991–2015 on jaettu kolmeen eri ajanjaksoon tulosten vertailua varten. Korrelaatiokertoimet finanssikriisin aikana, ja sen jälkeen, poikkesivat aiemmista tuloksista, sillä tuloilla oli negatiivinen korrelaatio ja väestönkasvulla heikko positiivinen korrelaatio asuntojen hintojen kanssa. Asunnon hinta-tulosuhteella mitattuna asumisen kohtuuhintaisuus heikkeni 2000-luvun puolivälissä ennen finanssikriisiä. On kuitenkin olemassa osavaltioita, joiden asunnon hinta-tulosuhde poikkeaa maan keskiarvosta. Tämä tutkimus täydentää olemassa olevaa kirjallisuutta korostamalla asumisen perustekijöiden vaikutusta asuntomarkkinoihin ja huomioimalla osavaltiotason eroja Yhdysvalloissa.

Avainsanat: asuntomarkkinat, makrotaloustiede.

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1 Introduction

The aim of this master's thesis in Economics is to explore the fundamentals of the housing market in the United States of America between 1991-2015. Much research has been done attempting to explain the causes of the 2008 financial crisis. Analysis on the aftermath and recover of the crisis has been far more subdued. This thesis will contribute to the existing literature by adding a study of the heterogeneity of the U.S. housing market in the years 1991-2015. I am fascinated by the link between the financial markets and housing market. Understanding the role of housing market fundamentals and the impact of the 2008 financial crisis on the housing market in the United States is a priority in this thesis.

The hypothesis in this research is that there was a run-up in house prices and price-to-income ratios nationwide in the mid-2000's before the financial crisis. In addition, I believe that income and population will have a positive correlation with house prices. Following the financial crisis, there was a recovery in both house prices and income per capita, leading to a positive recovery in the housing market. However, I believe the price-to-income ratio will be much healthier in the early 2010's than it was in the mid-2000's prior to the financial crisis. For example, regulation was put in place to curb excessive lending.

Components of housing demand will be investigated and modelled against the development of housing prices for a period of 25 years between 1991-2015. This chosen period allows us to see longer term patterns in the housing market. In addition, it was possible to get the required data for all variables in this timeframe, giving us strongly balanced panel data to work with. This thesis will focus on using state-level data in regressions, to account for the heterogeneity of housing markets between different U.S. states. This research will attempt to uncover possible correlation between housing demand components such as household income, inflation, unemployment rate, and various ratios, and house prices.

For most people, buying a home is one of the largest purchases that they will ever make. Hence understanding the impact of policy decisions on the housing market and therefore individuals is of utmost importance. In addition, home purchases are significant in terms of personal finances, family development, and stability. Income, population, and average unemployment will be the independent variables. I believe that out of the chosen variables, income and population will have the highest correlation with home prices. Rationale of the choice of variables is explained in Chapter 5.

Prior to delving deeper into the events that transpired when the housing bubble burst, a brief history of American housing markets will be done to understand the framework on which it was operating on. Subsequently, history of regulation and deregulation in the American housing market will be examined. This includes regulation in the financial sector because banks are the ones who allow most individuals to purchase a home with a mortgage.

Following neo-liberal policies starting in the 1980's, deregulation in the American lending market increased the availability of credit, including for mortgages for buying property. Housing prices were increasing for a long time because money for buying houses was cheap. Mortgages are longer and households can afford to buy higher priced homes than before (Guy and Hill, 2009). Individuals began seeing real estate as more of an investment rather than just a method for acquiring a place to live. Cheap and available money continued to fuel demand for property, especially once individuals and institutional investors began seeing increasing property values. Loose monetary conditions make credit more available, making it easier to buy a home, driving up prices (Jordá et al., 2015). This was the case in the mid-2000's, with mortgage credit more easily available (Mian and Sufi, 2011). Not only can loose monetary conditions cause housing price booms, but since the share of real estate lending of total bank lending has increased, central bank and governments should be mindful of policy effects on financial stability (Jordá et al., 2015).

Banks and financial institutions were not heavily regulated before the housing crisis. Decades of deregulation allowed banks to give ever larger mortgages to a wider swath of the population. Standards for screening borrowers were minimal, making it very easy to get a mortgage. Banks and financial institutions used financial engineering to create complex derivative products. These practically tied the whole banking sector together. Mortgages were bundled up and sold as batches to other investors. Lenders did not have an incentive to care about the creditworthiness of their borrowers. Once the loan had been made, it would be removed from their balance sheet because it was sold onwards. Possible future delinquencies and bankruptcies were a problem for the investor, and not bank who had made the original loan. The complex derivatives exhibited the problem of moral hazard. In finance, moral hazard refers to a phenomenon in which financial actors, such as banks, are incentivised to act in a deceitful manner (Kenton, 2023). The incentive is most often financial. For example, a bank may allow a mortgage to a non-qualified customer. Once the mortgage has been created, it can be sold to an investment bank. The original bank has essentially created a problem for

which they do not hold “financial responsibility” anymore. They have removed the potentially bad loan from their balance sheet.

Lenders helped turn a hot housing market into a bubble that burst, with far-reaching consequences. Once lending between banks dried up, liquidity vanished from the market and housing prices plummeted. Unemployment surged and many people were left with mortgages that they could not pay off. An oversupply of housing at unaffordable rates was one of the main triggers for the prices to fall. The influential and central nature of the housing market makes it an intriguing topic of research.

Forthcoming, there is a literature review. The literature review includes research about housing market fundamentals and insights into the 2008 financial crisis, the financial and psychological impacts, bubbles in the market, and the evidence of housing market turbulence from a variety of indicators. Following this, theory about the housing market is continued. In this section, the basics of demand and supply will be summarised. In addition, the Taylor rule will be explained in detail to understand the theory behind appropriate interest rate levels based on prevailing economic conditions. Subsequently, key characteristics of the US housing market are examined along with the Federal Reserve. With regards to the Federal Reserve, their monetary policy choices in the past few decades will be examined. After this, data, methodology and the results of the regressions will be discussed in detail. After discussing the results of the regression analysis and possible policy suggestions, the research is wrapped up in the conclusion.

2 Literature review

To meaningfully discuss and study the fundamentals of the U.S. housing market, one must be aware of the events that have unfolded during the given period and their effects. The period chosen for analysis is 1991-2015 and the effect of fundamentals on house prices and the house price-to-income ratio will be investigated. The aim is to understand the development of housing market fundamentals, the house price-to-income ratio, and possible outliers on a state-level.

2.1 Wealth distribution and income inequality

Wolff (2014) goes into depth about the run-up to the 2008 financial crisis and the aftermath of it. Wolff's insight is a good starting point for the research as the 2008 financial crisis had a clear, significant impact on the housing market during our period of research. Median wealth decreased by 44% in the years 2007-2010, almost double that of the drop in housing prices (ibid). This can be explained by the fact that many households held other financial assets, such as stocks, whose value fell even more than house prices. Wolff points out that in the decades running up to the mid-2000s, indebtedness and home ownership rates had risen, especially with the middle class. Prior to the crisis, the middle class was highly leveraged with a high debt to net worth ratio (ibid). Mean wealth fell by only 18%, meaning that wealth inequality increased during the crisis. Hailemariam et al. (2021) find increased income inequality is associated with a decrease in house prices, partly due to crime. If crime rates increase in an area due to increased income inequality, the demand for housing in the area will decrease, pushing down prices. Määttänen and Terviö (2010) also found that increased income inequality lowered average house prices in 6 US metropolitan regions between 1998-2007. Likewise, Malpezzi (2017) finds that broader income distributions foster higher growth rates in house prices. Mian and Sufi (2011) also find that leverage increased sharply preceding the 2007 crisis and that over the preceding 30 years relative indebtedness by households increased compared to firms. High leverage meant that it increases returns when asset prices increase but returns decrease when asset prices fall. Leverage strengthens both gains and losses in asset prices compared to no leverage. Malpezzi (2017) describes the effects of the financial crisis through excessive leverage and volatility in housing prices.

2.2 Differences in exposure to real estate

Likewise, Kuhn et al. (2016) describe how the "composition and leverage of household portfolios are very different along the wealth distribution". They find that the portfolios of the

bottom 90% are undiversified and highly leveraged (ibid). For them, houses are the biggest asset in their portfolio, leaving them very exposed to changes in house prices (ibid). On the other hand, the top 10% are way less exposed to house prices and hold more than 90% of stocks (ibid). Therefore, a house is the biggest asset for most people (Black et al., 2006). Kouwenberg and Zwinkels (2010) also found that a house is usually a big fraction of household wealth.

Davidoff (2006) considers that some homeowners own too much housing. Since houses are an illiquid asset, one cannot sell a part of their house when they need cash (ibid). The middle class are therefore more burdened due to disturbances in house prices than the top 10%. Lower- and middle-class households are more prone to changes in housing prices because the house is a relatively large part of their household assets (Malpezzi, 2017). Davidoff (2006) also found that new homeowners hold a smaller share of stocks compared to longer tenured homeowners. Large mortgage debt brought on by a recent home purchase leads to more risk averse behaviour regarding other forms of investments (ibid). Additionally, repeat buyers can finance a large portion of the down payment of a new home from the sale of their previous home (Kouwenberg and Zwinkels, 2010). This means that once a household has purchased their first home, upgrading to a more expensive home becomes relatively more affordable compared to the first home.

Ultimately, the middle class are hurt relatively more than the top class by a sudden drop in house prices. Sutton (2002) found stock market wealth to be a notable determinant of house prices. Case et al. (2005) studied wealth effects between the stock market and housing market with data from the 1980's and 1990's. They find that those with stocks change consumption patterns according to the development of the stock market, but those who without stocks do not (ibid). In other words, stock market development affected the consumption patterns of stock owners. One could argue that this is a notable part of the population due to exposure by retirement savings.

Wolff (2014) also discusses wider impacts of the crisis regarding asset prices and inequality. He defines wealth as "a store of value and therefore potential consumption". The fall in house prices during the crisis increased the share of households with zero or negative net worth for many years. The middle class invested most of their wealth in homes, whereas the upper class had more in corporate stock and investment real estate (ibid). Median net worth fell by more than mean wealth, owing to increased wealth inequality. Bertrand and Morse (2016) also

found increased economic inequality since the 1980's. However, for a few years following 2007, income inequality decreased due to reduced property income and unrealised capital gains (Wolff, 2014). As asset prices recovered, this reversed back to the old trend of increasing wealth and income inequality. As aforementioned, middle-class households were less diversified.

Hurd and Rohwedder (2010) mention the simultaneous shocks in the stock market, labour market and housing market. This trilogy of shocks made the crisis unprecedented in terms of magnitude and effects. Not only did the labour market cool significantly with lots of layoffs, but this in turn decreased individuals' ability to pay through decreased income. It is intuitive that if people have less net income, they will not be able to pay as much for housing. In fact, vast majority of households reduced spending in response to the financial crisis (ibid). This has a cooling effect on house prices.

Furthermore, tightening of financial conditions and general financial distress plunged stock prices in the United States and globally. The prices of stocks and homes fell double that of incomes (Glover et al., 2020). Americans have lots of private retirement savings in stocks, making a stock market crash like 2008 devastating not only for the soon retired, but also the wider population. When considering retirement, falls in asset prices have a bigger impact on older individuals since they have less time for asset prices to recover (ibid). Their ratio of assets-to-income is significantly higher than for young people (ibid). Real estate is a big portion of assets at retirement (Himmelberg et al., 2005). Black et al. (2006) find that house price shocks have a bigger impact on the economy than stock market shocks. As aforementioned, houses are the biggest asset for most people.

2.3 Affordability

Tightened financial conditions, in terms of bank lending, makes it more difficult to obtain a mortgage to purchase the home. Mortgage rates are closely intertwined with interest rates. The interest rate in the United States is a component of interest due to its impact on the affordability of homes. This will be discussed further in the coming chapters. Sutton et al. (2017) find that the impact of change in long-term rates is bigger initially, but after a few years the effects of short- and long-term rates is the same. Guy and Hill (2009) examine three different forms of affordability: purchase, repayment, and income. Purchase affordability determines the buyer's ability to borrow, and repayment affordability refers to the borrower's ability to pay back the mortgage in line with the terms in the contract (ibid).

Lee and Ahn (2013) take a nuanced view of affordability. Lee and Ahn (2013) and Iqbal et al. (2023) consider that housing is affordable if the housing costs are less than 30% of annual income. Joice (2014) also finds the cost burden to be an important measure of housing affordability, similarly, citing the 30% rule. When incomes increase, housing affordability capacity increases. The purchasing power of individuals' increases, so they can afford more housing. Likewise, the decrease of purchasing power decreases affordability capacity. For example, this can happen when inflation increases (Lee and Ahn, 2013). Low-income households are disproportionately affected by higher prices due to their relative income level (ibid). Lastly, housing affordability is negatively correlated with household income, meaning that housing costs are a big portion total income for low-income households (ibid).

2.4 The housing market, consumption, and unemployment

Laitamäki and Järvinen (2013) examine the impact of the 2008 financial crises on both American and Finnish households. Given that the world economy is so intertwined in terms of trade, financial markets, and information, the effects of the crises went beyond the borders of the United States. Private consumption fell dramatically due to reduced confidence and falling housing equity (ibid). Since private consumption in the USA is about 70% of GDP, a change in consumption has a big impact on GDP (Malpezzi, 2017). GDP (economic expansion) is closely tied to house price changes (Berahca and Hirschey, 2009). An increase in the GDP growth rate leads to an increase in house prices (Conefrey and Whelan, 2013). Kaplan et al. (2016) also find that consumption fell, of which half can be attributed to housing price dynamics. In addition, Angrisani et al. (2019) show that stronger falls in house prices were accompanied by more significant decreases in consumption.

Furthermore, Elul (2019) notes that between 2006-2009, consumption fell the most in areas where the value of houses fell the most. On the other hand, Vinson (2021) found that if the value of one's home increases, one tends to increase consumption by a relatively smaller amount. This is plausible since homes are illiquid assets and increased values do not directly translate into more disposable income. House prices effect household consumption levels and perceived financial well-being, thus having a wider impact on the economy (Oikarinen et al., 2023). The largest effect of house prices on consumption can be seen with older homeowners, whereas the smallest effect is with younger renters (Campbell and Cocco, 2007). This is plausible because if you do not own a home, there will not be significant actual or perceived wealth impacts from changing house prices that would affect your consumption.

However, Elul (2019) find only moderate wealth effects between house prices and consumption levels. This means that a decrease in house prices would only lead to a small decrease in consumption. Elul (2019) rather argues that house price declines affect consumption through credit constraints. Falling house prices may lead to defaults and therefore lower credit scores, making it difficult to obtain consumer loans in the future (ibid). Bhatia (1987) also finds that real estate has an impact on consumer spending decisions. As aforementioned, increased unemployment also played a role in decreasing levels of consumption. In the United States, GDP fell, and unemployment almost doubled, reaching multi-decade highs (Laitamäki & Järvinen, 2013). There were more people out of work and confidence in the wider economy was low. Laitamäki and Järvinen (2013) go on to determine that declines in house prices were the greatest in states where the boom had been the greatest.

Generally, fall in income is seen as temporary (Bahmani-Oskooee and Ghodsi, 2017). When the individual believes that the fall in income is temporary, they do not adjust their level of consumption to the new, lower level. Rather, they try their utmost the uphold their consumption level. Milton Friedman (1957) split income into permanent and transitory components. He argued that only changes in permanent income change consumption levels (ibid). An interpretation of this is that individuals want to be sure of their permanent income level before adjusting consumption.

2.5 Heterogeneity of housing markets

The increase in house prices up until the crisis was unevenly distributed throughout states in the USA (Füss and Zietz, 2016). The price-to-income ratio changes were more pronounced in boom-bust states (Case and Shiller, 2003). Generally, a house price-to-income ratio of 2,6 is seen as healthy (Florida, 2018). Nationwide, the ratio was 7x income in 2006, fell to under 5 in 2010-2011, and then gradually started increasing (Kiburz, 2022). The west coast and the northeast are the two least affordable regions (Tekin, 2022). In addition, mean family net worth fell more than family income (Laitamäki and Järvinen, 2013). This is because the volatility of financial assets such as real estate and stocks are much higher than income. When comparing the volatility of house prices and the stock market, house prices tend to be less volatile (Case and Shiller, 2003). The turnover rate for public stocks is 15 times that of houses, due to the various unique costs associated with selling a house (ibid). These costs include a brokerage fee to a real estate agent, moving costs, and psychological costs (ibid). Moving costs, brokerage commissions, and mortgage fees make it expensive to move between

owning and renting (Himmelberg et al., 2005). Adjustments in housing markets are slow due to transaction costs, time of construction, and liquidity constraints (Oikarinen et al., 2018). The housing market is illiquid (Ellis, 2011). Piazzesi and Schneider (2016) find that housing markets are illiquid compared to other assets.

Housing markets in the United States are not homogeneous, meaning that one should consider them individually when examining the effects of the housing crisis. Considering that, the developments of the housing market post-financial crisis will be examined on a state level to allow for differences between states, rather than just looking at the matter on a national level. There are variations between regions, making it important to study the housing market regionally to understand the differences (Yunus and Swanson, 2013). Angrisani et al. (2019) found that the relationship between house prices and unemployment varied across states. Malpezzi (2017) also found that national average prices are not a good indicator for local markets due to the heterogeneity of housing markets in different areas and states. Finally, Bahmani-Oskooee and Ghodsi (2017) also bring the notion of state specific effects, making it better to use state data rather than nationwide. This notion is further supported by Oikarinen et al. (2023) who confer that house price-to-income ratio varies based on location due to heterogeneity of housing markets.

People moving away from the area puts downward pressure on house prices. In fact, population will be one of the independent variables in the regression analysis. Ceteris paribus, a rising population will increase the demand for homes and hence prices should increase (Case and Shiller, 2003). Ceteris paribus is the economic term for “all other factors remaining equal”. In this context, solely the effect of a rising population would be to increase the demand for housing. Füss and Zietz (2016) also find increasing population to be a factor increasing housing demand. Similarly, Oikarinen et al. (2023) find that population growth has a positive effect on house price-to-income ratio.

2.6 Housing market policies

Former Fed Chairman Ben Bernanke has described monetary policy as “too blunt a tool to be routinely used to address possible financial imbalances” (Schaefer, 2011). Therefore, he sees monetary policy working like a large hammer even in situations that may have required more precise fine work. Bahmani-Oskooee and Ghodsi (2016) also question the effectiveness of contractionary monetary policy to act against a bubble if higher interest rates do not hurt prices. Their study concluded that the effect of fundamentals, such as interest rates, on house

prices is asymmetric (ibid). Paul (2020) similarly finds that house prices are less responsive to monetary policy when prices are high, but more responsive when prices are low. However, Goodman et al. (2018) find that high interest rates decrease affordability of homes. Nevertheless, lower interest rates reduce the costs of financing the purchase of a home (Füss and Zietz, 2016). Furthermore, lower rates reduce the cost of debt and opportunity cost of buying a home (Himmelberg et al., 2005). However, La Cava (2016) argues that a decline in interest rates makes home ownership more costly due to higher demand. This can be also true if we solely focus on the premise that lower interest rates increase the nominal price of the home. A decrease in real interest rates leads to higher house prices (Sutton, 2002). Paul (2020) goes on to say that a "rapid rise in asset prices increase the likelihood and severity of financial crises". Asset prices in general take changes in monetary policy into account quickly (ibid). For instance, an increase in interest rates will often decrease the price of stocks due to a higher discount rate of the value of future cash flows. Nonetheless, there is a monetary policy lag when it comes to the housing market (Füss and Zietz, 2016).

When considering policies more broadly, Kuttner and Shim (2016) see supply-side credit policies effecting countries most in which home purchases are mostly financed through banks. Banks are at the mercy of monetary policy set by the central bank. Monetary policy and the housing market are tightly linked (Vogiazas and Alexiou, 2017). Increased credit availability increases the supply of credit at any interest rate (Füss and Zietz, 2016). An example of a supply-side policy in this situation would be increasing house building permits to increase supply of homes. Deregulation of housing construction restrictions can help make homes more affordable (Miles et al., 2023).

