STOCKHOLM SCHOOL OF ECONOMICS
Department of Economics
5350 Master's thesis in economics
Academic year 2021–2022

# Quantitative Easing and Asset Price Bubbles

Andrew Buckner (41911)

**Abstract.** This paper examines the effect of Quantitative Easing policies from the central banks of the United States and Sweden on the housing prices of their respective countries. Controlling for macroeconomic indicators focuses the analysis on just the effects of the bond purchases directly. Despite the magnitude of the intervention, and the seeming distortions present in both markets, a Local Linear Projection model suggests there is a very small effect. The lack of strong evidence for a substantial effect indicates the apparent distortion is driven by a factor besides Quantitative Easing programs.

Keywords: Federal Reserve, Housing Prices, Quantitative Easing, Riksbanken

JEL: E58, R310

Supervisor: Sampreet Goraya
Date Submitted: 5 May 2022
Date Examined: 16 May 2022
Discussant: Victoria Gruner
Examiner: Kelly Ragan

# Contents

# 1 Introduction

The 2008 Financial Crisis was the largest financial shock to the world in almost 80 years, since the Great Depression. The magnitude of the shock was so great that conventional monetary tools were deemed inadequate and policy from Japan was used by many of the other nations of the world for the first time. Quantitative Easing (QE), also called Unconventional Monetary Policy (UMP), was utilized by many countries on an unprecedented scale. Now, over 10 years later, it is time to assess the side effects of this policy.

In the wake of the Dot-Com bubble bursting and the shock of 9/11, a housing bubble formed in the United States primarily, but to a lesser extent in other countries. Financial instruments like Mortgage-Backed Securities (MBS) were used to supercharge the housing sales increases; but also spread the risk from the housing market to the financial sector. Lending standards dropped, with a focus on Sub-Prime loans that were guaranteed to fail if housing prices ever plateaued. Around late 2006 this happened, with some loan providers going bankrupt in early 2007.

By mid-2007, the losses spread into the financial sector, especially into investment banks. This was not limited to the United States, as many foreign banks had also bought heavily into MBS and related products. By late 2007, the value of the MBSs collapsed, driving some investment banks to bankruptcy, others into being acquired, and a massive liquidity crisis set in. Many people's homes were for-closed on, banks stopped lending, and the world economy threatened to grind to a halt. Also, oil had just hit a record high of about 140$ per barrel which only added to all the other problems. Oil price spikes are known to either cause or exacerbate existing downturns.

The U.S. Federal Reserve (The Fed) and other central banks responded at first with conventional monetary policy, dropping interest rates to near zero, and ensuring banks were adequately capitalized to prevent bank runs. There was no mass panic and withdrawals, and no consumers lost their savings in retail accounts. This was a success compared with 1929, but the 0 percent interest rates did not stop the increasing unemployment and general liquidity freeze. Something more was needed.

Enter Quantitative Easing to the world financial system. QE is when a central bank adds more cash to the economy by buying massive quantities of securities from financial markets. This policy was first implemented in 2001 by the Bank of Japan. They had maintained a 0 percent interest rate for years; but were still under threat of deflation. Being in a similar situation now, other central banks look to this example for a potential solution. Central banks bought MBS, Treasury Bonds, and even some corporate bonds in an effort to inject more cash into economies that failed to show robust growth.

At the time of writing, Covid-19 is raging across the world. Starting in the beginning of 2020, the whole world was thrown into turmoil, and we are still feeling the direct effects, let alone the aftershocks. As such, this analysis will stop at the end of 2019, as I cannot know for certain how to adjust for something ongoing. QE has restarted during the pandemic, and the trends in asset prices have been supercharged, so this analysis will still be relevant to what becomes the new normal on the far side.

From our Vantage point in 2019, asset prices are at seeming historical highs. Housing affordability is on everyone's minds, with prices going up every year, much faster than incomes. Stock prices hit new highs constantly, with the Cyclically Adjusted Price to Earnings(CAPE) Ratio for the S&P500 approaching 30. I now ask, is this a result of QE

programs? It's a very easy story to tell, but is it accurate? That question is what this thesis seeks to answer.

This paper will examine whether or not QE programs in the US and Sweden have significantly increased housing prices, independent of all other factors. The hypothesis to be tested is that QE significantly increases housing costs, all other things equal. If this is found to be true, it means that policymakers will need to account for this unexpected cost when deciding how to implement QE programs in the future. If not, it means further examination into other determinants of housing prices is warranted.

The research method will have two parts. The first is to demonstrate that housing prices are elevated relative to fundamentals as defined in this paper. It is important to note that this is done from the perspective of the owner-resident, someone who owns one dwelling and lives in it. The second part will be a Vector Auto Regression analysis to determine if QE is increasing prices while controlling for other economic factors.

This paper finds that home prices appear elevated relative to the fundamentals examined. However, a Local Linear Projection fails to find that QE significantly impacts those elevated housing prices. The effect is both small, and barely significant, suggesting that QE in isolation does not have a large impact. That isolation is important to keep in mind, as QE is so far utilized when interest rates are approximately zero, which also could have a significant effect.