Credit growth restrictions, reserve requirements and liquidity requirements are examples of policies that central banks can implement during a lending or housing boom to curtail lending by retail banks (Kuttner and Shim, 2016). In fact, Vogiazas and Alexiou (2017) emphasise the impact of liquidity in the formation of housing bubbles. Kuttner and Shim (2016) also argue that policy actions have a greater impact on housing credit than house prices. In the USA, there is a high correlation of 0,75 between house prices and housing credit (ibid). Meanwhile in a sample of 51 countries, the median was 0,44 (ibid). Gelain and Lansing (2014) find that investors had high expectations about future returns when the market was at the peak. Both supply-side policies and demand fundamentals effect the development of the housing market in any region. As previously stated, governments can use supply-side policies to affect the demand for housing. The usual channels for this are interest rates and housing regulation.

2.7 Housing market fundamentals

Bahmani-Oskooee and Ghodsi (2016) studied how fundamentals effect housing prices. They used cointegration tests in their paper. Cointegration is when two or more variables share a long-term trend and move in the same pattern. Fundamentals (such as income) are cointegrated if they are linked by a long run equilibrium relationship (Gallin, 2006). Miles et al. (2023) find mixed results from empirical studies about the long run relationship between income and house prices. Vogiazas and Alexiou (2017) show evidence of a cointegrating relationship between house prices and real incomes in the United States between 1975-2003.

The general view of the housing market was that there was a stable long-run relationship between house prices and income even though they may differ in the short-run (ibid). However, Oikarinen et al. (2023) find that the equilibrium house price-to-income ratio is not stable in the long run. It can be altered by shocks and the elasticity of housing supply (ibid). If house prices are above the equilibrium (overshoot), an undershoot typically follows, i.e. a correction below the equilibrium (Oikarinen et al., 2018). Prices tend to cycle around the long-term equilibrium levels and house price cycles are usually regional in nature (ibid). Himmelberg et al. (2005) also find that housing prices are not always at or close to equilibrium levels. House prices can be far from fundamentals for long periods (Mikhed and Zemčík, 2009). The illiquid nature of houses makes corrections towards the long-run trend slow (Black et al., 2006). Data used by Gallin does not support the view that house prices and income are cointegrated (Gallin, 2006).

However, Määttänen and Terviö (2010) find that income effects with housing are large because housing is a big portion of household consumption. There is a common assumption that effects of fundamentals on house prices are symmetric (Bahmani-Oskooee and Ghodsi, 2016). This means that when household income rises, house prices rise and vice versa. However, when income decreases, not everyone sells their house because they need a place to live and have an emotional attachment to the home (ibid). Despite that, Sutton et al. (2017) conclude that GDP growth, proxy for income, does not have a strong effect on house prices.

2.7.1 User cost of housing

Himmelberg et al. (2005) introduce an alternative to price-to-income and price-to-rent ratios to calculate the true cost of homeownership. They call it user cost of housing (or imputed rent) and it has six components:

- Forgone interest from an alternative investment
    - House price times risk free interest rate
    - $P_t r_t^{rf}$
- One-year property tax cost
    - House price times property tax rate
    - $P_t \omega_t$
- Tax deductibility of mortgage interest
    - Effective tax rate times mortgage and property tax payments
    - $P_t \tau_t (r_t^m + \omega_t)$
- Maintenance costs
    - Fraction of home value
    - $P_t \delta_t$
- Expected capital gain (loss) during the year
    - $-P_t g_{t+1}$
- Risk premium
    - $P_t \gamma_t$

The components can be put together into an equation for the annual cost of ownership (Himmelberg et al., 2005):

$$P_t r_t^{rf} + P_t \omega_t - P_t \tau_t (r_t^m + \omega_t) + P_t \delta_t - P_t g_{t+1} + P_t \gamma_t \quad (1)$$

Rearranging the annual cost of ownership by moving the price term onto the right-hand side we get (ibid):

$$R_t = P_t u_t \quad (2)$$

u_t is the user cost of housing and can be shown as:

$$r_t^{rf} + \omega_t - \tau_t(r_t^m + \omega_t) + \delta_t - g_{t+1} + \gamma_t \quad (3)$$

u_t is therefore the annual total cost of home ownership expressed per dollar of house value (ibid). Furthermore, we can rearrange the equation further to get:

$$P_t/R_t = 1/u_t \quad (4)$$

This shows that the equilibrium price-to-rent ratio should equal the inverse of user cost (ibid). Therefore, changes in the user costs lead to changes in the price-to-rent ratio. For example, changes in interest rates or taxes will affect the user cost, hence price-to-rent ratio (ibid). Himmelberg et al. (2005) see the user cost of housing to be the basis for calculating the price-to-rent ratio. If one compares price-to-rent ratios over time without considering the user cost of housing, this will be misleading (ibid).

2.7.2 Behavioural aspects

No matter the price of the home, the owner still realises consumption value by living there, contrary to stocks (Case and Shiller, 2003). Home prices tend to be sticky due to factors such as loss aversion and liquidity constraints (ibid). Loss aversion is the concept that financial losses feel psychologically worse than equivalent gains. Owners of homes are reluctant to realise losses by selling their home for less than they purchased it for (ibid). Sutton et al. (2017) conclude that interest rates, income and other fundamentals affect house prices gradually, rather than having one big impact. Stickiness of house prices can be key to understanding why the effect of fundamentals on house prices is seen as gradual. Consumers are limited to how much they can borrow, so their liquidity is constrained. Demand for housing is partly driven by how much individuals can borrow, hence financial institutions play a big role in determining housing demand and therefore prices (McQuinn and O'Reilly, 2008). Often rather than selling, people will finance their mortgage through their savings (Bahmani-Oskooee and Ghodsi, 2016).

Likewise, a drop in house prices should affect consumption only if the fall is viewed as permanent (Elul, 2019). The implication of this is that the effect of income and other fundamentals on house prices would be asymmetric (Bahmani-Oskooee and Ghodsi, 2016). Bahmani-Oskooee and Ghodsi (2016) found that this was the case in most states; house prices are driven by fundamentals, though the effects of changes are asymmetric. Lastly, adjustment asymmetry was spotted. The speed of the effect of increase in income is different than a

decrease in income (Bahmani-Oskooee and Ghodsi, 2017). House prices usually rise in real terms, so when prices decrease, it can be a surprise to many (Beracha and Hirschey, 2009)

Holly et al. (2010) studied the extent to which house prices are driven by fundamentals such as income. More importantly, they were looking for cointegration between income and house prices. Holly et al. (2010) found that there were lots of differences between states in the U.S.: levels and growth rates of income, scarcity of land, technological change, and change in price-to-income ratio. If taken a long enough time sample, the change in the ratio of house prices to income should be zero (ibid).

2.8 Price bubbles and real estate speculation

The United States has a history of real estate speculation (Hu and Oxley, 2018). Himmelberg et al. (2005) say that a bubble is present when fundamental factors do not justify the price. Hu and Oxley (2018) define a bubble "when the growth of the price of an asset is not supported by fundamentals" and argue that subprime lending in the mid-2000's was a consequence, rather than a cause of the housing bubble. Contrary to the former, Kivedal (2013) concluded that growth in subprime mortgages led to increased housing prices. In addition, Levitin and Watcher (2012) also argue that an oversupply on mortgage financing, in other words availability of home loans, was the primary cause of the bubble in the mid-2000's.

2.8.1 Subprime mortgages

Subprime mortgages undoubtably played a role in the housing crisis in the late-2000's. Subprime mortgages were housing loans given to individuals with lower credit scores, making the loans riskier. The Consumer Financial Protection Bureau (2023) defines a credit score as "a prediction of your credit behaviour". The credit score is used by companies and financial institutions to make credit decisions, pricing the credit, and how much credit will be granted (ibid). Since the credit score depends on the data used to calculate it, individuals will have multiple credit scores at once and the number will depend on the institution calculating the score (ibid). People who would not have gotten mortgages earlier now had access to the expanded credit market (Duca, 2013). These subprime mortgages were funded by mortgage-backed securities (MBS). Mortgage-backed securities allowed for banks to pool mortgages together and sell them to outside investors, removing the risk from their own balance sheet (ibid).

2.8.2 Bubbles: definition, components, and experiences

Bourassa et al. (2019) discuss the difficulty in saying with certainty what constitutes a house price bubble; what fundamentals should be measured and how much do prices need to increase or decrease to declare a bubble (ibid). Piazzesi and Schneider (2016) find a positive correlation between income growth and mortgage growth between 2002-2005. Between 2000-2006, house prices were above their fundamental values, indicating a bubble (Kouwenberg and Zwinkels, 2014). Mikhed and Zemčík (2009) consider the impact of the 2000 stock market crash on the run up of housing prices in the 2000's. After the stock market crash, shifting wealth from the stock market to the real estate market increased demand for housing (ibid).

Kivedal (2013) sees the mid-2000's bubble as a speculative one exacerbated by the financial accelerator effect: increased wealth increases house prices because of increased wealth. As prices increased, the collateral value of homes also increased, pushing home prices even higher (ibid). Vinson (2021) concludes that rising house prices, hence higher collateral values, allows households to borrow more. This leads to higher house prices through increased demand. Since most homes are bought with leverage, price cycles of houses intertwine with credit cycles (Ellis, 2011). This is because higher house prices allow household to borrow more due to higher collateral values (ibid).

We can also examine the impact of appreciated assets from a different perspective. If an asset, such as real estate, appreciates in value, there are two ways that the homeowner can make use of the appreciation. They can either sell the appreciated asset or use the house as collateral to borrow money (Bhatia, 1987). Real estate gains are often seen as more permanent than stocks due to lower volatility, making them a better asset for collateral (ibid). Furthermore, selling the asset would leave the owner exposed to tax liabilities and they would also need to find a new residence (ibid). Borrowing against the appreciated value of their real estate asset, their home, allows homeowners to reap the benefits of the appreciation of their assets through increased consumption.

Sutton (2002) also sees demand for housing being positively related to real income and wealth. Likewise, Davidoff (2006) and Yin (2021) find a positive correlation between income and home prices. An up market leads to higher demand, pushing prices up (Black et al., 2006). This same trend is seen in downturns, hence making cycles in the real estate market slower and longer compared to other assets (ibid). Supply constraints have a role in the

formation of housing bubbles (Malpezzi, 2017). Low interest rates and limited housing supply fuelled the recovery from the crisis and led to increasing house prices (LBM Journal, 2023).

The price-to-income ratio is used as an indicator of affordability of houses and overvaluation of prices compared to income (Chen and Cheng, 2017). If there was enough housing supply, the prices of homes would not increase as fast. La Cava (2016) finds that house prices rise especially in states with restricted supply of housing. House price bubbles have various negative effects, including loss of wealth, poverty, and bankruptcy (Bourassa et al., 2019). When a housing bubble bursts, there is a decrease in household wealth, impacting consumption and outlook on future economic prospects (Mikhed and Zemčík, 2009). In addition to the financial impact of a bubble bursting, there are psychological impacts. People who have bought a house near the peak of the bubble lose confidence in themselves and their decision-making, possibly leaving wide swaths of the population disenfranchised and increasing distrust throughout society towards economic or political systems (Thronton, 2009).

Hu & Oxley (2018) go on to mention that the bubble in the mid-2000's was not a national one, but rather concentrated geographically on the coasts and upper-Midwest (Michigan, Minnesota, and Wisconsin). Oikarinen et al. (2018) also found that cities on the coasts experience higher positive house price and income growth. Ganong and Shoag (2017) also find that there was a "disproportionate increase in housing prices in high-income places". They go on to review the decrease in income convergence between U.S. states. More, as price rise it becomes disproportionately more expensive for low-skilled households to afford housing (Ganong & Shoag, 2017).

2.8.3 Boom post-2008

Glick et al. (2018) focus their research on the housing boom after the financial crisis. This is in line with the research topic of this thesis, as the financial crisis is an event of interest that affected the housing market. The financial crisis ought to be considered when studying U.S. housing market fundamentals between 1991-2015. Between 2006-2011, the median price of a home in the USA fell about 30% but had nearly fully recovered by the end of 2015 (ibid). When contrasting the 2000's bubble to the 2010's recovery, the authors find many key differences. Whereas the former bubble was credit fuelled with both house price-to-rent ratio and mortgage debt-to-income ratio increasing, the latter one consisted of smaller increases in housing valuation and a decrease in leverage owing to better lending standards (Glick et al.,

2018). The price-to-income and price-to-rent ratios are the most used housing market indicators to measure affordability (André et al., 2014). Policies should be used to understand why these ratios have been increasing and why they are so high (ibid). Himmelberg et al. (2015) used the user cost of housing as an improvement to the price-to-rent ratio. The improvements in affordability after the crisis were not universal (Kroll, 2013).

Lower housing prices does not automatically mean improved affordability, because the effects are different for homeowners and renters (ibid). The shortcomings of the home price-income ratio are discussed further in upcoming sections. André et al. (2014) find that changes in fundamentals explain only about half of the increase in the ratios. They conclude that very optimistic expectations about future house price increases drove up the ratios (ibid). Case and Shiller (1988) also find that expectations are largely based on past price movements rather than fundamentals. Jin et al. (2014) divided the components of price increases into fundamentals and irrational expectations.

The house price-to-income ratio is used as a bubble indicator (Oikarinen et al., 2023). House price-to-rent ratio is a measure of housing valuation and mortgage debt-to-income ratio is a measure of household leverage (Glick et al., 2018). For Bourassa et al. (2019), their preferred method for identifying bubbles in the housing market is the price-to-rent ratio. The loan-to-value ratio (LTV) is also a measure of leverage for individual mortgages (Malpezzi, 2017). Simply, this ratio is the loan amount divided by the value of the home. Employment rates took far longer to recover in states with large housing bubbles, showing the close link with the housing and labour market (Glick et al., 2018).

3 Theory/Model

The research in this thesis will consist of a regression analysis aiming to understand possible correlation between household prices in the 50 states of the USA and fundamentals of the housing markets, such as per capita income, the unemployment rate, and population growth. Interest rates and stock market development would have been intriguing variables, but they are on a national level. The focus is on variables that are collected on a state-level, giving us the possibility to compare results between states. The hypothesis is that there was a fast increase in home prices and home price-income ratio in the early 2000's, followed by a steep correction and a subsequent modest recovery. The results of the regressions analyses are discussed later in Chapter 7.

Vogiazas and Alexiou (2017) emphasise the existing relationship between macroeconomic indicators and the property market. Furthermore, Beracha and Hirschey (2009) find that income per capita and mortgage interest rates impact housing prices. Per capita income growth and falling interest rates help explain home price increases (Case and Shiller, 2003). Housing prices are affected by a demand shock (Harter-Dreiman, 2004). For the average family, residential real estate can be described as a normal good. A normal good is one for which an increase in demand will increase the price of the good. Likewise, a decrease in the demand will decrease the price of the good. Figure 1 below shows the demand curve for normal goods. An example of a component of demand is income. If income increases, this shifts the demand curve for a normal curve right, as shown below. The amount of goods demand at every price level increases. Likewise, the price for the same quantity of goods increases. Initially, 5 goods were demanded at a price of 5, but after the shift in the demand curve, the demand has increased to 8 units.

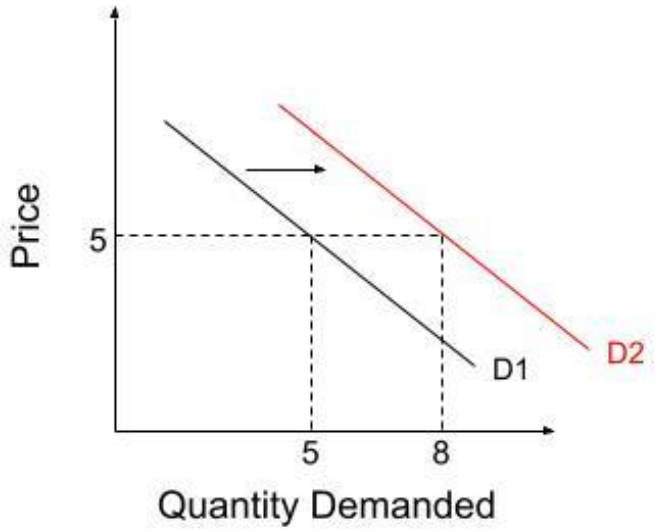

Figure 1. Demand for normal goods.

If one sticks to housing where the family will live themselves (i.e. excluding residential real estate), there is diminishing marginal utility in housing. Once a certain level of housing is reached, the utility from better housing will not increase as fast. An important concept to be aware of is the marginal rate of substitution between house quality and other goods. It is a measure of how much people are willing to pay for a higher quality house (Määttänen and Terviö, 2010).

Damen et al. (2016) study the effect of mortgage characteristics on house prices. Households maximise their lifetime utility and the amount they can borrow depends on income and interest rates (ibid). When it comes to house prices, they are determined in the short run by demand and in the long run by supply (ibid). This is intuitive because the supply of housing is inelastic (Granziera and Kozicki, 2015). This means that as the price of housing changes, the supply will change by less. A 10% increase in prices will lead to a less than 10% increase in supply. Housing usually takes years to build, there are bureaucratic building policies, and often a scarcity of land in growing population centres. Inelastic demand means that as the price of the good changes, the quantity of goods demand changes by relatively less. For example, demand for a good is deemed to be inelastic if a 5% rise in prices causes a decrease in demand of less than 5%. Examples of goods with inelastic demand are usually essentials, such as housing, fuel, and food. The equation for elasticity of demand is:

$$e_P = {}^{\%\Delta Q_D}/_{\%\Delta P} \text{ (Amadeo, 2022)} \quad (5)$$

If the value for price elasticity of demand is less than one, the demand is inelastic. On the contrary, if the price elasticity of demand is greater than one, the demand is considered elastic. Demand for housing will be inelastic in situations where there are few substitutes. This shows that when looking at elasticity, the demand and supply of housing are tightly linked. A relatively low supply of houses means that there are less substitutes (other houses) for people to buy or rent, forcing them to pay a higher price. In other words, the low supply makes it difficult for people to consume "less" housing as there are little houses to choose from.

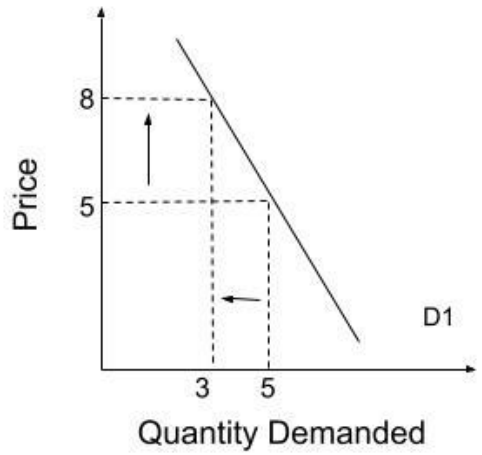

Figure 2. Inelastic demand diagram.

Figure 2 above shows an inelastic demand curve. As price increases from 5 to 8 (60%), the quantity of goods demand falls from 5 to 3 (-40%). The absolute value of the change in quantity demand is less than the change in price, hence the demand is inelastic. The steeper the demand or supply curve, the more inelastic demand or supply is. The following figure shows an example of inelastic supply.

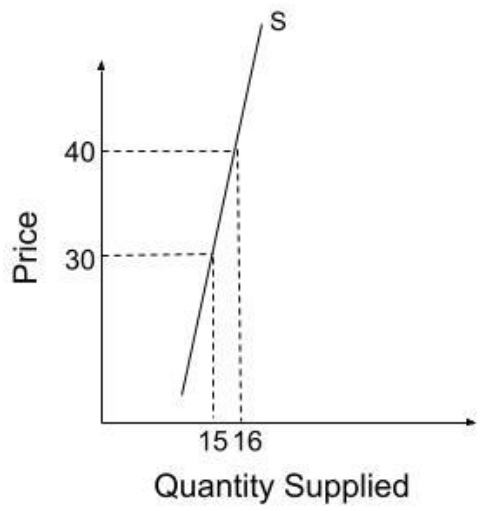

Figure 3. Inelastic supply diagram.

Figure 3 above shows an example of inelastic supply. The situation can be looked at from both cases, either quantity increasing or decreasing. Let us go through both. Firstly, if the quantity increases from 15 to 16 units (6,66%), the price of the good will increase from 30 to 40 (33,33%). In other words, the price of the good changes more than the supply, making the supply inelastic. On the other hand, we can have a situation of decreasing supply. The supply decreases from 16 to 15 (-6,25%). Meanwhile, the price of the good falls from 40 to 30 (-25%). Like previously, the inelastic supply means that supply reacts less than the price of the good.

Like elasticity of demand, the elasticity of supply can be described with the following equation:

$$e_P = {}^{\%\Delta Q_S}/_{\%\Delta P} \text{ (Pettinger, 2019)} \quad (6)$$

If the value for elasticity is less than 1, supply is price inelastic. If the value for elasticity is greater than 1, supply is price elastic. If the value for elasticity is 1, then supply is unit elastic. This means that supply and price change in the same degree.

Case and Shiller (2003) find correlation between demand-side variables and price. In addition, they also find that supply for homes is not perfectly elastic (Case and Shiller, 2003). The supply cannot change quickly to account for demand, meaning that house prices must change in the short run. Housing supply is slow to react to sudden supply shocks, so the price will increase (Leung and Tang, 2023). Construction costs impact how housing supply will be able to react to housing demand shocks (Meen, 2002). Conefrey and Whelan (2013) argue that

fundamentals affect house prices through their effect on the supply of new homes. Hattapoglu and Hoxha (2021) find that if housing supply is inelastic, house prices are more sensitive to interest rates. Housing supply is inelastic in urban environments where there is shortage of land to build new housing on. The higher the elasticity of housing supply, the smaller growth in price-to-income ratio (Oikarinen et al., 2023). Lower interest rates make housing prices more sensitive to changes in real interest rates (Himmelberg et al., 2005). Interestingly, La Cava (2016) notes that housing demand should become inelastic over time. As household or countrywide income grow, the share of spending on housing should fall (ibid).

A person in considered unemployed when they are actively searching for a job but are not able to find one (Hayes, 2024). The unemployment rate is the percentage of people in the labour force that are unemployed (ibid). The labour force includes all employed people and those who are unemployed and actively searching for work. The labour force does not include those on parental leave, full-time students, pensioners, or those who are not searching for employment. Hence, this group of people are not included in the unemployment rate. The unemployment rate is a gauge on the healthiness of the economy. A low unemployment rate means that most people are employed, helping the economy grow. In general, a higher unemployment rate can mean less aggregate demand due to lower income levels. It can also be a sign of a situation in which the type of labour supply and demand does not match well. This is when the skillset of unemployed people does not match with the need of employers.

Figure 4 below shows the development of completed new privately-owned housing units in the United States between 1991-2015. The frequency of the data is monthly. The graph shows multiple interesting concepts. Firstly, the number of completed housing units increased steadily from 2000 until it peaked in April 2006 at 2245000 units. The supply of new homes was increasing due to increasing supply and demand of mortgages. Banks and financial institutions were lending to a wider audience and a bubble was forming in the housing market with more people wanting to join. Secondly, the number of completed housing units plummeted around 75% in the next 5 years down to 520000 units. Banks restrictedly lending, unemployment increased, and demand for housing decreased, leading to a significant decrease in construction of new homes. Thirdly, by the end of 2015, the number of new privately-owned completed housing units was around 1991 levels. There was a consistent increase since the period low in January 2011 until the end of 2015. The graph is important when trying to understand the effects of housing market fundamentals. In the early 2010's, the number of completed housing units was at multi-decade lows. Had the supply of new houses been

greater, the recovery in housing prices would most likely have been more muted. The suppressed supply of new houses aided the recovery in housing prices. Lastly, the graph shows that the number of new completed housing units can vary greatly, affecting house prices along with housing market fundamentals.

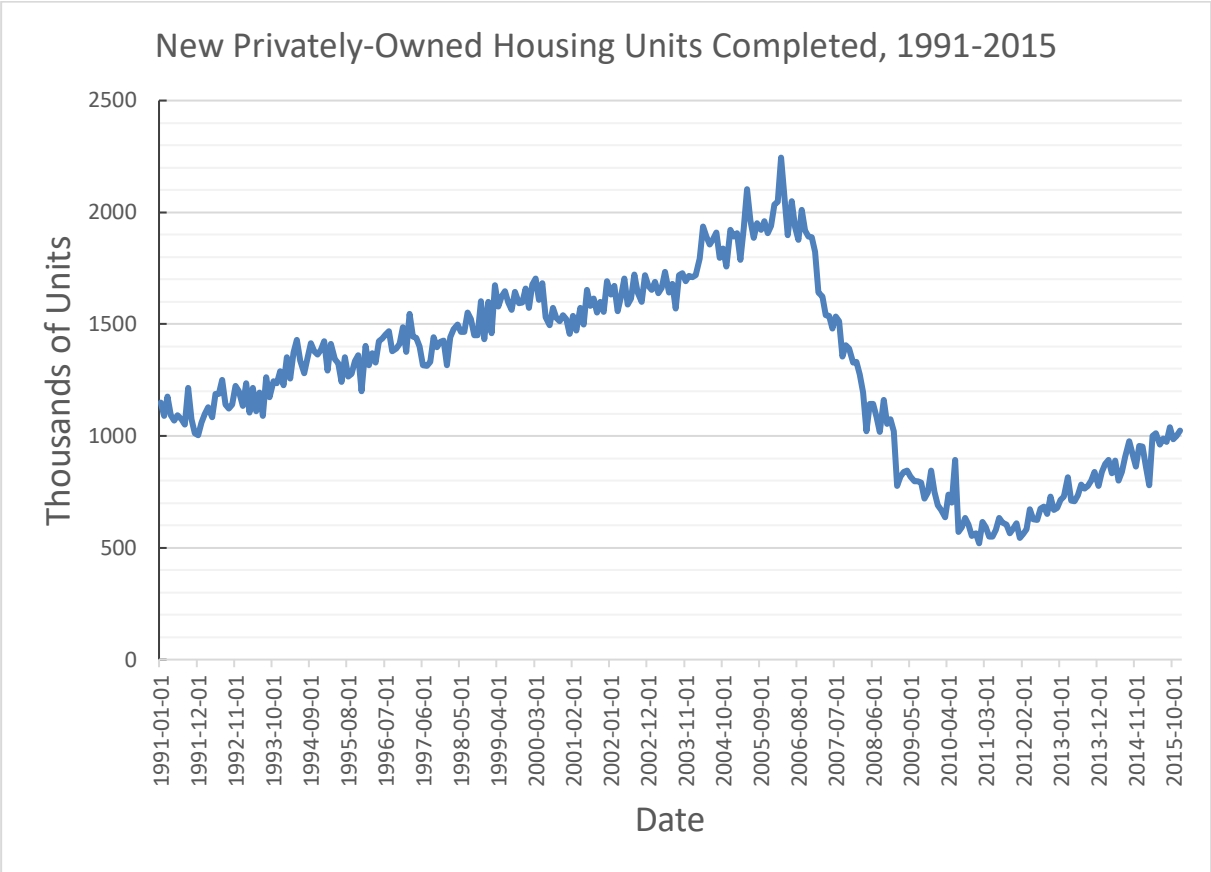

Figure 4. New Privately-Owned Housing Units Completed, 1991-2015 (U.S. Census Bureau and U.S. Department of Housing and Urban Development, 2024).

One aspect that makes studying the demand for residential housing and real estate interesting as a topic is that everyone needs a home. Everyone needs a home, so the market is the whole population. For a long time, homeownership has been seen as way to build stability and generational wealth for families. Heinrich (2024) also considers homeownership significant in building wealth. This has made home ownership a desirable choice for many. Young people are often renters until they have been able to save up money for the down payment. Homeownership rates increase with income (Piazzesi and Schneider, 2016). Homeowners gain from house price increases whereas renters lose (Gan and Hill, 2009). The net wealth of the homeowner increases along with the collateral value. Renters lose because they need to save more for a down payment. Nevertheless, there are other ways to become a homeowner. For example, one can inherit a house through the passing away of a family member.

The cost of homes can be compared with our income. Income is the price of our labour (Kiburz, 2022). As seen later in Chapter 7, income has strong correlation with housing prices measured by the home price index.

Harter-Dreiman (2004) studied the cointegration between house prices and income using the following equation:

$$\ln(P_{it}) = \alpha_i + \beta \ln(I_{it)}) + \upsilon_{it} \quad (7)$$

$\ln(P_{it})$ represents the natural logarithm of house prices in place i at time t and $\ln(I_{it)})$ represents the natural logarithm of personal income level in place i at time t (Harter-Dreiman, 2004). If beta is positive, we can see a positive relationship between the logarithm of house prices and the logarithm of personal income.

The Taylor rule is an equation created by economist John Taylor to examine the appropriate interest rate level for prevailing economic conditions. The equation is as follows:

$$r = p + 0.5y + 0.5(p - 2) + 2 \text{ (Taylor, 1993)} \quad (8)$$

Where:

- r: federal funds rate
- p: rate of inflation over the previous four quarters
- y: percent deviation of real GDP from a target

The equation shows that the Federal reserve is expected to increase the federal funds rate half a percentage point for each percentage point that inflation rises above the Fed target or each percentage point that output rises relative to its potential (Bernanke, 2015). Simply, the Fed should increase interest rates if prices are increasing, and target output is exceeded. Taylor (2007) has criticised the Fed that the interest rate during 2003-2006 was too low for prevailing economic conditions. The Taylor rule is often considered when examining previous economic conditions. The Federal Reserve rarely keeps the Fed Funds rate at the level suggested by the Taylor rule.

Figure 5 below shows the development of the Fed funds rate compared to the suggested rate given by the Taylor rule. As aforementioned, the actual fed funds rate was well below the Taylor rule suggestion for many years during the mid-2000's. In fact, except for a brief period

around 2010, the Federal reserve has kept interest rates lower than the Taylor rule suggests. Following the financial crisis, interest rates were put and held low to attempt to improve housing affordability and make investments more practical (Kroll, 2013).

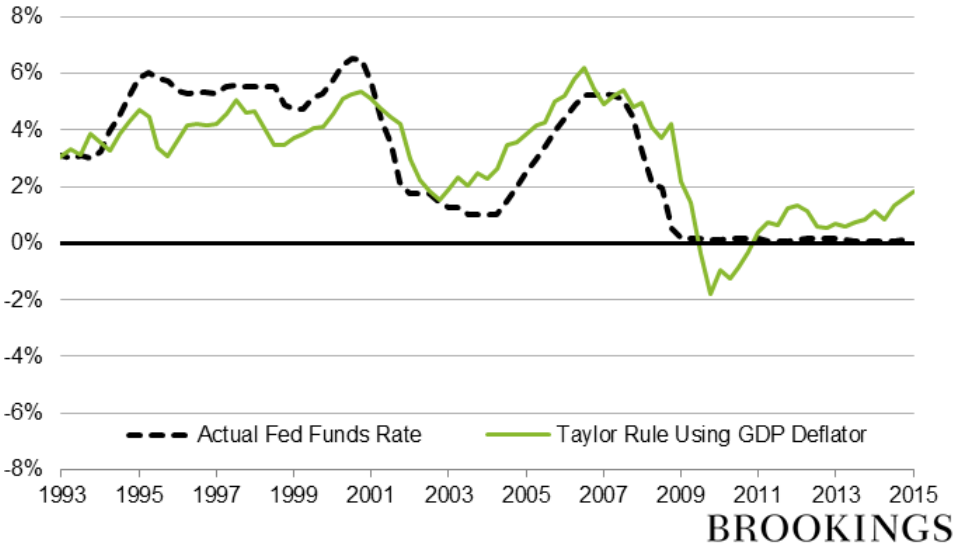

Figure 5. Taylor rule, 1993-2015 (Bernanke, B.S.).

4 U.S. Housing Market

The US housing market is very big and influential. The housing market plays a big role in the health of an economy (Conefrey and Whelan, 2013). Movements in the US often have an effect abroad due to the interconnectedness of financial markets. In fact, Sutton et al. (2017) show that US interest rates also impact house prices abroad. Monetary policy shocks effect countries with larger mortgage stock more (Rahal, 2016). This is intuitive since more individuals will be affected by changes in interest rates. Monetary policy, especially short-term interest rates, impact house prices (Taylor, 2007). During the financial crisis, there was increased volatility in stock markets and interest rates were decreased close to the zero lower bound (ibid). Zero lower bound refers to the concept of 0% being the minimum interest rate since negative interest rates would require depositors to pay banks to keep money and banks paying customers to borrow money. Moreover, if the stock market is rising, this can have an encouraging effect on home buying.

When comparing with Finland, Americans tend to finance their home purchases with fixed rate 30-year mortgages. This means that the buyer will pay the same interest rate for the duration of the loan. In times of higher interest rates, this decreases demand for housing through mortgages since the interest rate will be elevated for the duration of the loan. If the household has other debt, including consumer and/or car loans, the interest payments will also increase on these loans. In the financial crisis, debt was used to increase consumption (Angrisani et al., 2019). Expectations about future economic outcomes also impact spending (ibid). If a household is optimistic about their future employment status and income, they are more likely to make purchases such as housing. Expectations also effect house prices (Granziera and Kozicki, 2015). Expectations can become self-fulfilling, driving house prices even further from the equilibrium (Oikarinen et al, 2018).

Given the prevalence of fixed rate mortgages, refinancing is common practice in the United States. Refinancing is when a borrower takes a new mortgage to pay off the old mortgage. This is often done to get better terms and a lower interest rate, making monthly payments more affordable. In turn, refinancing helps households lock in a certain interest rate for the duration of the mortgage. A lower, fixed interest rate provides stability to household finances. As housing is arguably the largest purchase most households make, refinancing decisions are also critical. In addition, refinancing mortgages have been more common than normal mortgages for house purchases. Between 2000-2009, Americans took 52 million mortgages

for a new home purchase, yet 71 million for refinancing (Agarwal et al., 2016). For optimal refinancing, the borrower must refinance at the correct time and with the correct interest differential (ibid). There are various fees such as brokerage fees and commissions that individuals must consider when thinking about refinancing. Agarwal et al. (2016) find that over half of borrowers miss the optimal refinancing interest rate by at least 50 basis points and 17% of borrowers wait for at least six months too long. The results from their study point to the fact that lots of people struggle to refinance at the right time at an optimal rate.

A side effect of fixed rate mortgages is that monetary policy is not as effective a tool to influence demand. If consumers have adjustable-rate mortgages, the interest rate on their mortgages and consumer loans will usually be updated every 3-12 months. In a period of rising interest rates, higher interest costs are borne by the consumer way faster than if they have a fixed rate mortgage. Adjustable-rate mortgages make homeowners more sensitive to changes in the interest rate (Himmelberg et al., 2005), Often with rising interest rates, the goal of central banks is to decrease consumer spending to curb inflation. In areas with fixed rate mortgages, current borrowers will not be impacted by higher interest costs. They are only impacted if they wish to buy a new home. It can be argued that even though borrowers with fixed rates are not directly impacted by increased interest rates, they still have way less incentive to move houses. This is because they would then have to take a new mortgage at a higher rate, increasing their financing costs and monthly payments. One could say that it leaves consumers stuck in their current house, for better or worse.

It should be noted that there are various benefits about the fixed rate system. Since the interest rate does not change, the monthly payment stays the same and the household can better prepare their monthly budget to fit their current financing situation. One can say that fixed rate mortgages are comparable with insurance for your family income because a sudden rise in monthly mortgage payments will not happen. In addition, banks benefit from longer customer relationships due to the long nature of fixed rate mortgages. Thirdly, if interest rates are low, borrowers can lock in low interest rates for the duration of the mortgage. Essentially fixed rate mortgages incentivise borrowers to get a mortgage when rates are low and curtail borrowing when rates have been increased to higher levels. So, with fixed interest rates, the central bank can impact loan demand through a more indirect way compared to places with more adjustable-rate mortgages.

When it comes to the U.S. housing market, there are multiple aspects to take into consideration about affordability. Since the price-to-income ratio has risen in the USA since 1990, the housing affordability problem is growing (Iqbal et al., 2023). As aforementioned, the housing market is local and heterogeneous compared to other markets (ibid). Ellis (2011) also finds that homes are heterogenous. Increased income (usually correlated with lower unemployment) coincides with increased affordability (Iqbal et al., 2023).

4.1 Overview of U.S. housing market supply regulations

There is a long history of regulation in the United States housing market. Regulation is often traced back to the 1910's, when the first single-family zoning laws were enacted (Meyersohn, 2023). Since the zoning laws and regulating land has been left to the local governments, this has led to heterogeneity of regulations (Gyourko and Molloy, 2014). The laws were initially created to limit negative externalities of spill overs between different kinds of land users, such as industrial and residential areas (Glaeser and Gyourko, 2018). An example would be to restrict the development of a factory near a residential neighbourhood to avoid pollution from the factory being carried by wind towards the nearby neighbourhood. Zoning laws designate certain areas of cities for a specific type of real-estate development. Examples of such categories include factories, retail spaces, single-family homes, apartment building, and parks. The zoning laws were created to protect the value of homes, but they restricted the growth of housing supply (Meyersohn, 2023). Homeowners have an incentive to restrict undesired development nearby to maintain or increase the value of their own home (Gyourko and Molloy, 2014). Brown Calder (2017) sees that the three aims of regulation are safety, environment, and aesthetics. The zoning and land-use regulations include restrictions on property size, height, and number of units (Heinrich, 2024). Smith (2023) notes that the biggest problem in the U.S. housing market is a lack of supply of homes.

Regulation is the most important influence on the supply of homes, as they affect the amount, location, and shape of residential development (Gyourko and Molloy, 2014). The significant underlying issue with land use regulation stems from the belief that regulators can accurately and effectively plan real estate markets (Romney, 2021). This assumes that regulators know what the residents desire and are capable of changing regulations when necessary. As seen, removing regulations to help with housing supply shortages is difficult, since homeowners have an incentive to maintain their property value. A phenomenon called "not in my backyard" can be associated with actions to oppose land development in your own

neighbourhood. Due to the inherently selfish nature of humans, we often look out for our family's best interest rather than looking out for the greater good of the state or nation. Rather, housing market regulations are often coupled with increasing traffic, commutes, unaffordable prices, and shortages of housing (ibid).

Supply shortages also have an impact on long-term economic growth through higher cost of housing and lower labour mobility, resulting in an up to 2% loss in GDP (Bernstein et al., 2021). Romney (2021) is critical of regulations because he sees them as an "artificial restriction of supply". Glaeser and Gyoruko (2018) also find that regulation reduces the elasticity of supply, causes higher and more volatile prices, and is associated with a smaller housing stock. Likewise, Saks (2017) finds that the more housing regulation there is, the lower will be the elasticity of the supply of housing. This means that the supply of housing cannot react to price changes fast enough (ibid). Brown Calder (2017) also finds that regulation causes housing affordability problems as it reduces housing supply. There is a correlation between amount of regulation and higher housing prices (ibid). Both Saks (2017) and Brown Calder (2017) find that with rising demand, housing prices will increase the most in areas with more regulation restricting supply. The house prices increase the most in these areas because the supply cannot react to the increased demand.

The effect of geography should be considered when considering the impact of housing supply regulation. Glaeser and Gyourko (2018) note that due to geography, building in some areas can be more expensive when compared to areas with similar levels of regulation. Naturally, coastal cities have limited room for expansion due to their proximity with the ocean (ibid). In addition to better geography (space) for expansion of cities, many areas in the Sun Belt and interior of the United States have less regulation than their coastal counterparts. The Sun Belt is a term to refer to states in the southern United States, from California and Arizona through Texas all the way to Florida on the east coast (Laumont, 2019). Furthermore, since land use is under local control, there is a big variation in regulation across communities (ibid). State and local governments impose varying levels of land development regulations (Brown Calder, 2017).