Immediately following is a survey of the related literature, outlining some of the challenges that have previously been identified. Then the methodology of this analysis is laid out. A brief overview of the data leads the results. Last, these results are discussed with implications for the research hypothesis and further research.

# 2 Literature Review

## 2.1 A Brief History of Quantitative Easing

Quantitative Easing (QE) is a very new monetary policy tool. It was first implemented in Japan in 2001. After the 1991 asset bubble burst there, the economy never recovered. Interest rates were at 0.5% in 1995, and prices were still not rising. Then the 1997 Asian Financial Crisis forced interest rates down to approximately zero; and caused a credit crunch. Inflation went negative, and the world economy slowed in the wake of the Dot-com bust, so something more was needed.

QE in Japan was designed to treat two problems: A liquidity crisis in the banking sector, and deflation. The central bank vowed to keep interest rates at zero until deflation was no longer a problem; and to use government bond purchases to inject liquidity into the financial system as needed. Over the next three years, the central bank bought enough bonds to equal about 10% of GDP. As the economy recovered, they began selling these off, until the world economy began to slow again in 2007. During this period, Ueda, 2012 find evidence they lowered interest rates some, and eased the liquidity crisis, but were not enough to stop prices from falling further. This seems to be an issue of scale, and more would have been needed to counteract the very strong deflationary pressure.

Japan's response to the Great Recession was initially very weak; but ramped up after the 2012 election of Prime Minister Abe. The central bank began buying bonds and

exchange-traded funds, to the scale of about 20% of GDP per year. Despite this huge influx, prices have not begun to rise, and deflation is still a serious threat. Michaelis and Watzka, 2017 find that this QE program had no significant effect on GDP, and despite an effect on prices, did not shift inflation away from Zero. In contrast, Matousek et al., 2019 find that Japan's QE program was successful in increasing lending, then inflation and GDP growth, primarily in banks that had higher amounts of non-performing loans. Differences in this research are very common in this field, highlighting the challenges of correctly analyzing these components.

The Great Recession put the United States in the same boat as Japan was almost a decade earlier. Liquidity was completely frozen, and deflation was a threat even after interest rates were dropped to near zero. In November 2008, the Federal Reserve then began a program similar to that of Japan, called QE1. Initially, the federal reserve began only buying Mortgage-Backed Securities(MBS), the toxic asset that caused the crisis in the first place. October 2010 saw QE2, the purchase of long-term government bonds. QE3 ran from September 2012 to October 2014, buying both MBS and treasury bonds. Eventually, about 3.5 Trillion dollars; or 22% of GDP was spent on QE programs between 2008 and 2015.

Luck and Zimmermann, 2017 analyze the employment effects of QE, finding that the removal of MBSs from banks increased their lending rates. This in turn led to increased employment in areas those banks operate in. This supports the first purpose for QE, easing a liquidity crisis. MBS were an asset of low or unknown value, so banks could not be sure how much capital they had to lend from. QE turned these potential losses into direct cash, allowing the financial system to move normally again. However, Ivanova, 2018 finds that employment, productivity, and investment growth during the recovery were extremely weak, questioning the benefits of QE to the economy as a whole.

In contrast to the U.S., the Eurozone faced a different variation of the crisis. What began in the baking sector morphed into a sovereign debt crisis, with the governments of Greece, Ireland, Italy, Portugal, and Spain believed unlikely to be able to pay their debts. In 2010, the European Central Bank (ECB) began purchasing government bonds to address the sovereign debt crisis, similar to the Bank of Japan's and Federal Reserve's treatment of the liquidity crises. In 2014, the ECB began buying mass amounts of government and corporate bonds, reaching about 23% of GDP by 2018.

Sweden, while a member of the European Union, is not yet a part of the Eurozone. They have their own central bank and currency still. Sweden was comparatively undamaged by the housing bubble burst, and toxic asset contagion. This is likely due to their experience with an asset bubble and accompanying banking crisis in 1991, as explored by Sjögren and Iversen, 2018. The Riksbank only cut interest rates to 0% in 2014, much later than the previous central banks. In response to continued threats of deflation, they began a program of quantitative easing in 2015. This peaked in 2019 with about 7% of GDP in assets.

There is still debate over the effectiveness of QE in increasing inflation over the long term. While it seems to be excellent at fixing the liquidity crisis aspects of recession, the evidence for its use in general economic stimulation once that phase has passed is mixed. Karadi and Nakov, 2021 have a very good summary of this dichotomy. This project does not have the scope to cover this topic, but it should be kept in mind when evaluating the side effects of QE programs, whether or not they are worth the distortions they cause, or if another policy would fit the circumstances better.

This latter point is highlighted by Japan. They have been using QE in non-trivial

amounts since 2001. But their deflation is either so powerful that it overwhelmed QE's inflationary effects, or the policy is not having the desired effects. If other nations end up in a similar position to Japan, using QE has been floated as a potential treatment. Given this proposition, and the use of the policy during the Covid-19 pandemic, full knowledge of the risks associated with the policy will remain salient into the foreseeable future.

## 2.2 Bonds and Stocks

While Quantitative Easing varies in each implementation, the important aspects are common across all programs. Central Banks announce that they will buy certain types of assets from the financial market on specific days. These are usually Government Bonds, Corporate Bonds, and Mortgage Securities. While buying government and corporate bonds has very similar functions and effects, MBS are a bit special and will be discussed separately.

When the central bank buys bonds, it has two immediate effects, and one closely following effect. The price of the bond type being bond rises, due to the increased demand now added to the market, and cash is injected into the financial market. The latter effect is important if there is a liquidity crisis. It allows firms and institutions to meet cash demand by selling some of their non-cash assets. The increase in demand causes the following effect, a lowering of the Bond's yield.

The Bond's yield is how much interest the bondholder gets. If you have a 1-year treasury bond with a 1% yield, you make 1% on your money for that year. Normally, the government or firm would have to keep paying the market rate for people to want those bonds. However, with the Central bank adding lots of demand, they can offer less of an interest rate, say 0.75% instead, and still issue the same number of bonds. Thus, the central bank pushes down yields with its actions on the bonds it buys. Dell'Ariccia et al., 2018 find significant reductions in bond yields across the QE programs of Japan, the EU, and the UK in their meta-analysis.

The next stage of interaction is governed by the Portfolio Balancing effect. Hamilton and WU, 2012 show this to be the primary mechanism that spreads this effect from the single type of bond that the central bank buys to the whole market. Investors, single or institutional, usually want some balance of risk versus reward. Since the Central bank has lowered the reward on their target bonds, investors will buy other bonds to get the reward/risk profile they want. This causes those prices to rise, and yields to fall as well, causing the effect of the QE to apply across the whole bond market. In this way, the Central bank lowers all interest rates on bonds with the QE program.

Mortgage Back Securities would behave like other bonds when subjected to QE in normal market conditions. However, in 2009, the MBS market was not normal. With housing prices falling, some of the securities could be worth nothing, so there was massive uncertainty and a liquidity problem in that market. The QE programs that bought MBS were able to fix both of these problems, but most especially the removal of these toxic assets from the market. Di Maggio et al., 2019 find that the purchases of MBS in the US were vastly more effective in stimulating the economy overall than the purchases of government bonds.

Portfolio balancing works not only within the bond market but within the investment market as a whole. When the yields on one type of asset go down, investors move some of their money to other asset types, driving up their prices, and/or driving down their

yields. Koijen et al., 2017 quantify this across the Euro area, showing investors shift their money out of bonds, and into other holdings.

There is ample literature on QE's effect on stock prices. Swanson, 2021 shows the immediate reactions to QE announcements in the short term. Miyakoshi et al., 2017 and Lombardi et al., 2019 show that QE not only affects the markets of the country doing the implementation, but also other countries that are connected. In this case, American QE programs boosted Asian stock markets.

There are two main channels through which QE can affect stock prices, Portfolio Rebalancing and Fundamentals. Portfolio Rebalancing is described above and does not affect the company's profitability. In contrast, the Fundamentals channel requires QE to affect the company's earnings, and boost the price through that mechanism. The challenge to analysis of equities lies in their being a leading indicator. If investors believe the QE program will raise corporate earnings in the future, they will bid up the price now, long before the fundamentals increase to the level that justifies the new price. For this reason, I will not attempt to evaluate whether stocks are overvalued. Their purpose here is to serve as a comparison for the variable of interest, Housing.

## 2.3 Housing

Housing is the asset that everyone interacts with regularly. Most people pay rent or a mortgage, and those who don't probably purchase their housing outright. In addition to touching every person's life, a stable housing market is important for the entire macroeconomy. Cournède et al., 2019 find that large housing price contractions, especially those associated with bursting bubbles, are highly correlated with severe recessions. Their research indicates that falling house prices amplify existing contractions. Therefore, avoiding unnecessary contractions will lessen downturns.

Housing prices are driven by many inter-tangled and complex factors. These include but are not limited to government policy, central bank interest rates, building restrictions, material costs, buyer's incomes, inflation, and more. For QE to affect housing prices, I need to identify what are housing fundamentals in its absence, then identify any deviation it has caused.

Fundamentals for housing are not straightforward. A wide overview is provided by Girouard et al., 2006 in "Recent House Price Developments: The Role of Fundamentals". They examine a number of metrics including affordability ratio, price-to-rent ratio, housing construction restrictions, demographics, Buy-to-let markets, and more. This paper is especially important, as it was written in 2007, just as the housing market had peaked from its bubble.