Brown Calder (2017) suggests some solutions for the housing supply and affordability problem. Reducing regulation, including decreasing the limits to building permits, and speeding up approval processes can help (ibid). Homeownership boosts economic well-being and mobility (Heinrich, 2024).

The current Biden administration recognises that lack of housing supply is an issue (Bernstein et al., 2021). Shortage of available land and local zoning restrictions are seen as the main issues restricting housing supply (ibid). Single-family zoning restrictions are especially detrimental. These kinds of restrictions prevent the construction of multi-family units that could increase both housing density and supply. In fact, following since 2008, 64% of all housing units approved for construction have been for single-family homes (ibid). While demand for homes recovered after the 2008 crisis, the supply of homes did not (Heinrich, 2024). Housing starts are at a good level, but the completions trail clearly (Smith, 2023). Housing market regulations impact the timeline in which started houses are completed and available for use. Only completed housing units can alleviate housing supply shortages. Smith (2023) criticizes the effectiveness of the Biden Administration Housing Supply Action Plan, which plans to give cash incentives to local governments to remove home construction barriers. He notes that the $85 million budget for this is too small and will hardly solve the issue because housing regulations are chosen by local governments (ibid). Local governments focus on the desires of locals, rather than the whole nation.

As aforementioned, the land use regulations are set on the local level, so it is difficult for the Federal government to directly change these. There have been attempts in various states such as California and Oregon to change zoning regulations to allow for more units to be built on land to alleviate the shortage of housing supply (Bernstein et al., 2021).

4.2 The Dodd-Frank Act

As aforementioned, the 2008 financial crisis raised scrutiny about the state of the financial markets and brought forward the need for regulation to prevent similar events in the future. One of the most notable pieces of legislation in the United States was the Dodd-Frank Act of 2010. In the Dodd-Frank Act, there were five key components (Hayes, 2023):

- Financial Stability Oversight Council
- Consumer Financial Protection Bureau
- Volcker Rule
- Securities and Exchange Commission (SEC) Office of Credit Ratings
- Whistleblower Program

The Financial Stability Oversight Council (FSOC) is tasked with surveillance of the financial system and large institutions (Kagan, 2021). The FSOC is headed by the US Treasury Secretary and must make annual reports on possible risks to the financial system and wider economy (ibid). The Consumer Financial Protection Bureau (CFPB) was created in 2011 to help protect consumer against firms in the financial industry when it comes to fees, transparency, and overall fair treatment (Sahadi, 2023). Consumers can file complaints to the CFPB, who enforce consumer protection laws (ibid).

The aim of the Volcker Rule was to ban proprietary trading (Berman, 2023). This meant that banks could not use their own money to trade securities (ibid). A big proponent of the rule, former FED Chairman Paul Volcker, believed that firms who take speculative risks should not be subsidised by the government (ibid). The SEC Office of Credit Ratings is entrusted to make sure credit rating agencies give fair and accurate credit ratings of all the entities they evaluate (SEC, 2022). The Whistleblower Program provides monetary incentives for individuals to report violations of securities laws (SEC, 2023). The idea behind the program is that whistleblowers should be compensated monetarily since their actions often have a detrimental impact on their future job prospects.

During his presidency, Donald Trump led the effort to roll back major parts of the Dodd-Frank Act and signed the changes into law in May 2018. The rollback removed thousands of small and medium-sized banks from strict federal surveillance (Rappeport and Flitter, 2018). These same banks were no longer required to undergo stress tests and large institutions like American Express were no longer deemed systematically important (ibid). The main aim of the Republican-led legislative changes was to reduce regulation in the financial sector, which would hopefully allow for more economic growth.

4.3 The Federal Reserve

The role of the Federal Reserve is key in shaping US economic and housing market outcomes. The impact of the Federal reserve is shortly described by the following diagrams.

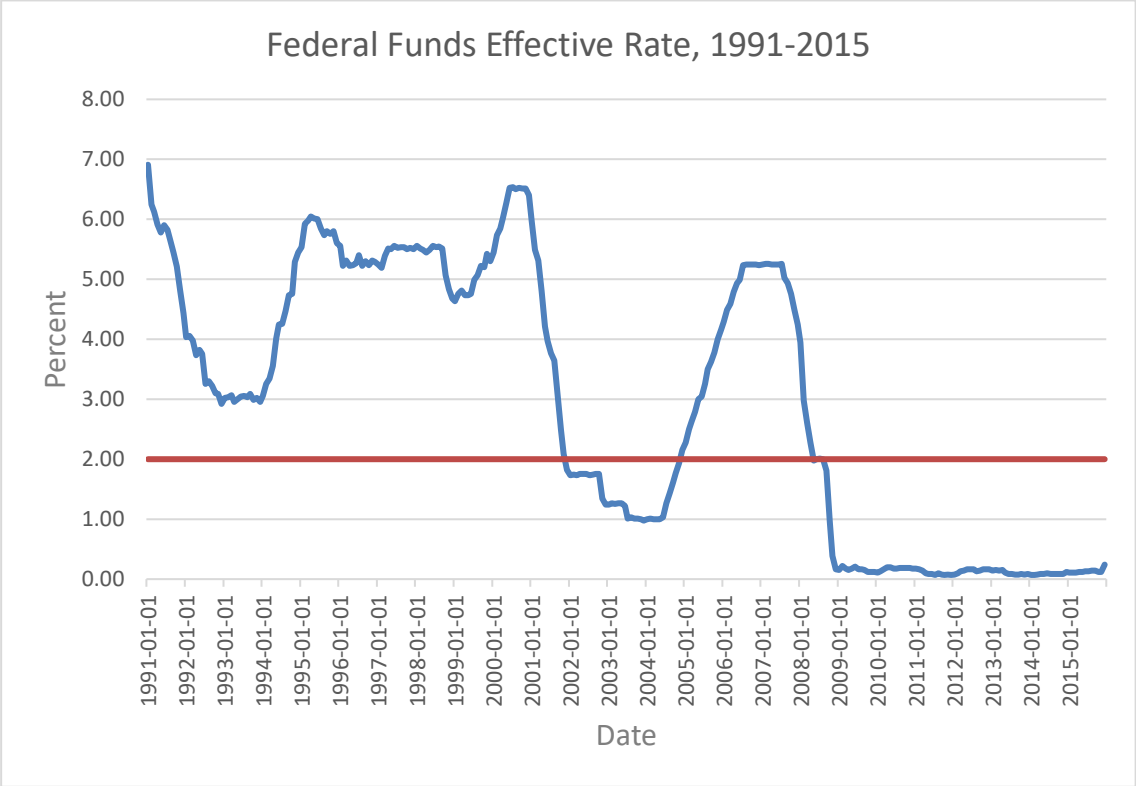

Figure 6. Federal Funds Effective Rate 1991-2015 (Board of Governors of the Federal Reserve System, 2024).

Figure 6 above shows the Effective Federal Funds Rate between 1991-2015. The red line shows the 2% long-run inflation target of the Federal Reserve. The Federal Reserve has a dual mandate of price stability and maximum employment. When the Federal Reserve keeps the rate above the 2% target, it is trying to slow down the economy. On the other hand, when the rate is below 2%, the Fed is trying to spur growth. The 2 % target has been deemed suitable because it allows for room for the Fed to operate above or below 2%. For instance, if the target was 1%, the lower bound of 0% would be very close, leaving the Fed little room to stimulate growth through expansionary monetary policy. The Fed Funds rate is a key determinant in mortgage rates that banks offer individuals. It is consequential when considering housing market fundamentals. Therefore, the monetary policy decisions of the Federal Reserve can impact the demand for housing in the United States.

In the 1990's, the Fed Funds Rate was between 3-6%. Prior to the financial crisis, the Fed Funds Rate was increased from around 1% to around 5,25% around mid-2007. After the financial crisis, the rate was a touch above zero for over five years.

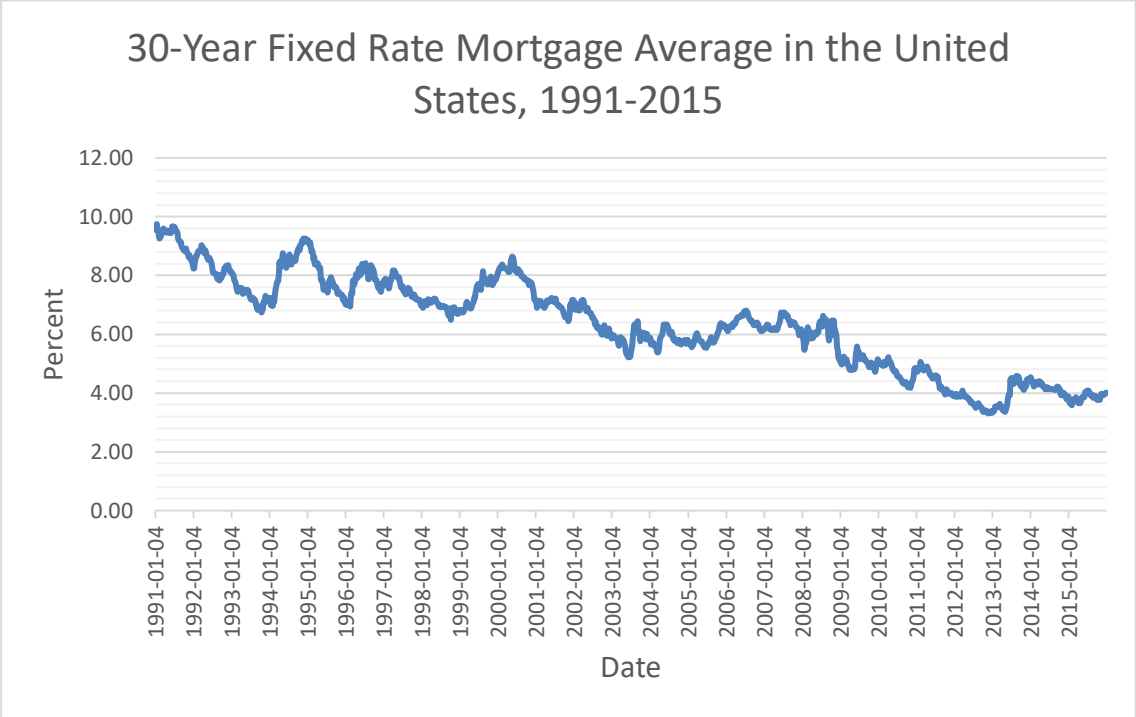

Figure 7. 30-Year Fixed Rate Mortgage Average in the United States, 1991-2015 (Freddie Mac, 2024).

The 30-year fixed rate mortgage average is displayed above in Figure 7. The average 30-year mortgage rate in the United States has been steadily decreasing from around 10% in 1991 to around 4% by the end of 2015. This means that financing a mortgage has become more affordable, because the average fixed interest rate on mortgages had decreased.

5 Data

Data on the various components of housing demand and variables to be used in the regression model have been collected from different websites and sources. The sources of the data are described in future detail in the next section. Stata was used to perform the regression and data analysis in this thesis. The data is panel data since we observe multiple variables on multiple individuals (states) over time.

5.1 Selected data and sources

The data for this thesis has been retrieved from a variety of sources. One of the components of housing demand is the stock market. The stock market can be represented by the Standard & Poor's S&P 500 Index. This is the most known index in the USA and the world. The index tracks the share prices of the 500 largest American firms big market value. The index is of vast significance related to the American housing market because Americans tend to have a large portion of their retirement savings in Exchange Traded Funds (ETF) or mutual funds that track the performance of the S&P 500 Index. Developments in the price of the index can be thought to play an indirect role on demand through expectations about future purchasing power. If the index is performing badly for an extended period, perceptions about the future may be lower. Decreased purchasing power will decrease demand for housing. However, Sutton (2002) found that the impact of the stock market on house prices is smaller in the USA than in the other countries in his study: United Kingdom, Canada, Australia, Netherlands, and Ireland. This data was retrieved from Yahoo Finance. Figure 8 below shows the development of the S&P 500 Index. The S&P 500 index is not used in the regressions because the relationship with individual states cannot be determined. Although not use in the regressions, the graph gives simple but valuable understanding of how the macroeconomy, and broad stock market are related. We can compare the chart of the S&P 500 index with that of the Federal Funds Effective rate. Both in the early 2000's and 2008 when there was a market correction, there was a decrease in the Federal Funds Effective rate. In addition, it must be noted that although there have been many corrections in the past two decades, the long-term trend of the market is up; the index has more than tripled between 2000-2023.

Figure 8. S&P 500 index, 2000-2023 (Yahoo Finance, 2024).

Another component of the data is Gross Domestic Product (GDP) per capita by state. This data was retrieved from the Bureau of Economic Analysis. Nevertheless, the scope of the data available was limited. The data was only available from 1997 onwards, unlike the other variables that are available from 1991. In addition, one can expect the effect of GDP per capita to be like income per capita, so not using GDP is not a major issue.

In this thesis, our main interest is on the fundamentals of and the heterogeneity of the U.S. housing market. Therefore, we need to observe data that is state-specific, meaning that it alters between states. Hence, in our regressions, we cannot use national data, because they are the same in all states. These variables include the S&P 500 index, Federal Reserve funds rate, 30-year mortgage rate, and inflation.

For this thesis, I was able to find multiple variables of state-specific data. It was important to find variables that have data points for each year 1991-2015 for each state. This means that the panel data is strongly balanced. A dummy (indicator) variable was created for each state, so that Stata can recognize the data.

Firstly, I found house price index (HPI) data for each state. The HPI measures the percentage change in single-family homes relative to a common starting point. HPI data for each state is indexed to the year 1991, which is when the analysis will begin. The HPI per state is until 2015, so a total of 25 years. This allows us to visualise the development of house prices before, during and after the financial crisis. In addition, I believe 25 years is an appropriate period since homes are usually a long-term investment and the turnover is assumed to be low. This means that most people do not switch houses yearly or a correspondingly short period of

time. Since this data is quarterly, Q1 data was chosen to represent the value for that whole year. For example, the HPI for 1995 is the Q1 1995 value. This has been done because the other data in this thesis is yearly. It is vital to have the data in the same time intervals. Q1 was chosen so that the data can accurately be indexed to the beginning of 1991. Having a 25-year period allows for enough observations.

Secondly, per capita income per state data was retrieved from the St. Louis Federal Reserve Economic Data website. This data is also yearly. This data was available from 1950-2022, but for the purposes of this thesis, it was indexed to 1991, like HPI. This is an important variable for two reasons. It shows us how per capita income has developed and therefore is a good proxy for purchasing power. As aforementioned, higher income allows people to pay for more expensive homes. Secondly, having HPI and per capita income data indexed for the same period, 1991-2015, allows us to calculate a ratio of HPI to per capita income. The ratio allows us to measure the development of house prices and income, hence housing affordability in all 50 US states.

The third variable is average unemployment rate is each state. Likewise, this is also yearly. When the unemployment rate increases in a recession, there is less income for the population to spend. Lower income may hinder to ability for people to save for a down payment and may decrease their ability to buy a home, putting downward pressure on house prices through demand. Increasing unemployment decreases demand for housing (Iqbal et al., 2023). The demand for normal goods was discussed earlier in section 3.

The last variable to be used is the state population. Yearly population data between 1991-2015 is used for all 50 states. While it may not be a major factor, increasing population increases demand for housing (ceteris paribus). One would therefore expect increasing population to increase the prices of homes. This is because population can change must faster than the supply of homes. If more people are demanding the same amount of housing, then the prices of homes in the area will inevitably go up, at least in the short run. There is clear heterogeneity in population growth in the different states, making population an interesting variable to consider.

The data used in this thesis is strongly balanced since all subjects have measurements for all variables in all time periods. This makes the panel data more ideal for analysis. Real GDP per capita data on state level was only available starting from 1997. It was decided to omit this variable because a longer period (25 years) was preferred. All the chosen variables were

available for the longer period. Hence the decision was made to prefer the longer period and have less variables.

5.2 Descriptive statistics

Table 1. Key variables used in the regressions.

Variable name	Variable label
hpi	Home price index
inc	Income
ratio	Home price-income ratio
avgu	Average unemployment
pop	Population

Table 1 above shows the key variables that will be used in the regression. HPI is the home price index, which is calculated from the year 1991. This means that the year 1991=100. Inc is the per capita income data indexed to 1991. Likewise average unemployment and population are also indexed to 1991 to make the variables comparable. Due to their different absolute levels, comparison of trends would be very difficult without indexing the data. Since the data has been indexed, there is no need to convert the variables into log form.

Table 2 below shows the descriptive statistics for our panel data.

Table 2. Panel data descriptive statistics.

Variable		Mean	Std. Dev.	Min	Max	Observations	
Home price index	overall	166,97	53,56	88,38	353,88	N=	1250
"hpi"	between		23,62	135,65	225,71	n=	50
	within		48,19	41,27	319,47	T=	25
Income	overall	169,44	46,28	100,00	346,32	N=	1250
"inc"	between		8,63	146,02	199,36	n=	50
	within		45,48	70,07	316,39	T=	25
Home price-income ratio	overall	0,99	0,19	0,55	2,06	N=	1250
"ratio"	between		0,13	0,78	1,38	n=	50
	within		0,14	0,59	1,67	T=	25
Average unemployment	overall	90,71	30,11	31,40	248,28	N=	1250
"avgu"	between		16,86	60,71	165,38	n=	50
	within		25,06	14,99	209,19	T=	25
Population	overall	115,13	16,37	99,93	221,31	N=	1250
"pop"	between		12,23	101,55	169,00	n=	50
	within		11,02	46,13	167,44	T=	25

Table 2 above shows the descriptive statistics for our panel data. For each variable, we have overall, between and within standard deviation. The overall and within rows calculate the standard deviation values for the entire data set, using all 1250 observations for each variable. The between standard deviation row calculates the mean for each state separately and then calculates the variation between those means. The between row for each variable is calculated for all 50 states and each of the 25 years. On the other hand, within shows the variation within each state over time. Each variable varies overtime since the within standard deviation =/= 0 The observations on the right column show that for each variable, there are 1250 observations, 50 different subjects (states), and over a period of 25 years. The sample size is sufficient for this research, and it allows for an adequate perspective of the U.S. housing market before and after the 2008 financial crisis.

5.3 Histograms

We know that each variable has been indexed to 100. This helps us interpret the descriptive statistics shown above. The histograms of home price index, per capita income, average unemployment, and home price-income ratio are shown in Appendix 2. This section includes a description of the histogram of each variable and home price-income ratio.

Histograms allow us to see the distribution of the data, the skewness, and kurtosis. Skewness tests for normal distribution; it measures the horizontal distribution of the data. Data is positively skewed if there is a long right tail. On the contrary, data is negatively skewed if there is a long, left tail. Since we are working with indexed data and variable that tend to increase over time, if skewness is present, we can expect it to be positive. If the absolute value of the skewness is greater than 1, the data is said to be highly skewed. Kurtosis tests the vertical distribution of the data. In other words, it looks for the presence of outliers in the data. A kurtosis value of greater than 3 denotes lots of outliers in the data set. Detailed summary statistics of home price index, per capita income, home price-income ratio and average unemployment and population are in the Appendix. If the probability for skewness or kurtosis is greater than 0,05, then there is a normal distribution in the data. There is also a measure of the joint skewness-kurtosis probability which indicates normal distribution if over 0,05. If the probability is less than 0,05, we reject the null hypothesis of normality.

Firstly, we have the home price index -variable. As aforementioned, the histogram for the home price index is in the Appendix. For the home price index (HPI), the value of 88,38 for min shows that the largest decrease for any yearly state observation was 11,62%. This was recorded in New Hampshire in 1993. Likewise, the max shows that the largest increase was around 3,5 times the original value. This largest increase in the home price index was recorded in the year 2007 in Oregon. This makes sense as this was during the height of the housing bubble. A vast majority of the data points are evenly spread at levels less than 200. The normal density line shows the mean value at 166 and positive skewness denoted by the longer right tail. However, skewness is only of moderate magnitude with a value of 0,82. Kurtosis for home price index was 3,45. Naturally the highest density of data points is at 100 because we have indexed data from 100.

Secondly, we have the income variable. The histogram for per capita income data is in the Appendix. A minimum of 100 for income (inc) means that the yearly per capita income did not fall below 1991 values in any state. The max value for income shows us that the largest increase in income from 1991 to 2015 was about 3,46 times the 1991 value. This was recorded in 2014 in North Dakota. As with the home price index data, most of the data points are of equal frequency under 200. The mean value for indexed per capita income in our period is 169,44 and there is positive skewness, shown by the right tail. The value of skewness is 0,33 and kurtosis is 2,44. As with the previous histogram, the largest share of data points in the histogram for income is at or near 100 because the indexed data starts at 100.

Thirdly, we have the home price-income ratio. The ratio variable is of significant interest in this research. The histogram for home price-income ratio is seen in the Appendix. It shows that ratio between per capita income and the home price index. In our period of 1991-2015, the ratio almost halved (0,55) and more than doubled (2,05). This means there were significant changes in housing affordability, when examined through this ratio. The lowest value for ratio, 0,5523, was in Michigan in 2011. This can be interpreted as being the most affordable state and year (between 1991 and 2015) for housing compared to the 1991 levels. As with the home price index, it is natural that the highest value of ratio also be recorded during the housing bubble. The highest value for home price-income ratio was recorded in Hawaii in 2006.

The presence of a right tail indicates positive skewness. The skewness of the home price-income ratio data is 1,15. Through the skewness and kurtosis tests, we can reject the null hypothesis of normal distribution and conclude that our data is not normally distributed. This is also seen in the figure above. A kurtosis value of 6,02 denotes lots of outliers in the data. A detailed summary of the statistics for ratio is in the Appendix under Appendix 2.

Fourthly, we have the unemployment variable. Average unemployment also showed lots of variances in our period. The histogram for average unemployment is seen in the appendix. The values of average unemployment are also indexed to 1991=100. At the most, average unemployment decreased by almost 70% on a state level, but also rose by close to 150% compared to 1991 levels. The highest unemployment figure was in Hawaii in 2009, just a few years after it had the highest home price-income ratio for any state. The histogram has a right tail, so there is positive skewness. In other words, most of the values are less than the mean. The mean is shown by the highest point of the curve; in this case, the mean level of average unemployment is 90,71. The skewness and kurtosis for unemployment was quite high at 1,41 and 6,20 respectively.

Our final variable is population. As with income, population barely decreased in any state between 1991-2015. The largest increase in that time was about 121% and was recorded in Nevada in 2015, at the very end of our examination period. The histogram for population is in the Appendix. It shows that the compared to 1991, the population did not decrease in any U.S. state between 1991-2015. Over half of the observations for population were under the mean of 115,13. The skewness and kurtosis for population were high at 2,56 and 12,39 respectively.

5.4 Correlation and covariance

Table 3. Correlation between the variables.

	Home price index	Income	Average unemployment	Population
Home price index	1,00			
Income	0,74	1,00		
Average unemployment	0,05	0,12	1,00	
Population	0,48	0,43	0,29	1,00

Table 3 above shows the correlation between the variables. The correlation coefficient tells us how strongly two variables are related and the direction of the relationship. The value of the correlation coefficient can be between -1 and 1. Naturally, each variable has a perfect correlation with itself. The table gives us interesting insights into the correlation between the variables. We are especially interested in the correlation between home price index and the other variables. Firstly, home price index and income have a strong correlation of 0,7359. This means that every 1 unit increase in the home price index coincides with an income increase of 0,7359 units. However, this does not imply causation, as correlation does not equal causation. Another interpretation of this is that over our period of 1991-2015, income development does not keep up with the rising house prices. Secondly, average unemployment has a low but positive correlation with home prices. Thirdly, population and home prices have a moderate positive correlation of 0,4795. This means that as home prices increase, so too will population but with a smaller factor. The other correlations are quite low, except for the correlation between income and population, which is 0,4303.

Table 4. Covariance between the variables.

	Home price index	Income	Average unemployment	Population
Home price index	2869,03			
Income	1824,24	2141,73		
Average unemployment	83,60	166,06	906,52	
Population	420,50	326,03	141,27	268,11

Table 4 above shows the covariance of the between the variables home price-index, income, average unemployment, and population. The value of the covariance between two variables tells us how they change compared to each other. The greater the value of covariance, the stronger the relationship between the two variables. If the covariance is positive, it tells us that the variables move in the same direction, both increase and decrease. In the variables above, home price-index and income have the highest covariance out of any pair of variables.

The main correlation of interest is between the home price index and income. It is displayed in Figure 9 below. Each blue point represents an observation for a state in a certain year. As stated before, there are 50 states and 25 years, so the graph has 1250 data points in total. The red line shows the fitted value of the relationship between home prices and income. There is a positive relationship between the two variables, which is to be expected. Since income is one the major determinants of house prices, more income allows people to pay more for housing and hence house prices will be higher. The graph shows that there are more points above the fitted line than below it, especially with home price index levels of over 250. A conclusion that can be drawn from this is that over time, house prices increase faster than income. If this was not the case, most of the data points would be closer to the fitted line. To explain this further, there are data points in the graph representing a home price index value of around 350 and income index of less than 200. This means that from the start of the period, 1991, the price of home had increased 3,5 times while income had not even doubled. This is an example of deteriorating affordability that can be seen from the graph.

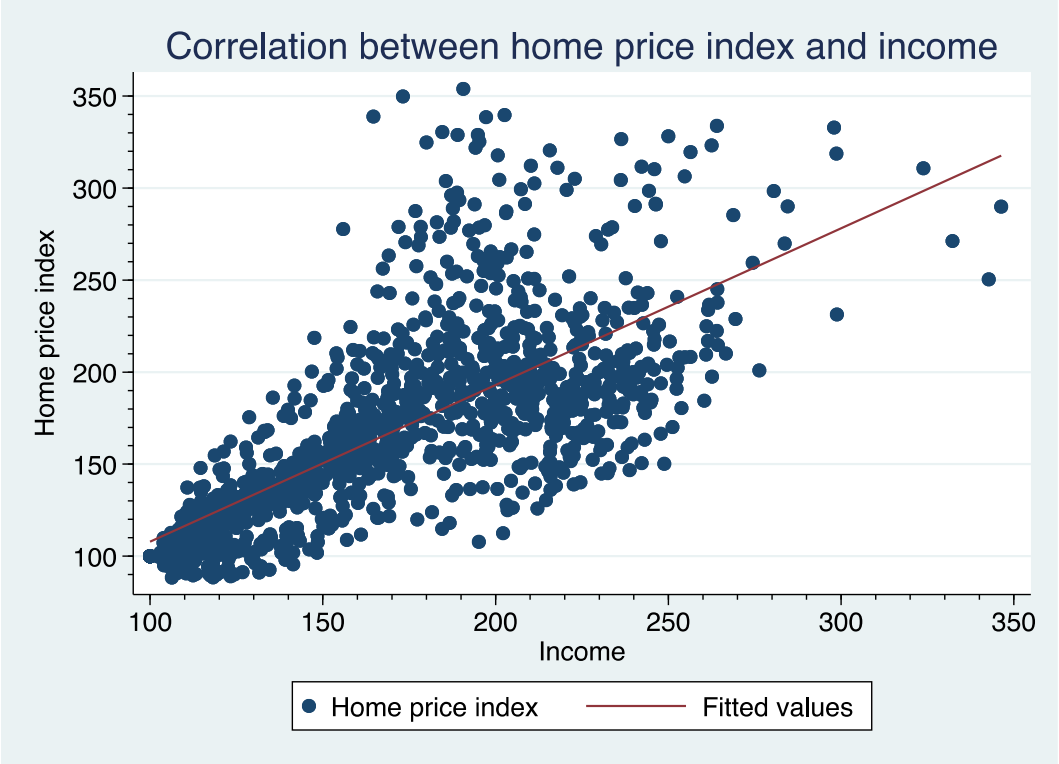

Figure 9. Correlation between home prices and income.

5.5 Development of the home price index

Before turning towards the empirical analysis, one should also visualise the development of the home price index throughout 1991-2015. This is shown in Figure 10 below.

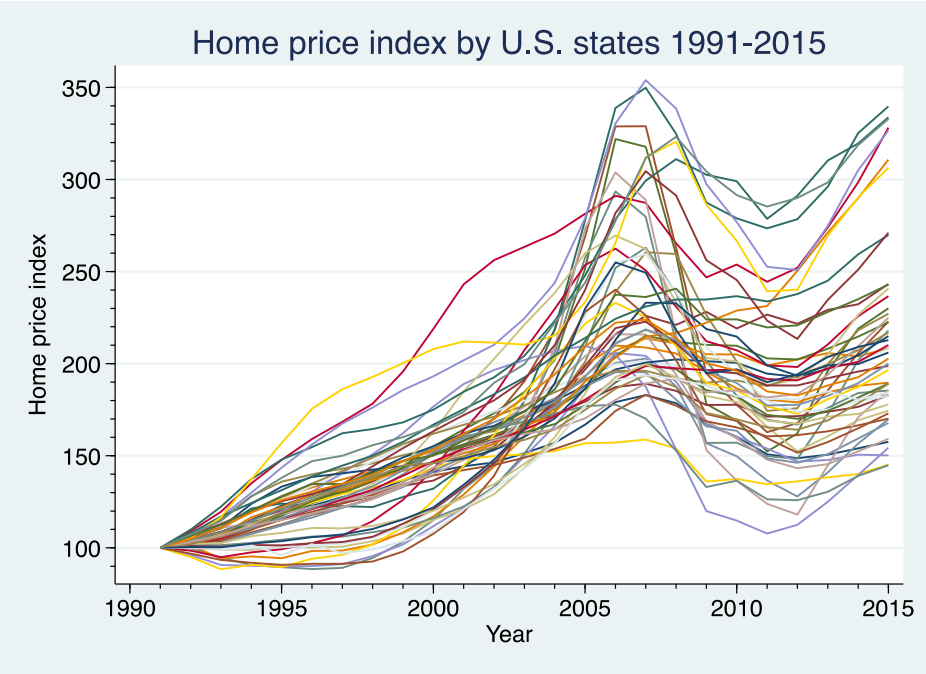

Figure 10. Development of the home price index.

Figure 10 above displays how the home price index developed in the United States between 1991-2015. The home price index trend is comparable between states, albeit including a few outliers. At the beginning of the dataset, the home price index starts increasing in most states. By the late 1990's, the home price index was increasing in all states. In 2007, there was a peak, followed by a drop in home prices nationwide. This is in conjunction with the 2008 financial crisis, during which home values fell in part due to increased unemployment, lower demand, and foreclosures. In the early 2010's, the home price index recorded their trough and began increasing, with some states having sharp increases. However, the increases in the home price index nationwide in the early 2010's was not as steep as in the 2000's, reflecting a healthier housing market. In addition, regulatory changes including the Dodd-Frank Act created a more sustainable base for financial and hence housing markets to recover after the 2008 crisis. The results in Figure 10 back up the findings of Hu & Oxley (2018) and Oikarinen et al. (2018): house price growth was not the same nationwide, with there being differences based on geography. The development of the home price-income ratio for each state can be seen in Appendix 3.

Alternatively, Figure 11 below shows how the relationship between mean home price index and mean per capita income. In the figure, we can see that from 1991 until the early 2000's, the mean home price index and mean per capita income increased in the same proportion. Holly et al. (2010) came to the same conclusion in their research of U.S. housing markets.

The overlapping time between this research and Holly et al. (2010), 1991-2003, shows a similar pattern in which home prices rose in line with income. Also, a housing bubble began forming in the early 2000's when the rise in home price index diverged from the rise in income. Starting in the early 2000's, the mean home price index grew significantly faster than mean income. It peaked in 2007 and hit a trough in 2012, from which it began increasing again. Throughout the 25 years in question, mean per capita income grew steadily. Lastly, the graph shows that the mean house price in the United States more than doubled and mean per capita income increased by around 2,5 times between 1991 and 2015.

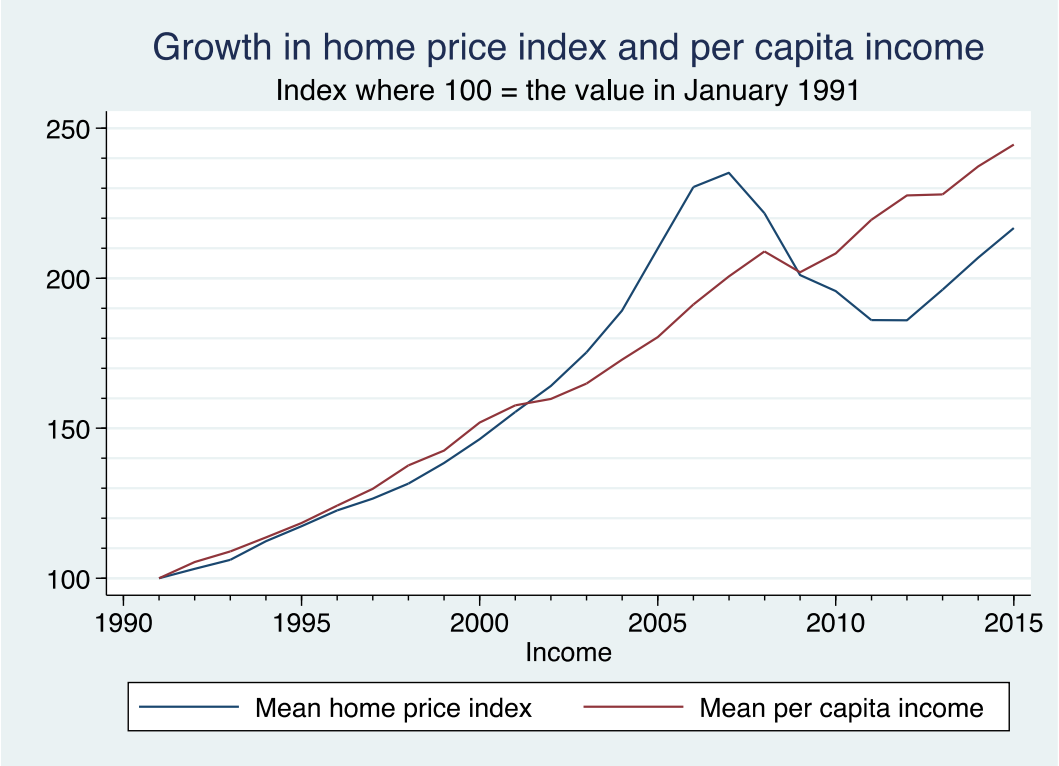

Figure 11. Growth in home price index and per capita income.

In addition, the development of house prices in the past few decades has been researched. This can be seen in Figure 11 above. The mean home price index diverges from the long-term trend in the mid 2000's, causing an increase in the price-income ratio. In fact, house prices in major metropolitan areas have increase 4 times faster than incomes since 1960 (Tekin, 2022). Prices rising faster than incomes decreases housing affordability (Miles et al., 2023).

The trend of the median sales price of houses sold in the United States is shown below in Figure 12. When looking at the overall period between 1991-2015, there is a steady rise in house prices. However, there is a deviation from the long-term trend in the mid-2000's prior to the financial crisis. House prices grew faster than before, but after the crisis, prices of

homes decreased significantly. The recovery of housing prices along the long-term trend began in the early 2010's.

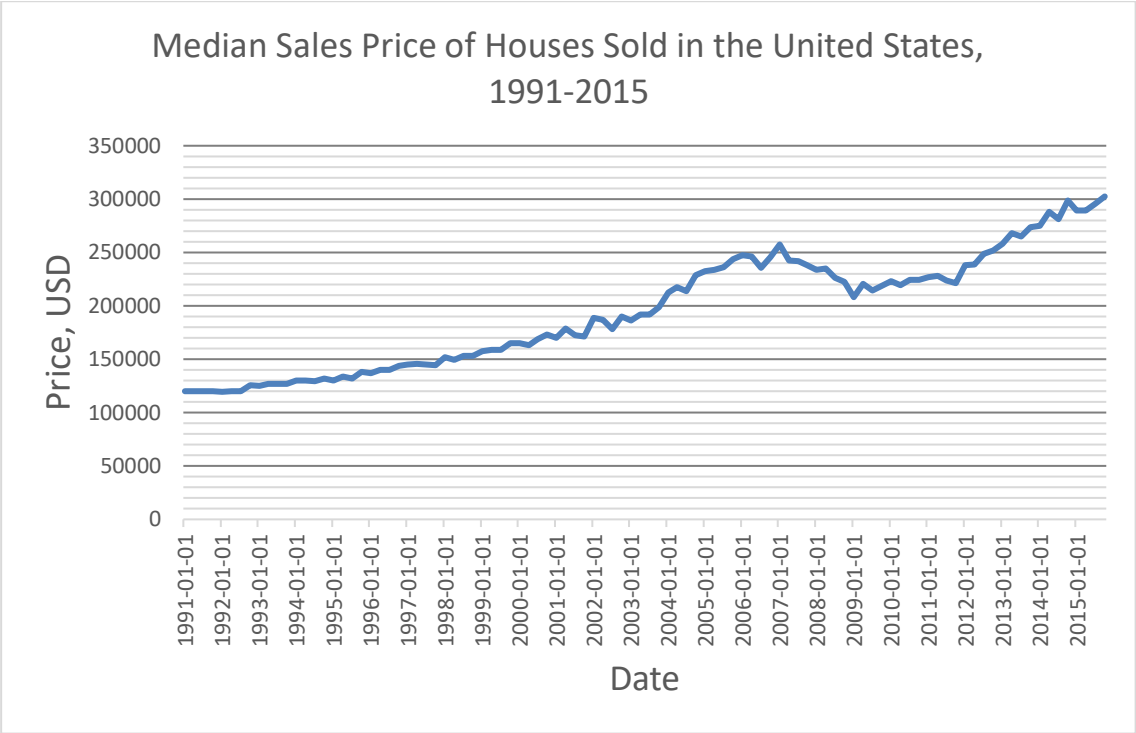

Figure 12. Median Sales Price of Houses Sold in the United States, 1991-2015 (U.S. Census Bureau, 2024).

5.6 Development of the house price-rent ratio

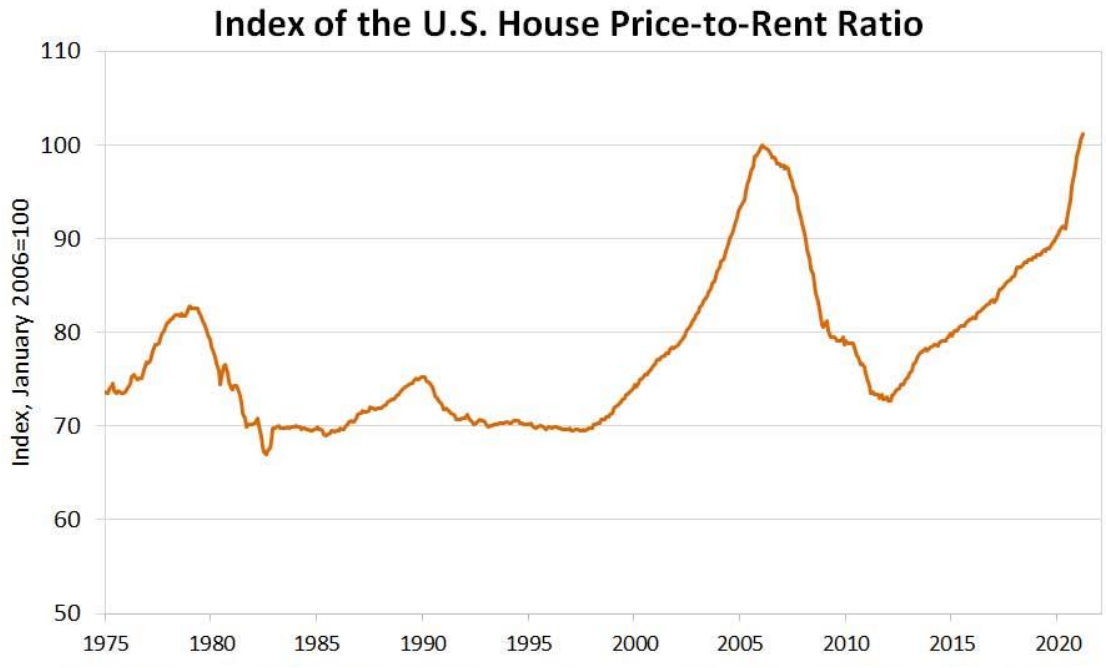

Figure 13. U.S. House Price-to-Rent Ratio (Emmons, 2021).