A key takeaway was that only some of the indicators measured signaled an over-inflation of housing prices. Some of them were unable to detect what is now known to be a bubble that would burst spectacularly. I will separate the drivers of housing price growth into two channels: Fundamentals and Investments. Fundamentals will view housing through the lens of the primary buyer, looking to live in and own a residence. Investments will view housing as an investment to be purchased and rented out.

QE would utilize the Fundamentals channel by improving the macroeconomy. QE would increase economic activity, lower unemployment, and raise incomes. People having additional money would be able to spend more on housing, and drive up prices. Since

the increase in prices reflects real economic activity, this is not a bubble. Controlling for these factors will be important to separate out which parts of housing prices are from each channel. This is reflected in the affordability ratio, the ratio of a house's price to the buyer's income. If the rise in prices reflects additional buying power, the ratio of the two will remain stationary for long periods of time.

Housing can be viewed as an investment just like stock. You pay a large sum upfront to purchase it, then rent it out. The rental payments function the same way as the dividend, giving you a return on your money. The simplest measurement here is the rent-price ratio. This ratio compares housing prices with rental incomes, so if housing prices are driven by an increase in rent prices, the ratio should remain roughly constant. There is evidence that this is an increasing share of home sales, though it's far from conclusive. Redfin's report by Katz and Bokhari, 2022 shows these numbers, which is at least suggestive of a potential driver.

In non-housing bubble recessions, housing prices could be expected to rise as housing is generally viewed as a safe investment in times of uncertainty. However, this crisis being caused by a housing bubble bursting can be expected to remove that concern for this case. As shown in the Data, Housing prices in the US declined from 2007 through 2012. The worst parts of the financial crisis were 2007-10, so housing was not viewed as enough of a safe haven to prevent the price from sliding during that time. As such, we will assume this is not a key driving factor in investment decisions during this period.

QE could affect housing prices as an investment through the Portfolio Rebalancing mentioned above. Just like stock prices, lowering the yields from bonds will push some investors into buying housing as an investment. This would raise the price of houses, without affecting incomes. This is the primary channel this paper will test, by analyzing house price increases while controlling for income and macroeconomic variables.

Importantly, there are two sub-channels to the investment idea. Low-interest rates from the Central bank create downward pressure on bond yields, which translate to increased asset prices as mentioned above. QE's direct buying of bonds also depresses yields, creating the same effect. Low-interest rates can occur outside of QE programs, so it is important to differentiate between the two. This analysis will control for interest rates, examining only the direct buying of bonds portion of the QE program.

## 2.4 Challenges to analysis

Of the major banks that implemented QE, there are some issues around data that limit the scope of this analysis. The Eurozone is not always aggregated properly, especially before the creation of the Eurozone. And the UK's leaving the EU causes a massive disruption, making their data hard to interpret. As such, the US and Sweden are the two countries with uniform data that I have access to over the time periods desired. Japan would be nice to add, but Japanese data is much harder to get for a non-Japanese speaker and was outside the scope of this project.

One additional advantage to comparing the US and Sweden is the different structures of their economies. While this adds an additional potential issue, it can be seen as an opportunity. The US is generally classified as a Liberal Market economy, in contrast with Sweden being more of a Coordinated Market economy. If an effect is found in both or neither, a more sweeping conclusion can be drawn. On the other hand, finding an effect in only one could give further insight into the different ways the two economies function.

The big remaining problem to tackle is that of timing or identification. Monetary policy takes place in two parts: Announcement (also called Forward Guidance), and implementation. Some markets react to the announcement of a policy by pricing in the consequences of that policy as soon as it is announced, long before it has been carried out. As long as the central bank has credibility, and people assume it will follow through on its announcements, this will occur. This has been used in many papers, looking at the price of stocks right before and after an announcement. This allows the researcher to make the assumption that the announcement is the only major thing that has changed, and the rest of the macroeconomy has not in the period of a few minutes or hours. Curcuru et al., 2018 use this methodology on bond price changes over a day with the announcements.

Housing will not work with that type of analysis. Buying a house is a long process in both the US and Sweden, so even if someone has a large pile of cash, they cannot push up prices overnight as one can do on the stock or bond market. As such, I will need a method that allows for a longer duration to be enacted. Research like Jordà et al., 2020 had shown that the effects of Monetary policy, both conventional and unconventional persist for a long time, so there is justification for using a longer-term analysis. However, that makes the analysis much more difficult because the entire macroeconomy now influences that price change as well. This identification problem will be addressed when the methodology is laid out in section 4.3.

# 3 Data

All specific data codes and download citations will be in Appendix A

## 3.1 United States

For the United States, most of the data will come from the Federal Reserve. The St. Louis Federal Reserve, also known as FRED, keeps most economic statistics in a publicly accessible location. In March 2020, a working paper was released from FRED by McCracken, 2022. They compile about 200 series of data with a quarterly release schedule into a single CSV for easy acquisition for research.

From this, I have taken the series for GDP, Unemployment rate, Inflation Index, Federal Funds Rate, and 30-Year Mortgage rate. The series for Median income, Housing prices, and Federal Reserve balance sheets are downloaded separately from FRED. Each series will be outlined below.