Figure 13 above shows a nationwide index of the U.S. House Price-to-Rent ration between 1975 and 2021. This graph has been added to the end of the data section to demonstrate how this indicator has shown similar development with other indicators. When comparing this to Figure 10, we can see that the home price index and the home price-rent ratio followed similar trends. These include a sharp rise from the mid-1990's to the mid-2000's, a sharp decline for the next few years, followed by a rise in the following years to almost the mid-2000's peaks. However, the development differs to that of the home price-income ratio seen in Figure 15. Whereas the house price-rent ratio did not fall below 1990's lows around 2010, the home price-income ratio fell clearly below 1990's level around 2010. As aforementioned, buying a home and renting are substitutes. If someone is renting, it often means that they are not homeowners. In other words, tenants are usually not homeowners and homeowners live in a house they own. Nevertheless, there are exceptions where one is a homeowner and leases it to another person, while renting another unit themselves. This can happen when one temporarily moves to another city and maintains ownership of their initial home.

As with most graphs of different economic indicators, the effect of the financial crisis can be demonstrated by this graph. In the early 2000's, the relative cost of buying a home increased dramatically. Nonetheless, the financial crisis saw a significant shift the other way, with houses becoming relatively cheaper than renting. During the recover from the financial crisis, the house price-to-rent ratio once again increased to 2006 levels by the beginning of 2021. Another key takeaway from this graph is that one cannot say that buying a home or renting is always the cheaper option. Monetary policy and macroeconomic factors such as interest rates and unemployment play a role in determining the demand for housing. When home ownership is more sought-after, home prices tend to increase faster than rents.

6 Empirical analysis

The empirical analysis of this thesis will consist of regression analysis. The dependent variable in the analysis will be house prices in the United States. This will be studied by using the home price index for each state. There will be a variety of independent variables used to measure their possible impact and correlation with the dependent variable, house prices. In addition to these variables, the home price-income ratio is of great interest in this research. The home price-income ratio is a measure of affordability of housing on a state level. The data that we have backs up the earlier discussion about the heterogeneity of housing market in the United States.

The main dependent variable is per capita income. One can expect income to be the main driver of the ability for a person to finance the purchase of a home. Since income is a key component of demand, its' possible correlation with house prices is of interest and significance. Another dependent variable is population. The third dependent variable is average unemployment rate. In addition to the variables, a price-to-income ratio will be calculated to determine how the affordability of house prices has developed between 1991-2015 and especially after the financial crisis.

As aforementioned, there would have been plenty of other interesting variables to use, but since they are not available on a state-level, they will not be used in the regressions. A simple analysis of these variables follows. One of these is real GDP per capita. This is like per capita income in that higher GDP can be thought to increase demand for housing. Other dependent variables will be the S&P 500 index, inflation, and interest rates. Especially for higher income households, upturns and downturns in the broad stock market may impact their willingness to make a big purchase, such as a home. Thus, the demand for housing may be affected through how the stock market develops. Inflation is important to consider when studying house prices due to its link with interest rates. Inflation is often a sign of a hot economy. As aforementioned, higher interest rates make buying homes with mortgages more expensive, so this can reduce the prices of homes. In addition, inflation increases the cost of building a new home, leading to lower demand of housing at a certain price level.

6.1 Regression

The regression analysis of this thesis will consist of multiple variable panel regression analysis. The multiple regression analysis will bring in the other dependent variables. Many

different regressions will be conducted so that one can compare how well certain variables can explain variation in the independent variable, house prices.

For example, Case and Shiller (2003) find that interest rates themselves do not explain house price changes well, but when coupled with employment and income levels, it becomes a better indicator. All in all, house prices are sensitive to changes in interest rates (Füss and Zietz, 2016). Nevertheless, as aforementioned, interest rates will not be used in the regressions since they are on a national level, so there are no differences between states.

6.2 Methodology

As aforementioned, the research in this thesis is conducted using regression analysis. Panel data is used so that the impact of multiple variables on multiple subjects over time can be investigated. In other words, panel data is a combination of time series and cross-sectional data. With panel data, fixed and/or random effects of individuals or time can be tested (Park, 2011). According to Murray (no date), the functional form for fixed effects is as follows:

$$Y_{it} = \beta_0 + \alpha_i + \beta_k X_{k,it} + \varepsilon_{it} \quad (9)$$

In equation 9 above, Y is the dependent variable, i denotes states, t denotes time, β represents the independent variable, α denotes the intercept, and ε is the error term.

With fixed effects, the effect of time-invariant characteristics is removed, and we can assess the effect of the predictors on the outcome variable (Al Amin and Qin, 2024). In the panel data in this research, there are no time-invariant characteristics since every independent variable varies over time.

According to Schmidheiny (2023), the random effects model is one in which individual-specific effects are uncorrelated with the independent variables. Contrary, the fixed effects model is one where the individual-specific effects are correlated with the independent variables (ibid).

The Hausman test was performed to check whether the fixed effects or random effects is best for our data. In the Hausman test, the null hypothesis is that the random effects model is appropriate. Hence, the alternative hypothesis in the Hausman test is that fixed effects is better. If the p-value in the Hausman test is less than 0,05, we reject the null hypothesis and conclude that the fixed effects model is superior for our data set. In this research, the panel regressions for fixed effects and random effects were run with the same dependent variables.

The dependent variables were per capita income, average unemployment, and population. The independent variable was home price index. The Hausman test showed a p-value of 0,00, meaning that we can reject the null hypothesis and conclude that the fixed effects model is better for our data.

Following this, we must also check for heteroskedasticity. Heteroskedasticity in panel data means that the variance of the error terms is not constant. The Breusch-Pagan test is used to test for heteroskedasticity (Halunga et al., 2017). Like with the Hausman test, the null hypothesis is that homoskedasticity is present. The alternative hypothesis is that there is heteroskedasticity. If the p-value from the Breusch-Pagan test is less than 0,05, we reject the null hypothesis and conclude the presence of heteroskedasticity in the regression.

Robust standard errors are used to account for the presence of heteroskedasticity. With this, the standard errors are adjusted to account for heteroskedasticity.

7 Results

This section will include the results of the regression and discussion about what we can infer from them. As aforementioned, in this thesis, we are using panel data. This means that we have multiple variables measured for multiple subjects over time. In this case, the variables of interest are home price index, per capita income, average unemployment, and population. The results presented in this thesis contribute to the existing literature by adding knowledge about how different housing market fundamentals impacted house prices and affordability in the U.S. between 1991-2015.

The first regression will include measurements of the variables between 1991-2015. To compare effects and explanatory power, the following regressions will also be included: 1991-1999, 2000-2007, and 2008-2015. This way we can compare the connection of the independent variables and the home price index throughout the sequential periods. We have strongly balanced panel data as we have measurements for each variable and subject for each year. Descriptive statistics for the data were calculated to help us understand the variables. Following this, panel regression analysis was conducted. The regressions have been conducted using indexed data of the variables where 1991=100.

7.1 Household fundamentals regression results

This section includes the results of the household fundamentals regression tests. The first column shows the results of the panel regression. The second column includes robust standard errors. The third column is the panel regression results with fixed effects. The fixed effects model assumes that effects of the variables remain constant throughout observations (Mustafa, 2023). The fourth column is the panel regression with random effects. Random effects assumes that the effects of the variables vary throughout the larger group of observations (*ibid*).

7.1.1 The whole period: 1991-2015

Table 5. Regression results 1991-2015.

	(1)	(2)	(3)	(4)
	Model 1	Model 2	HPI	HPI
VARIABLES	OLS	Robust	fixed effects	random effects
Income	0.770***	0.770***	0.773***	0.770***
	(0.0223)	(0.0519)	(0.0231)	(0.0223)
Avg. Unemployment	-0.393***	-0.393***	-0.414***	-0.393***
	(0.0302)	(0.0450)	(0.0304)	(0.0302)
Population	0.813***	0.813***	0.813***	0.813***
	(0.0907)	(0.241)	(0.0968)	(0.0907)
Constant	-21.38**	-21.38	-20.02**	-21.38**
	(8.723)	(22.37)	(8.668)	(8.723)
Observations	1,250	1,250	1,250	1,250
Number of state1	50	50	50	50
R-squared			0.723	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5 above shows the regression results for the first panel regression, containing the data for the whole period: 1991-2015. The table has four columns. The first column is the basic panel regression where the dependent variable is home price index, and the independent variables are income, average unemployment, and population. The standard errors are shown in parentheses and the stars represent the levels of significance of the results. In all columns, all independent variables are significant at the 1% level. The second column is the robust regression with the same variables. The robust regression is used when we are concerned

about the presence of heteroskedasticity. As one can see when comparing the results in the table, the coefficients are the same, but the standard errors are different. The robust regression changes the standard errors and fixes heteroskedasticity. Next, we conducted the fixed effects and random effects panel regression. The third column shows the panel regression results with fixed effects and the fourth column shows the panel regression results for random effects. The levels of significance are the same for both fixed effects and random effects regressions.

After running these regressions, the estimates were saved to be used in the Hausman test. Next, the Hausman test was conducted to determine whether fixed effects or random effects is better for our data. As aforementioned, the Hausman p-value indicates whether we should support the null hypothesis and use random effects or reject the null hypothesis and use fixed effects. To summarise, if $p > 0,05$ we use random effects and if $p < 0,05$ we use fixed effects.

Table 6. Hausman test 1991-2015.

	Coefficients			
	Fixed effects	Random effects	Difference	Std. Error
Income	0,773	0,770	0,003	0,006
Average unemployment	-0,414	-0,393	-0,021	0,003
Population	0,813	0,813	0,000	0,034
Prob > chi2	0,00			

The data in Table 6 above are the results of the Hausman test. As we can see, the value for "Prob > chi2" is 0,00. This means that we can reject the null hypothesis and determine that the fixed effects model is more suitable for our data.

7.1.2 1991-1999

The first of the shorter-period regressions include our data from the 1990's, more specifically 1991-1999. Table 7 below shows the results of the panel regressions.

Table 7. Regression results 1991-1999.

	(1)	(2)	(3)	(4)
	HPI	HPI	HPI	HPI
VARIABLES	OLS	Robust	Fixed effects	Random effects
Income	0.899***	0.899***	0.904***	0.899***
	(0.0549)	(0.126)	(0.0568)	(0.0549)
Avg. Unemployment	0.206***	0.206***	0.211***	0.206***
	(0.0371)	(0.0637)	(0.0394)	(0.0371)
Population	0.812***	0.812*	0.799***	0.812***
	(0.121)	(0.467)	(0.127)	(0.121)
Constant	-93.70***	-93.70**	-93.43***	-93.70***
	(11.91)	(39.76)	(12.53)	(11.91)
Observations	450	450	450	450
Number of state1	50	50	50	50
R-squared			0.758	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As with the panel regression for the whole period, this panel regression has income, average unemployment, and population as the independent variables. The dependent variable is the home price index. The variables are all significant at the 1% level, except in the robust results, where population, in the robust panel regression, is only significant at the 10% level.

The coefficients for the variables are the same in all columns except for the fixed effects. When comparing to the first regression, 1991-2015, the coefficient of income is higher at 0,899. This indicates that in 1991-1999, income was highly correlated with the home price index. The coefficient for population was almost identical, whereas there was a big difference in the relationship between average unemployment and the home price index. In this period, there is a weak positive relationship and in the entire period there was a moderate negative relationship. The positive relationship means that, to some extent, the home price index increased as average unemployment did. This is interesting as increasing unemployment decreases demand through loss of purchasing power. A possible explanation for this is that

employed people were willing to pay higher prices for homes. The former comparison between the periods implies that in our other periods, the coefficient for average unemployment will be negative. The r-squared value of 0,758 is slightly higher than the value for the whole period: 0,723. An r-squared of 0,758 indicates that the independent variables do a fairly good job explaining the variation in the dependent variable.

The third and fourth rows of the table above shows the regression results of the fixed- and random effects models for 1991-1999. The coefficients for income and average unemployment are slightly higher in the fixed effects model compared to the random effects model. On the contrary, the coefficient for population is slightly lower in the fixed effects model. As aforementioned, the fixed effects model assumes the individual-specific effects are correlated with the independent variables; in the random effects model, they are not (Schmidheiny, 2023).

Table 8. Hausman test 1991-1999.

	Coefficients			
	Fixed effects	Random effects	Difference	Std. Error
Income	0,904	0,899	0,006	0,015
Average unemployment	0,211	0,206	0,005	0,013
Population	0,799	0,812	-0,013	0,039
Prob > chi2	0,10			

As in the previous section, the Hausman test was performed to determine whether fixed effects or random effects model is better in this regression. The result of the Hausman test in this regression is shown in Table 8 above. The value of 0,10 is greater than 0,05, meaning that we should support the null hypothesis and use the random effects model.

7.1.3 2000-2007

Table 9. Regression results 2000-2007.

	(1)	(2)	(3)	(4)
	HPI	HPI	HPI	HPI
VARIABLES	OLS	Robust	Fixed effects	Random effects
Income	1.578***	1.578***	1.398***	1.578***
	(0.0685)	(0.135)	(0.0787)	(0.0685)
Avg. Unemployment	-0.130	-0.130	-0.199**	-0.130
	(0.0804)	(0.123)	(0.0824)	(0.0804)
Population	1.705***	1.705***	2.959***	1.705***
	(0.213)	(0.317)	(0.346)	(0.213)
Constant	-271.6***	-271.6***	-380.7***	-271.6***
	(23.35)	(34.19)	(33.77)	(23.35)
Observations	400	400	400	400
Number of state1	50	50	50	50
R-squared			0.766	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9 above shows the panel regression of home price index on income, average unemployment, and population in the years 2000-2007. This is the period immediately preceding the 2008 financial crisis. The constant, income and population are all statistically significant at the 1% level. However, average unemployment is not statistically significant, except in the fixed effects model where it is statistically significant at the 10% level. Average unemployment had a weak negative correlation with the home price index. This is expected as increasing unemployment decreases people's ability to pay for goods such as homes, often decreasing demand and home prices as a result.

When considering the coefficients, both income and population have stronger positive correlations compared the previous period, 1991-1999. This indicates that income and population had a stronger relationship with the home price index. It is a logical conclusion when we consider the period in question. As aforementioned, this period preceded the financial crisis. There was a boom in the housing market, with prices rising fast in many areas of the country. Higher income allowed households to spend more on houses. This has a relationship with higher prices, as seen in the regression results. Also, population growth in urban areas played a role in the increase of home prices.

Table 10. Hausman test 2000-2007.

	Coefficients			
	Fixed effects	Random effects	Difference	Std. Error
Income	1,398	1,578	-0,180	0,039
Average unemployment	-0,199	-0,130	-0,070	0,018
Population	2,959	1,705	1,254	0,272
Prob > chi2	0,00			

As with previous regressions, the Hausman test was performed to determine whether the fixed effects model or random effects model is better for this period. The results are shown in Table 10 above. The value of 0,00 indicates that we should reject the null hypothesis and conclude that the fixed effects model is more suitable this regression.

7.1.4 2008-2015

Table 11. Regression results 2008-2015.

	(1)	(2)	(3)	(4)
	HPI	HPI	HPI	HPI
VARIABLES	OLS	Robust	Fixed effects	Random effects
Income	-0.214***	-0.214	-0.254***	-0.214***
	(0.0667)	(0.150)	(0.0843)	(0.0667)
Avg. Unemployment	-0.474***	-0.474***	-0.491***	-0.474***
	(0.0374)	(0.0597)	(0.0374)	(0.0374)
Population	0.342	0.342	0.346	0.342
	(0.227)	(0.329)	(0.413)	(0.227)
Constant	258.6***	258.6***	268.8***	258.6***
	(27.03)	(54.12)	(40.80)	(27.03)
Observations	400	400	400	400
Number of state1	50	50	50	50
R-squared			0.364	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11 above shows the panel regression of home price index on income, average unemployment, and population in the years 2008-2015. This is the third and last separate period that was considered. It also includes the 2008 financial crisis, the fallout, and the recovery. The constant, income and average unemployment are statistically significant at the

1% level. However, income is not statistically significant in the robust standard errors regression seen in the second column. In addition, the coefficients for population are not statistically significant. In other words, during 2008-2015, population growth cannot accurately predict the home price index.

Interestingly income has a weak negative correlation with home price index. This means that as income increased, home prices fell. On the other hand, this also means that decreasing income was coupled with higher home prices. I believe income and average unemployment tie well together in this period, as unemployment increased, and income fell in many areas of the countries due to the crisis. In terms of the regression, higher rates of average unemployment were coupled with lower home price index values. Hence, both average unemployment and income having a negative correlation with the home price index in this period is logical.

Table 12. Hausman test 2008-2015.

	Coefficients			
	Fixed effects	Random effects	Difference	Std. Error
Income	-0,254	-0,214	-0,396	0,054
Average unemployment	-0,491	-0,474	-0,017	0,007
Population	0,346	0,342	0,004	0,353
Prob > chi2	0,00			

Like with previous regressions, the Hausman test was performed to determine whether the fixed effects model or random effects model is better for this period. The results are in Table 12 above. The value of 0,00 is less than 0,05, indicating that we should reject the null hypothesis and conclude that the fixed effects model is more suitable this regression.

7.1.5 Summary

Table 13. Summary of regression coefficients.

		Variables			
	Regression	Income	Avg. Unemployment	Population	Constant
1991-1999	OLS	0,899	0,206	0,812	-93,70
	Robust	0,899	0,206	0,812	-93,70
	FE	0,904	0,211	0,799	-93,43
	RE	0,899	0,206	0,812	-93,70
2000-2007	OLS	1,578	-0,130	1,705	-271,60
	Robust	1,578	-0,130	1,705	-271,60
	FE	1,398	-0,199	2,959	-380,70
	RE	1,578	-0,130	1,705	-271,60
2008-2015	OLS	-0,214	-0,474	0,342	258,60
	Robust	-0,214	-0,474	0,342	258,60
	FE	-0,254	-0,491	0,346	268,80
	RE	-0,214	-0,474	0,342	258,60
1991-2015	OLS	0,770	-0,393	0,813	-21,38
	Robust	0,770	-0,393	0,813	-21,38
	FE	0,773	-0,414	0,813	-20,02
	RE	0,770	-0,393	0,813	-21,38

Table 13 above is a summary of the regression coefficients of the different variables. The left-hand column indicates the corresponding period, and the top row denotes the independent variable in question. The coefficients of the variables vary between the time periods. The highest coefficients were the coefficients for population in 2000-2007 and the lowest coefficients were for unemployment in 2008-2015. We can see that in 1991-1999, all variables had positive correlation with the dependent variable, home price index. This was not the case in the following two periods. In 2000-2007, both income and population had strong positive correlations, whereas average unemployment had a weak negative correlation. Vogiazas and Alexiou (2017) discussed the long-run relationship between house prices and income being cointegrated. Similar results can be seen in this research as the correlation between income and home price index is strongly positive.

Moreover, the coefficient for population was positive in all three periods, with it being strong in the first two periods. As Case and Shiller (2003) found, population has a strong correlation with house prices through increasing demand for housing. In addition, it can be said that average unemployment had the weakest coefficient out of the three variables.

7.2 Discussion of regression analysis

As shown in the previous sections, the regression analysis of this thesis was split into four different sections: 1991-2015, 1991-1999, 2000-2007, and 2008-2015. This was done so that the correlation coefficients of the variables can be compared across the different periods. In fact, we found differences in the coefficients, highlighted in Table 13. Another strength of the regression analysis is that it is strongly balanced, as there was an observation for each variable for every year. Lastly, the regression coefficients back up the hypothesis of the thesis with the result that income and population had a strong positive correlation with house prices.

When considering the weaknesses of the regression analysis, there could have been more variables. More independent variables would have allowed for a more thorough analysis and would have provided more context on which variables affect house prices. Secondly, the data used is on a state-level rather than city level. Using city level data would have allowed for more observations and more accurate descriptions. This is because there is heterogeneity of housing markets within states. However, this data was not available widely enough, so it was not used in this thesis. A notable problem with the city-level approach is how to consider unemployment data. It is likely that individuals are willing to travel for work to neighbouring cities, rendering unemployment data impractical for this research. Finally, indexing the data to 1991 may impact the results, especially in the latter years. The data was indexed to 1991 to make comparisons between variables clear. Nonetheless, the data for each year is with respect to 1991, not the previous year.

7.3 Home price-income ratio

The following Figure 14 visualises the development of the home price-income ratio over the years 1991-2015. As aforementioned, home price-income ratio is the chosen determinant of affordability in this research. The home price-income ratio is calculated by dividing the value of the home price index by the value of per capita income. We have data points from all states in all years 1991-2015 for, among others, home price index and per capita income Since we have strongly balanced data, we can calculate a value of home price-income ratio for every state and every year. This means that we have a total of 1250 observations of home price-income ratio.

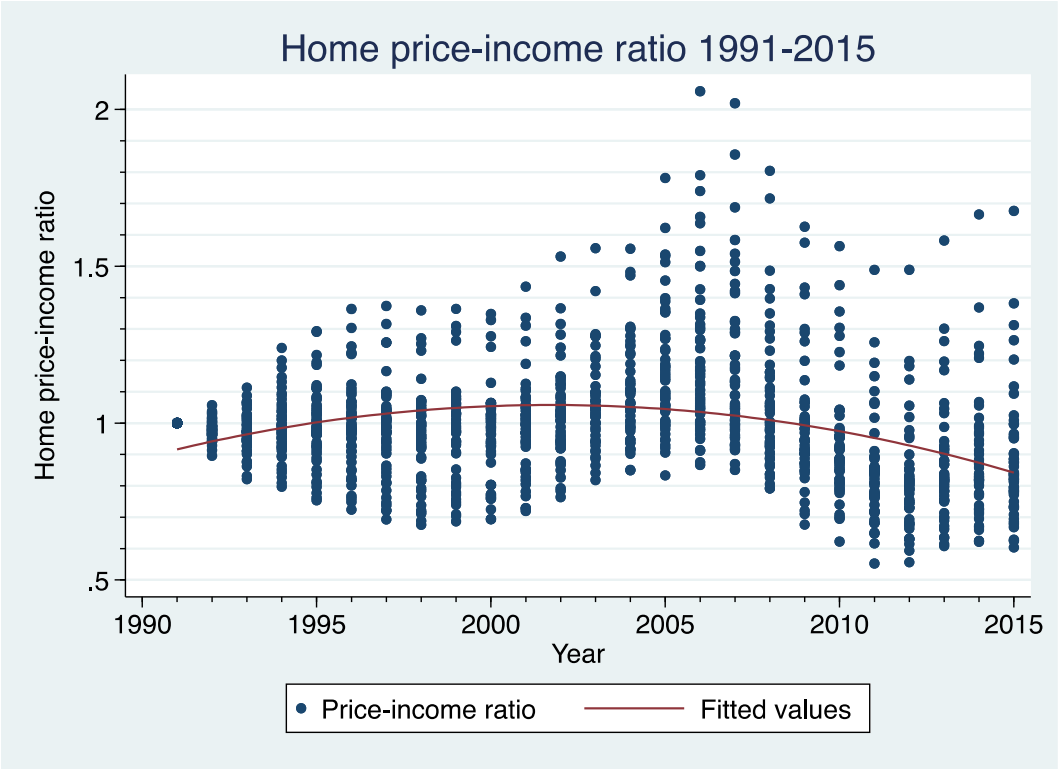

Figure 14. Home price-income ratio.

Figure 14 above gives a visual description about how the home price-income ratio changed in the years 1991-2015. The long-term trend, shown by the fitted quadratic line, is downwards. This means that on average, the home price-income ratio has decreased when comparing 1991 and 2015. However, it does show us that in the 2000's the ratio was higher. The highest single observations for the ratio were in 2006-2007, just prior to the financial crisis. Furthermore, the lowest observations were in the early 2010's in the wake of the bursting of the housing bubble. Following that, the ratio began to increase once again with recovering housing prices. This is further displayed in the following Figure 15.

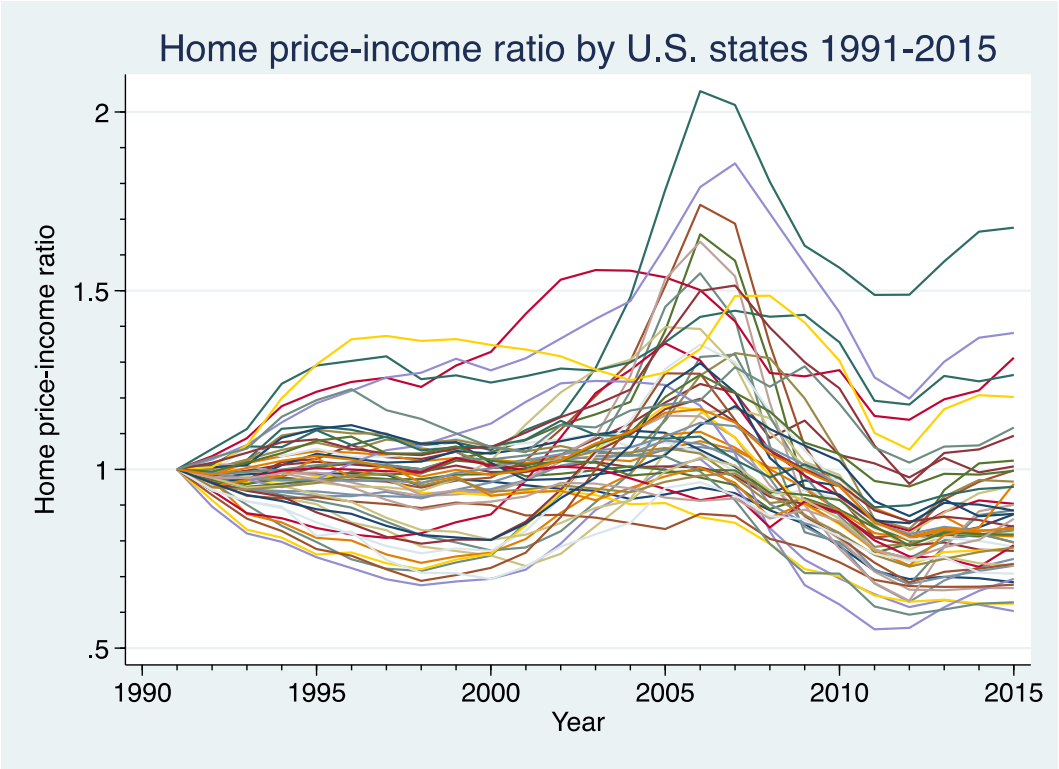

Figure 15. Development of the home price-income ratio.

Figure 15 above shows the development of the home price-income ratio. The lines are overlayed on top of one another and represent the different U.S. states. Naturally, all the lines start at 1 from the year 1991. After an initial decrease, the home price-income ratio rises dramatically in most states in the 2000's. The financial crisis caused this to come down quickly, after which the ratio began to rise again. Interestingly, most of the ratios are below 1 in 2015. This means that compared to 1991, homes were more affordable in most states in 2015. The graph also shows that there is clear variance in the home price-income ratio over time and across states.

In the appendix, under Appendix 3, there is a figure showing the home price-income ratio graph for each state separately. The graph shows that the development of the home price-income ratio was quite different between states. In addition, the graphs show that there was heterogeneity in the development of home price-income ratio before, during and after the 2008 financial crisis. Several states, such as Arizona, Florida, Hawaii, Nevada, and Oregon had high peak in the home price-income ratio in the late 2000's. When considering the percentage increase in population from 1991 to 2015, Arizona, Florida and Nevada were all in the top 10 states. Nevada had the highest relative population increase with an increase of 121,3%. On the other hand, many states in the south and mid-west of the country had slowly decreasing home price-income ratios between 1991-2015 without any peak during the 2000's.

These states include Alabama, Arkansas, Indiana, Iowa, Louisiana, Michigan, Mississippi, Ohio, Oklahoma, Pennsylvania, Texas, and Tennessee. Of these states, Louisiana, Michigan, Ohio, and Pennsylvania ranked in the bottom 10 in terms of population increase between 1991 and 2015. The U.S. Census Bureau, Domestic Net Migration in the United States: 2000 to 2004 (2006) also shows similar observations. In terms of states with the highest net domestic migration, Nevada, Arizona, and Florida were the top 3 highest (Perry, 2006). This includes both absolute and per capita levels. In addition, Louisiana, Michigan, and Ohio were in the top 5 lowest states in terms of absolute levels of net domestic migration (ibid). In fact, they all experienced negative domestic net migration in these years. When comparing migration levels between the 1990's and 2000-2004, the same states are present in the data. Arizona, Florida, and Nevada experienced positive migration in both periods while Louisiana, Michigan, Ohio, and Pennsylvania experienced outmigration in both periods (ibid). In the end, we can see that increases in migration and population coincided with relatively higher levels of home price-income ratio. On the other hand, decreases in net migration and lower levels of population growth corresponded with decreases in the home price-income ratio.

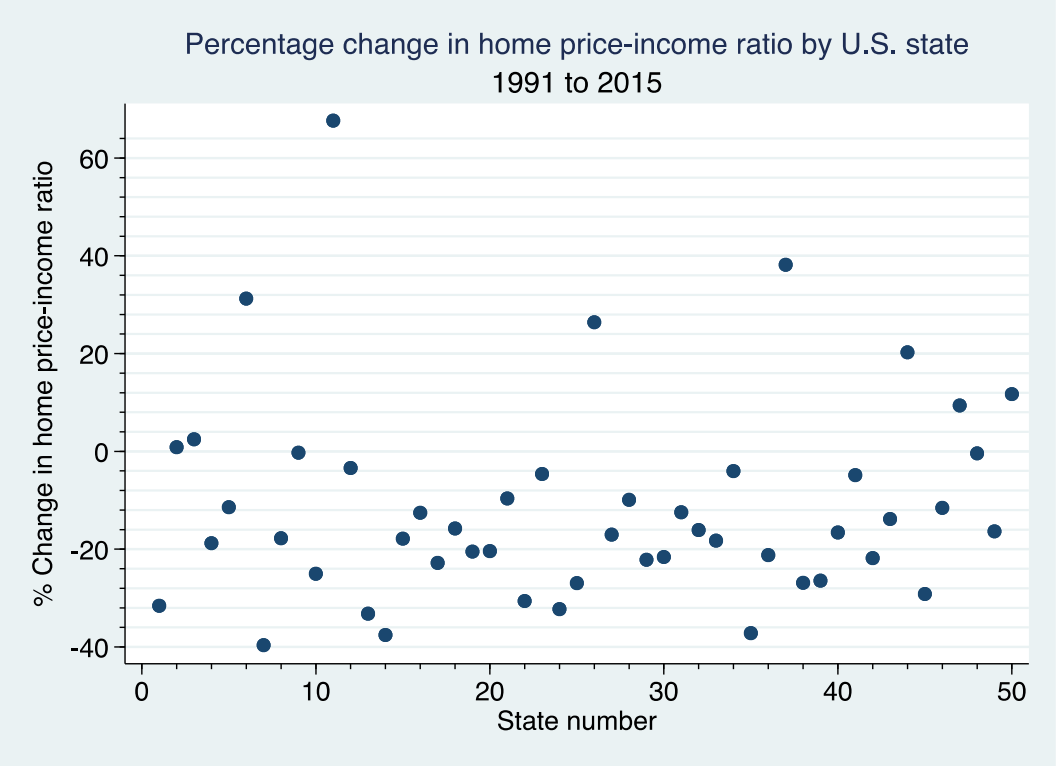

Figure 16. Percentage change in home price-income ratio by U.S. state.

Figure 16 above shows the variation in the change of home price-income ratio by U.S. state between 1991-2015. The states with the three largest positive changes in home price-income ratio during this time were Hawaii (+67,7%), Oregon (+38,2%), and Colorado (+31,3%). For

example, in 2015, the home price-income ratio in Hawaii was 67,7% higher than in 1991. The states with the three largest negative changes were Connecticut (-39,6%), Indiana (-37,6%), and Ohio (-37,2%). As one can see, there is big variation between states in how the home price-income ratio developed between 1991 and 2015. This is yet another example of how there is heterogeneity in the U.S. housing market.

Lastly, Figure 17 below shows the mean home price-income ratio nationwide. This figure allows us to understand the overall trend of the home price-income ratio in the years 1991-2015. Each year has one datapoint, being the mean ratio for all 50 states. Between 1991 and 2000, the ratio slightly decreases from 1 to 0,96. Following that, the mean ratio increases yearly until reaching its peak in 2006 at a level of 1,21. Once again, it is notable that this peak in the lack of affordability immediately preceded the financial crisis in 2008. In this context, affordability is measured by the mean home price-income ratio. This is a snapshot in which we can see, on average, what share of income was needed to purchase a home. The shortcomings of the home price-income ratio as a measure of affordability are explored in the following section. After 2006, the yearly mean ratio decreased to the trough in 2012. In 2012, the mean was at 0,82. Therefore, the ratio had decreased by around 32% in just 6 years. Hence homes were much more affordable in 2012 compared to 2012. In the final years of this research, the mean home price-income ratio increased modestly to around 0,89 in 2015.

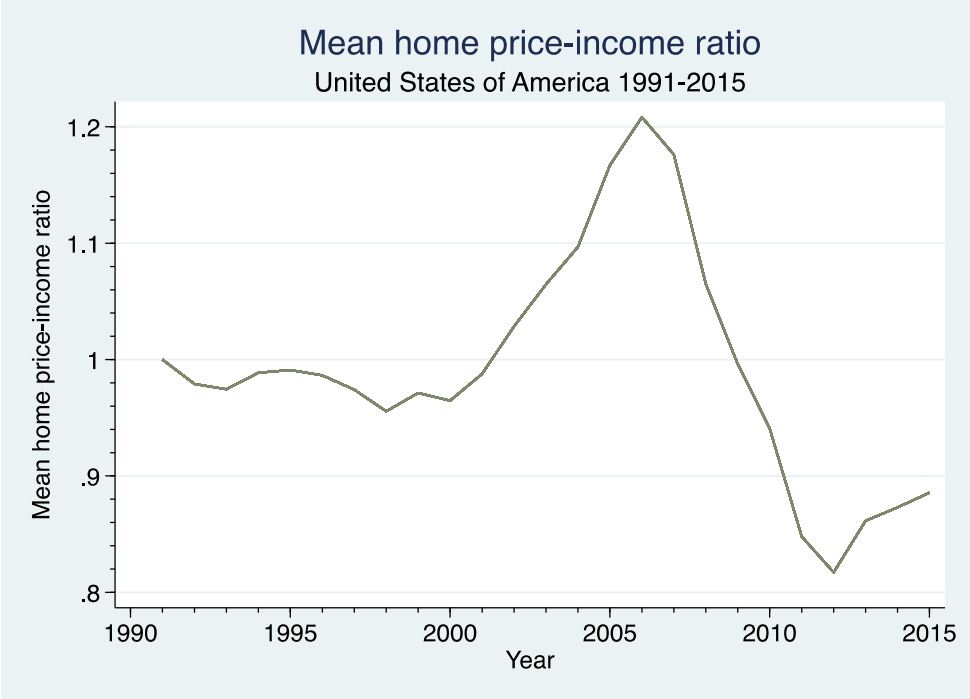

Figure 17. Mean home price-income ratio.

7.4 Discussion of the home price-income ratio

One of the key concepts in this thesis has been household affordability, and more precisely the home price-income ratio. When thinking about the price-income ratio, like other ratios, it is not perfect. The price-income ratio is calculated using the home price index and per capita income data. If the measurement of either of those variables is flawed, so too will be the price-income ratio. An example of a downfall of the ratio is that the ratio can be very local, making it difficult to find precise enough data to study it. In this thesis, the development of house prices between 1991 and 2015 has been studied on a state level. However, it may be the case that a certain metropolitan area in the state largely effects the price-to-income ratio for the whole state. The actual price-to-income ratio may be different in a smaller town or city in the same state. Himmelberg et al. (2005) find to be troublesome to compare price-to-income and price-to-rent ratios between cities.

Damen et al. (2016) further scrutinise the price-to-income ratio as being simple because it does not consider the effect of interest rates. It is a valid criticism, because if the interest rate level is not considered, we will get a distorted view of affordability. This means that housing can be more affordable than it seems. If interest rates are low, the price-to-income ratio may be higher than in a situation with higher interest rates. Nevertheless, the monthly payments on the mortgage can be lower in the former case, making housing more affordable, even though the price-to-income ratio is higher. Further, there may be other exogenous factors affecting the home-price income ratio. For example, there may be less completed housing units in the previous years, reducing the supply of homes away. A reduced supply of homes tends to increase the price, ceteris paribus. Another omitted factor from the ratio is population growth. Ceteris paribus, higher population will increase the price of homes. These are a few examples of the deficiencies of the home price-income ratio as a measure of housing affordability.

As previously discussed, interest rates were not used in this research because they are mandated on a federal level, rather than individually in different states. Damen et al. (2016) conclude that there is a high sensitivity of changes in interest rates on house prices. Case and Shiller (2003) find that lower rates stimulate demand but may also be a symptom of a weak economy.

Himmelberg et al. (2005) also find problems with the price-to-rent and price-to-income ratios. Firstly, the price of the house is not the annual cost of owning (ibid). The annual cost of owning includes factors such as mortgage payments, property tax, repairs, and depreciation.

Secondly, the price does not necessarily mean that housing is overvalued (ibid). Thirdly, there are different appreciation and tax rates between geographic areas (ibid). Higher tax rates drive up the price-to-rent ratio because of tax subsidies related to home ownership. Finally, Himmelberg et al. (2005) find outliers in price-to-rent ratio when real interest rates are historically high or low, narrowing the scope of when the ratio can accurately be used.

7.5 Policy suggestions

The housing market can never be fully controlled in a market-based economy like the United States. The prices of homes are largely determined by supply and demand. Various fundamentals, such as those explored in this thesis, have an impact on the housing market. However, actions of the Federal Reserve can have a big impact on the broad direction of housing markets. Housing markets do not operate in isolation, so they can be affected by policy.

The central bank of any country should try their utmost to maintain a steady price level. This keeps inflation in-check and prevents the economy from overheating. Enacting proactive pro-housing policy can help governments achieve positive housing market outcomes. These outcomes include affordable housing, decreased homelessness, and liquid housing markets. Based on the findings of this thesis, governments can expect population and income growth to create upward on housing prices. Hence, especially in places of high projected population growth, policymakers should ensure a sufficient supply of housing. This can include more residential building permits and relaxing land-use regulations. Extensive research about future demographic changes and migration should be carried out to understand where housing will be demanded in the future. Perceiving the necessary supply can help fight against housing bubbles, as the supply and demand for housing will be more in balance. Finally, avoiding sudden drastic changes in the interest rate can smooth-out demand peaks and bottoms in the housing market. Forecastability of policy is an important factor in the housing market, both for buyers and owners. Housing market counterparts may become cautious if they determine the near-term outlook to be unpredictable.