### Federal Reserve Balance Sheet

Data on the federal reserve's balance sheet gives us the quantity of QE by differencing any two points. I will use the series for "Assets: Total Assets: Total Assets (Less Eliminations from Consolidation): Wednesday Level." It contains all Government bonds, Housing securities, and Corporate bonds. The series shows weekly totals, so I will convert it to a quarterly series by taking the first observation from each quarter, then dropping the rest. Then, it will be differenced to determine the quarterly change. This will give the total QE amount per quarter, both positive and negative.

### GDP

GDP will come from FRED, using the Real Gross Domestic Product Series. It's already at the chained CPI 2012 level, so I only need to difference and calculate the percentage change. This will be a proxy for overall economic growth. The key weakness is the uneven distribution of gains, so this measure will mostly be in as a reference.

### Unemployment Rate

The Unemployment Rate will come from FRED. It will be the percent, seasonally adjusted series. Given its counter-cyclical nature, I expect it to have a negative impact on housing prices if any.

### Consumer prices

For price adjustments, I am using the Personal Consumption Expenditures Excluding Food and Energy (Chain-Type Price Index). This is Core inflation, and adjusts all prices to the 2012 level when used. I will use the raw numbers for adjustments, as well as getting percent change to use in this analysis.

### Federal Funds Rate

The Federal Funds rate is the Federal Funds Effective Rate, which the Federal Reserve charges to financial institutions trading money their reserves in the Fed. Under conventional monetary policy, this rate is used to grow or slow lending, and alter the economy to ensure price stability. This rate comes as a percentage, so no additional transformations will be necessary.

### 30 Year Mortgage Rate

The Mortgage rate is given with the 30-Year Fixed Rate Mortgage Average in the United States. This is the regular mortgage rate charged to homebuyers across the U.S. It should be driven by the interest rate environment, but also the estimated creditworthiness of borrowers. It is a strong driver of housing sales, as the interest on a 30-year mortgage will be a significant amount of the total repayment, and monthly payments. It comes as a percentage, no additional transformations are needed.

### Median Income

For income, I will use Employed full time: Median usual weekly real earnings: Wage and salary workers: 16 years and over. The Data series is from FRED, though not in the QD package. I want median earnings, to remove potential distortions from income disparities. The series is of real income, but in 1982-84 dollars. This will be converted to 2012 dollars, then multiplied by 52 for an approximation of yearly earnings. Since

the primary goal is to check a ratio over time, the level will not matter as long as it is accurate to itself in how it's changed over time.

#### Housing Prices

Housing prices for the US will come from the All-Transactions House Price Index for the United States. It measures single-family home sales, using data from Freddie Mac and Fanny Mae. That index is then given out through the FRED system. This should capture the general state of housing across the country, and not include some of the crazy high-end mansions that would otherwise have disproportional weight.

A key weakness is that apartments in cities are not included. This makes cross-country comparisons harder, as the US has more single-family units than most other nations that used QE. The series will need to be adjusted for inflation to 2012 levels.

In order to make the index more relatable to most American readers, I adjust the index in 2012, the reference year, to 1, then multiply by the median home price found in the US for that time. This is an approximation but gives people an idea of values they are more familiar with.

### 3.2 Sweden

Unless otherwise noted, the justifications for each data series mirror those of the US.

#### Riksbanken Balance Sheet

Parallel to the US, I will use the government bonds balance sheet from the Riksbanken to determine how much Unconventional Monetary Policy is conducted each quarter. This information comes from the Riskbanken website, and I will difference each quarter to get the net change.

#### GDP

Like in the US, GDP can be found on FRED. The series, Real Gross Domestic Product for Sweden (CLVMNACSCAB1GQSE), is already in real terms, so I will difference it and get the percent change to proxy overall economic growth. The data comes from Eurostat.

#### Unemployment

Unemployment also comes from through FRED, from the OECD database. The series is Harmonized Unemployment Rate: Total: All Persons for Sweden (LRHUTTTT-SEQ156S).

### CPI

The Consumer Price index values come from Statistics Sweden. There, I use the Consumer Price Index "(CPI), total 1980=100. Month 1980M01 - 2022M03". I use the values for 2012 to adjust any required series to 2012 prices.

### Central Bank Rate

Currently, the primary central bank rate in Sweden is called the Repo Rate. It is the rate at which banks can borrow money from the Central bank for seven days. This rate is used to set all other rates used by the bank, much like the US Fed's Federal Funds Effective Rate. The Repo rate is a proxy for interest rates in general because they are all based on this metric. This is the rate that hit the Zero lower bound, causing Unconventional Monetary Policy to be used.

### Income

In a minor departure from the US data, I was not able to get a quarterly median income metric like the US. Instead, I use the net real disposable income measure from Statistics Sweden. Specifically, the S14 set, with the B6 series. This opens up the possibility that inequality in income could bias the results. However, this is a much smaller problem than in the US, where median incomes were flat for almost 40 years. Sweden has a much flatter distribution, so I will assume that is not a driving factor.

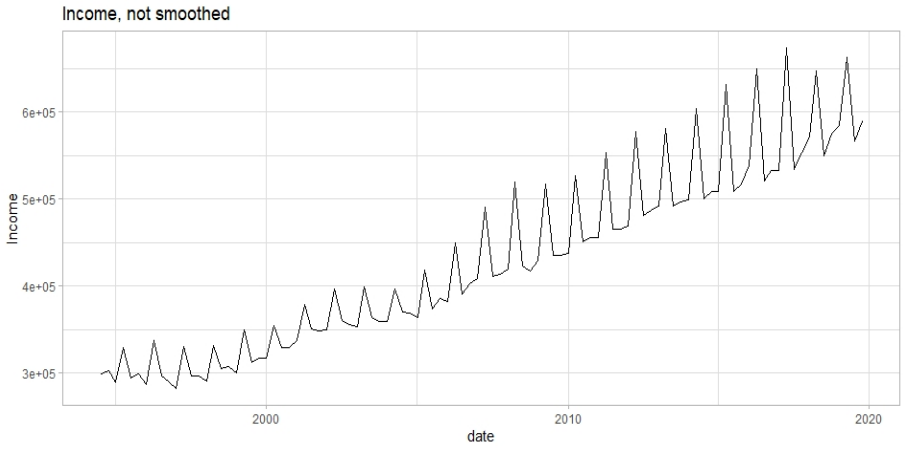


Figure 1: Sweden Non seasonally adjusted Income

There is another issue though. Some type of seasonal transaction is spiking incomes in the second quarter. This causes the later use of the Price/Income Ratio of housing to be quite erratic. In figure 1 one can see how this looks. For the LLP analysis, I will still use this series, as it is capturing a real effect and I cannot correct for it at this time. For the Affordability Ratio graph, I will omit Quarter 2. This will smooth the graph, while still conveying the overall information desired.

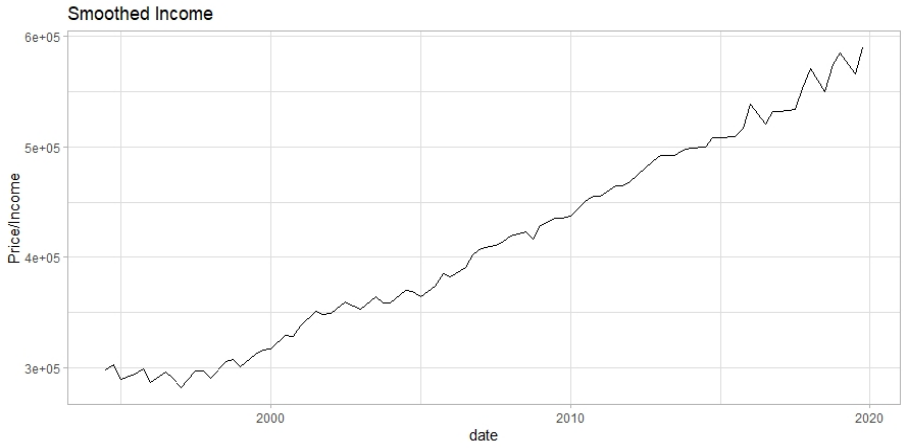


Figure 2: Sweden Smoothed Income

In figure 2, I have omitted the observations from quarter 2. This shows the incomes without the distortionary transfer that was causing the spikes. This is only done for graphical inspection purposes. The analysis will use the full series. It can now be seen that Swedish income generally climbs over time, in contrast to the American incomes that are constant for much of their series.

### Housing Prices

For Sweden, I use the Real Residential Property Price Index from the Bank of International Settlements. This index is at 100 in 2010, and 2012 which is my reference year. To make it more relatable, I multiply it by the average house price in Sweden and divide by 100, to get an approximation of the price that house would sell for.

# 4 Methodology

First I will demonstrate that housing prices are overvalued from a primary residence homeowner's perspective. Then a Chow test will be conducted to see if there is a structural break in housing prices. Finally, a Local Linear Projection will be created to analyze the impact of Quantitative Easing on housing prices.

This study will display internal validity if the analysis captures all the primary drivers of housing price increases that can be affected by Quantitative Easing. As laid out in the following section, I will lay out each component to be analyzed, and justify what they will capture. I believe that I have accounted for all the primary drivers present in each country, so the study should hold in these two locations, for this time period. Anything not included is either justified away or not known to be significant in a theoretical framework.

## 4.1 Overvalue

Unfortunately, housing is much more complex than equities to determine fundamentals. Where stock prices can be reduced to a function of profits, far more variables go into the price of a house. In addition to demand factors, there are factors affecting supply that are not present for stocks.