8 Conclusion

This thesis has consisted of studying housing market fundamentals in the United States of America between 1991–2015 to better understand how they affect both home prices and the home price-income ratio. It has contributed to the existing literature by adding knowledge about how fundamentals in the U.S. housing market contributed towards house prices and affordability on a state-level.

The literature review includes previous research on housing market fundamentals, their impact on the housing market, the nature of housing bubbles and insights into supply-side policies for the housing market. Following the theory section, the U.S. housing market is considered. Features of the U.S. housing market, such as fixed rate mortgages are analysed. Along with this, regulations in the housing market and the role of the Federal Reserve are dissected.

After this, state-level data of home price index, per capita income, population growth, and average unemployment were gathered and analysed using statistical methods and panel regression. The data was indexed to 100 to make comparisons between variables more straightforward. Based on the home price index and per capita income, a home price-income ratio was calculated for each state and for each year. This ratio was used as a measure of affordability. Shortcomings of ratio as a measure of affordability, such as the absence of interest rate consideration, were discussed in the previous section.

Major differences in the data between states confirmed the presence of heterogeneity in the U.S. housing market. Income, population, and average unemployment were associated with differing levels of changes in the home price index. The results supported the hypothesis of the thesis. Prior to the early 2000's, the mean home price-income ratio in the United States was flat or increasing slightly. A bubble in the housing market caused home prices to increase faster than income in most states, subsequently increasing the home price-income ratio. The financial crisis devastated housing prices, dramatically reducing the mean home price-income ratio. Following the financial crisis, both the home price index and home price-income ratio began increasing once again but remained at healthier levels. They did not reach 2007-2008 peaks in the timeframe of this research.

There are multiple improvements that could be contemplated for future studies of this sort. Firstly, the research could study the housing market fundamentals between large metropolitan

areas rather than states. Metropolitan areas may be more similar in nature than states, making for more fruitful analysis and comparison. Secondly, the timespan could be increased. This would be possible with larger data sets, allowing for more thorough analysis of housing market fundamentals and long-term trends. Thirdly, the impact of mortgage rates could be studied. However, this would require detailed data of mortgage rates on a local level. Lastly, causation of a certain policy shift could be explored using econometric methods such as differences-in-differences (DID). For this, one would need to determine treatment and control groups to study the effect of a certain housing market policy or regulation.

In the end, this research was able to broadly understand the key housing market fundamentals, their relationship and how they developed in the chose timeframe 1991-2015. Especially prior to the 2008 financial crisis, income had a very strong correlation with home price index. In addition, population had high correlation with the home price index. This supports the hypothesis that income and population have higher correlations with home prices than average unemployment does.

Finally, the U.S. housing market is immense, and the impact of housing market fundamentals varies between states. Nevertheless, a common pattern in the home price-income ratio was found between most states in 1991-2015. The housing market is a key pillar of daily life for everyone. It does not operate in isolation with the rest of the economy, making it vital to understand the link between economic factors and the housing market.

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Appendices

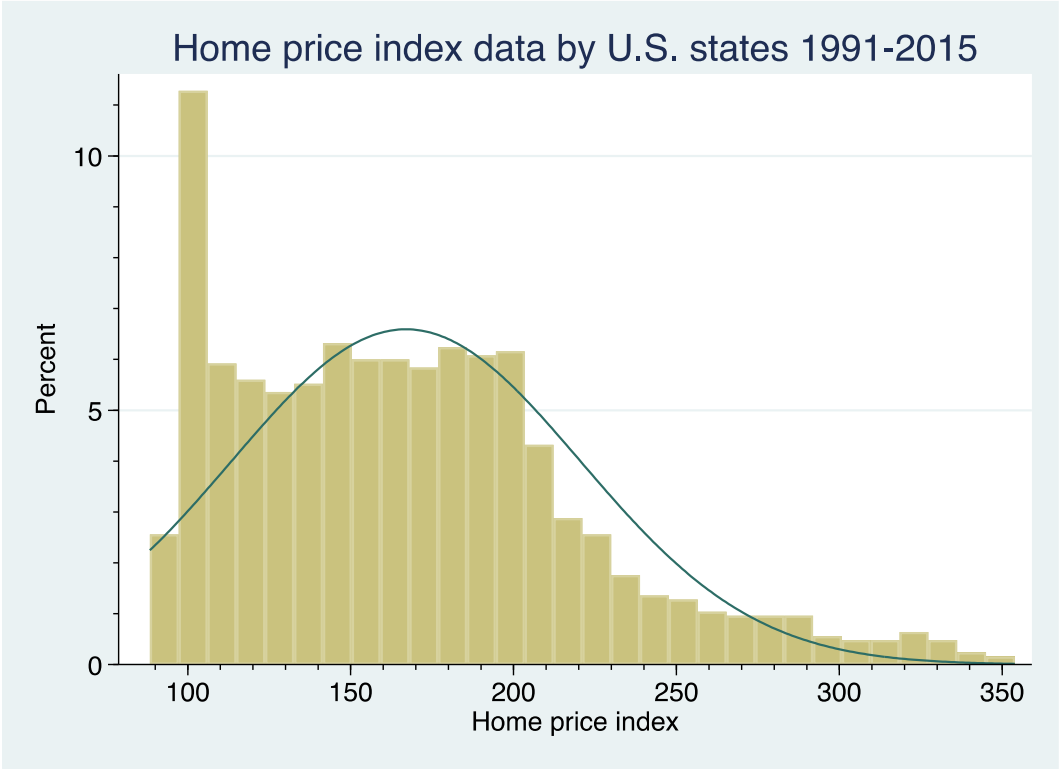
Appendix 1 State abbreviations

	State	Abbreviation
1	Alabama	AL
2	Alaska	AK
3	Arizona	AZ
4	Arkansas	AR
5	California	CA
6	Colorado	CO
7	Connecticut	CT
8	Delaware	DE
9	Florida	FL
10	Georgia	GA
11	Hawaii	HI
12	Idaho	ID
13	Illinois	IL
14	Indiana	IN
15	Iowa	IA
16	Kansas	KS
17	Kentucky	KY
18	Louisiana	LA
19	Maine	ME
20	Maryland	MD
21	Massachusetts	MA
22	Michigan	MI
23	Minnesota	MN
24	Mississippi	MS
25	Missouri	MO
26	Montana	MT
27	Nebraska	NE
28	Nevada	NV
29	New Hampshire	NH
30	New Jersey	NJ
31	New Mexico	NM
32	New York	NY
33	North Carolina	NC
34	North Dakota	ND

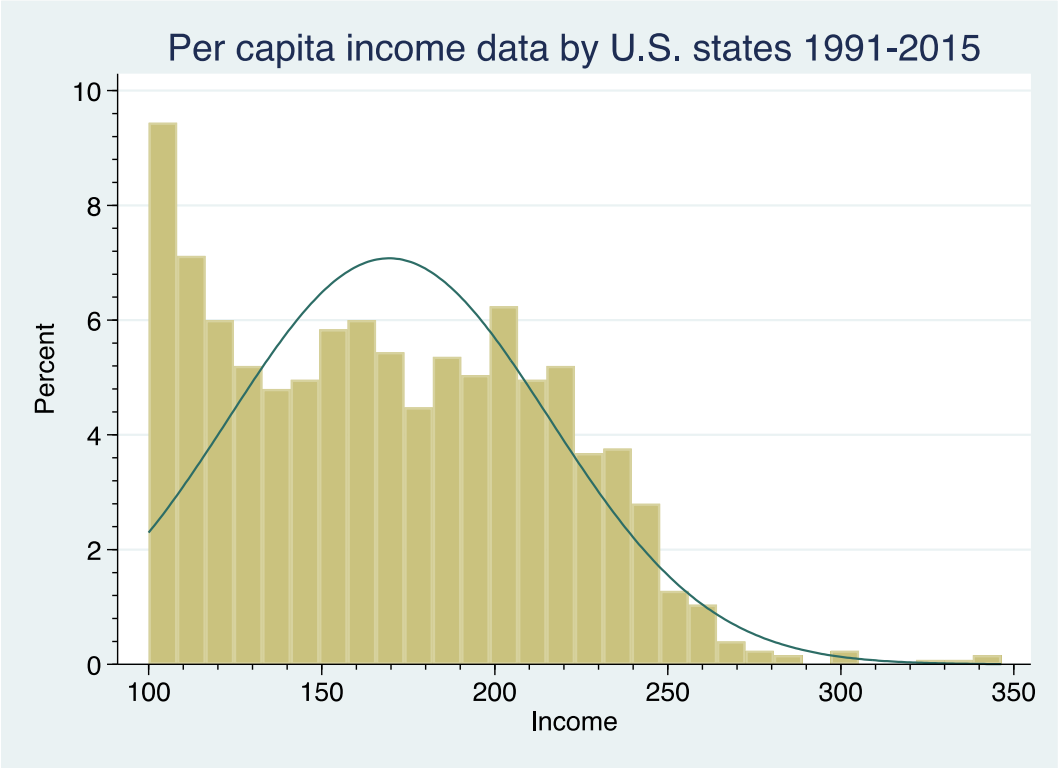
35	Ohio	OH
36	Oklahoma	OK
37	Oregon	OR
38	Pennsylvania	PA
39	Rhode Island	RI
40	South Carolina	SC
41	South Dakota	SD
42	Tennessee	TN
43	Texas	TX
44	Utah	UT
45	Vermont	VT
46	Virginia	VA
47	Washington	WA
48	West Virginia	WV
49	Wisconsin	WI
50	Wyoming	WY

Appendix 2 Detailed summary statistics and histograms

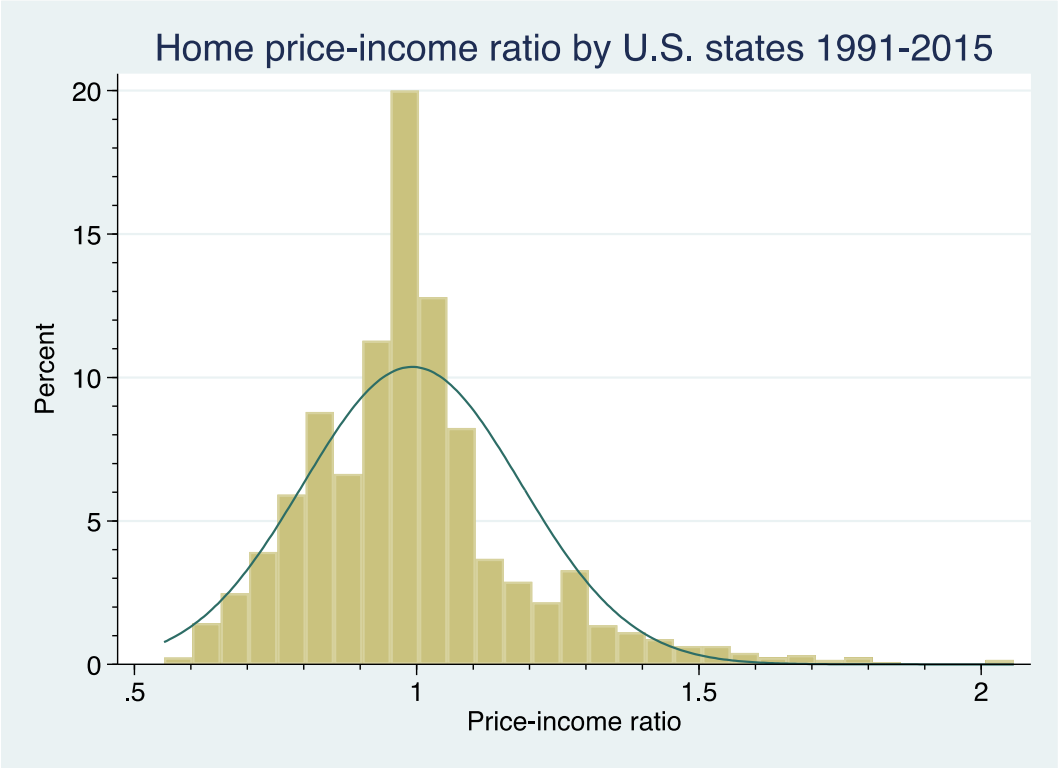
Home price index				
	Percentiles	Smallest		
1 %	91,15	88,38		
5 %	100,00	88,48		
10 %	102,29	89,10	Obs.	1250
25 %	122,37	89,53	Sum of wgt.	1250
50 %	161,17		Mean	166,97
			Std. Dev.	53,56
75 %	197,06	338,84		
90 %	236,60	339,66	Variance	2869,03
95 %	273,94	349,76	Skewness	0,82
99 %	325,20	353,88	Kurtosis	3,45



Income				
	Percentiles	Smallest		
1 %	100,00	100,00		
5 %	104,52	100,00		
10 %	109,04	100,00	Obs.	1250
25 %	128,28	100,00	Sum of wgt.	1250
50 %	166,20		Mean	169,44
			Std. Dev.	46,28
75 %	205,20	323,81		
90 %	231,73	332,22	Variance	2141,73
95 %	243,15	342,73	Skewness	0,33
99 %	269,43	346,32	Kurtosis	2,44

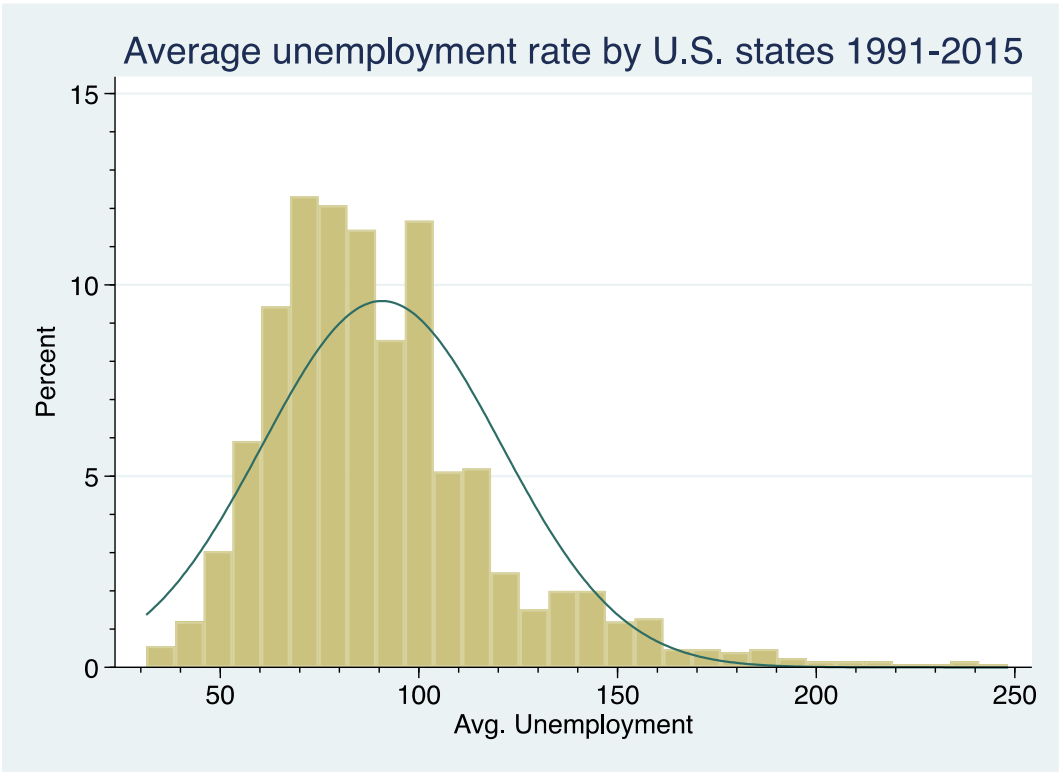


Home price-income ratio				
	Percentiles	Smallest		
1 %	0,62	0,55		
5 %	0,72	0,56		
10 %	0,77	0,59	Obs.	1250
25 %	0,87	0,60	Sum of wgt.	1250
50 %	0,98		Mean	0,99
			Std. Dev.	0,19
75 %	1,06	1,80		
90 %	1,24	1,86	Variance	0,04
95 %	1,35	2,02	Skewness	1,15
99 %	1,64	2,06	Kurtosis	6,02

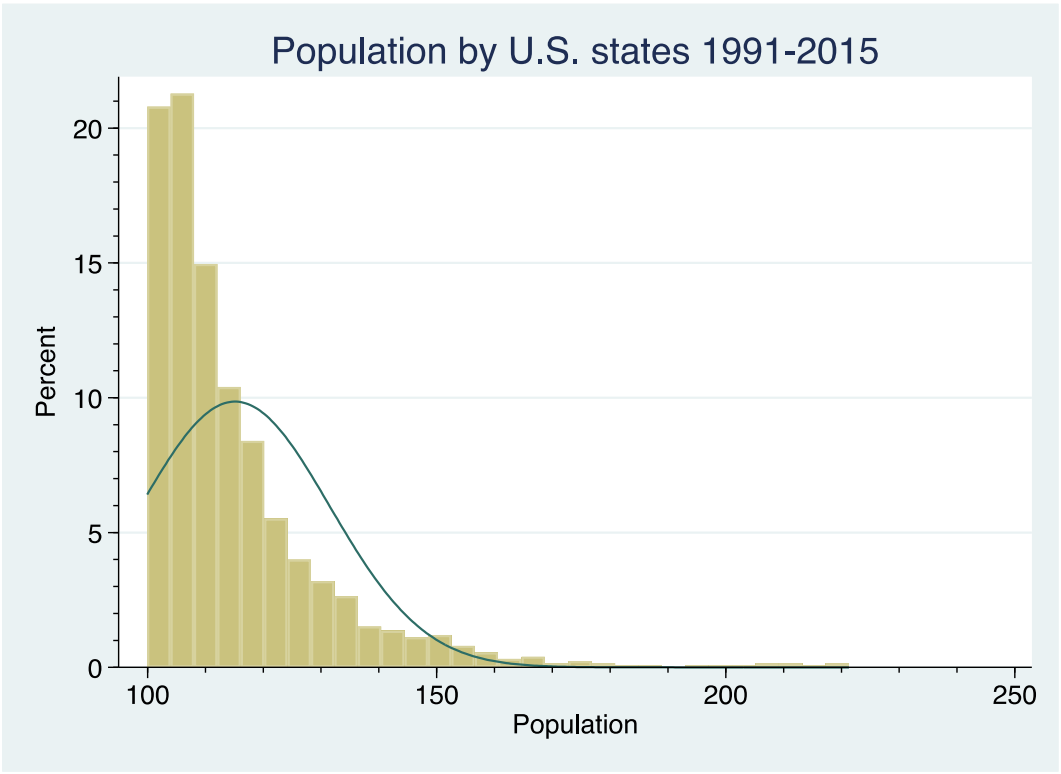


Skewness and kurtosis tests for normality						
				Joint test		
Variable	Obs	Pr(skewness)	Pr(kurtosis)	Adj chi2(2)		Prob>chi2
ratio	1250	0,00	0,00	216,81		0,00

Average unemployment				
	Percentiles	Smallest		
1 %	42,42	31,40		
5 %	53,33	36,92		
10 %	59,30	36,99	Obs.	1250
25 %	70,49	36,99	Sum of wgt.	1250
50 %	85,45		Mean	90,71
			Std. Dev.	30,11
75 %	101,92	232,76		
90 %	128,78	234,48	Variance	906,52
95 %	148,28	237,93	Skewness	1,41
99 %	194,83	248,28	Kurtosis	6,20



Population				
	Percentiles	Smallest		
1 %	100,00	99,93		
5 %	100,44	100,00		
10 %	101,50	100,00	Obs.	1250
25 %	104,85	100,00	Sum of wgt.	1250
50 %	109,98		Mean	115,13
			Std. Dev.	16,37
75 %	119,53	211,75		
90 %	134,20	214,24	Variance	268,11
95 %	147,36	217,48	Skewness	2,56
99 %	180,35	221,31	Kurtosis	12,39



Appendix 3 Home price-income ratio by state