There is no one easy fundamental that governs housing prices. The income to price ratio, also known as the Affordability Ratio, is the closest housing will have to the PE ratio from stocks. The upside is that with the right choices of income and prices, I can get a good idea if prices are rising faster than incomes in real terms. This will clarify prices for homeowners who are looking to buy a single unit to live in. This is in contrast to the Rent-to-price ratio, which is a much better measure of housing's value as an investment.

For house price, I will use the housing index for the entire US for primary analysis, with comparisons to others in robustness checks. This is to ensure that QE's effect on the whole country is measured, not just regions that may have other factors as primary determinants, like the tech boom in San Francisco. For incomes, it will be median real incomes. It is important to use median incomes instead of average, to allow for the changing income distributions currently seen in the US.

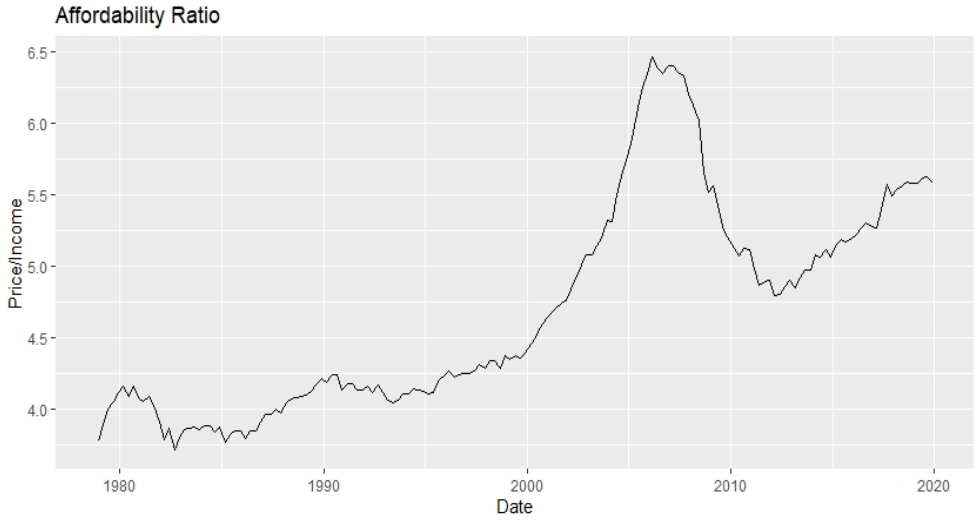


Figure 3: US Affordability Ratio

I can see in figure 3 that the Affordability Ratio stayed fairly constant from 1980 to about 2000. After 2000 it climbs dramatically, peaking at about 6.5 during the now recognized housing bubble. It dropped back to 4.8 as a result of the bubble crashing, then has climbed again since, currently almost at 5.75. This suggests that housing prices are still elevated relative to the fundamental of income, though it's not conclusive. At a minimum, more study is warranted.

The downside of this metric is it does not control at all for supply side factors or financial factors. I will need to control for as many of them as possible. The 30-year mortgage is highly predictive of housing prices, so it will need to be controlled for.

From the supply side, government building restrictions are the single biggest factor.

They generally increase the cost of building housing, driving down supply. All else equal, this would increase prices. Building restrictions are extremely hard to quantify though. For this analysis, I am going to make a key assumption: Government building restrictions did not change significantly during the QE period. If this assumption holds, building restrictions will have a similar effect both before and after QE. This assumption is supported by the findings in Bétin and Ziemann, 2019, who do not find land-use restrictions to have been a significant factor in housing price changes in the 21st century.

During the period QE was implemented, interest rates have also been near zero. Just using QE as a factor omits the possibility that interest rates are the real driver of both, and QE is just correlated. Being able to compare with low-interest rate periods before the implementation of QE will be important for analysis. These rates are known to be related, so I examine this relationship below.

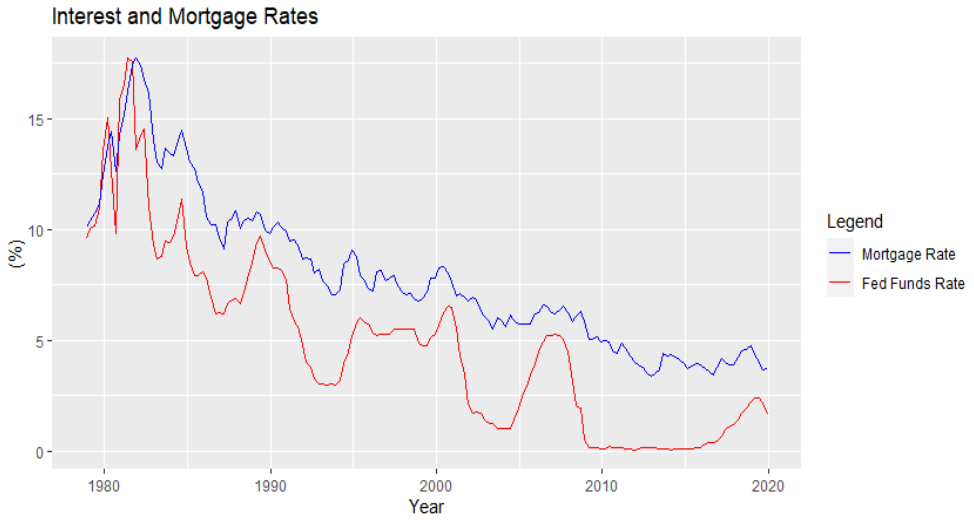


Figure 4: US Mortgage and Fed Fund Rates

One can see from figure 4 that these two move in an extremely coordinated way. Running a correlation test yields a correlation of 0.94 for these two series. Because of this, I will only use Mortgage rates in the primary analysis and Fed Funds rates for additional tests.

## 4.2 Structural Break

Quantitative Easing is something new to the United States. The program was only implemented when the zero lower bound was reached and more needed to be done. If this program affects housing prices, it could cause a detectable change around implementation. To test this, I will put the housing price series through a Chow test for structural breaks.

The Chow test, developed in Chow, 1960, analyzes two sections of a series to determine if they are the same, or different functions. Bai and Perron, 1998 popularize a method of detecting an analyzing series with multiple structural breaks. They then develop a computation method for it in Bai and Perron, 2003 based on the Bellman Principle.

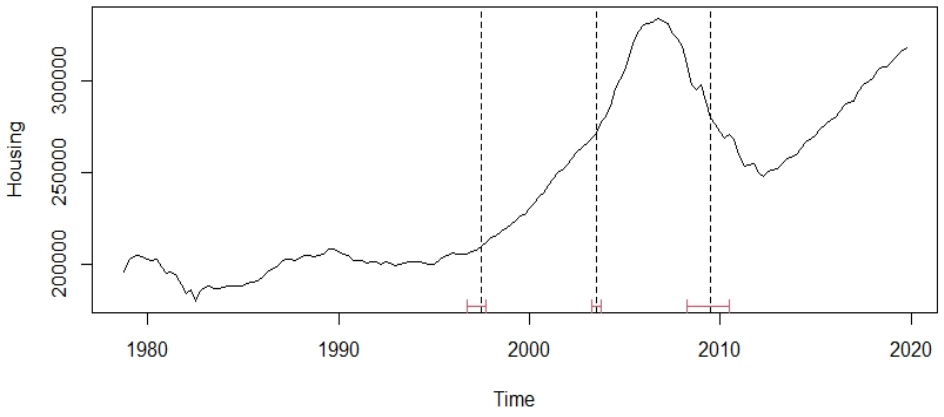


Figure 5: US Housing Structural Breaks

Figure 5 shows that a structural break analysis finds three structural breaks, shown by the lines with confidence intervals. One of them occurs around mid-2009, right around the implementation of QE in the United States. While this could signal the importance of QE to housing prices since 2009, extreme caution must be shown. 2009 was also when interest rates hit 0%, and the Great Recession worsened all around the world. This structural break could reflect many other events. At best this highlights the need for further study, this time to try and isolate the effects of QE away from other macroeconomic conditions.

## 4.3 Local Linear Projection

The type of analysis will require a time series. Housing prices depend on themselves from the past, as well as a variety of interdependent factors like incomes, employment, and lending rates. A regular Ordinary Least Squares would be inadequate for the task. Because of the multiple variables that are hypothesized to impact prices, some type of Vector Auto-Regression will be the best fit.

Vector Auto Regression uses existing data to fit a model, assigning impacts for the variables and controls used. It then creates a projection of what impact a unit of the chosen shock will cause on the other variable(s). For the analysis, I will use the method of Local Linear Projection (LLP) from Jordà, 2005. In particular, I will be mirroring the analysis of Fabiani et al., 2020 for structure.

I use an LLP instead of a VAR due to the belief that LLPs are more robust to misspecifying the lag length than VAR models. However, research by Plagborg-Møller and Wolf, 2021 shows this not to be the case, and both models would produce the same results for this analysis. Some differences remain at extremely long lag lengths, but the cap of 3 for this analysis prevents that from applying here. As for the information criterion, given a choice between the Akaike information criterion (AIC), and Bayesian information criterion (BIC), I am using the BIC for this analysis, due to the higher penalty terms. This increased parsimony will lower the likelihood of a false positive.

I will be estimating the following regression:

$$\Delta_h Y_{t+h} = \beta_{1,h} \Delta QE_t + \Gamma_h X_{t-1} + u_{t,h} \tag{1}$$

for $h = 0, 1, ..., 20$. The dependant variable, $\Delta_h Y_{t+h}$ is the cumulative change in the price of the US housing index from quarter $t-1$ and quarter $t+h$. The coefficient $\beta_{1,h}$ is the effect of 1 unit change in Quantitative Easing, represented by $\Delta QE_t$, for time $t$. $X_{t-1}$ is a time-lagged vector of controls that could also affect housing prices. In this analysis, they are GDP growth, Unemployment, median incomes, and 30-year mortgage rates. Lastly, $u_{t,h}$ is the robust error term.

This method will estimate the cumulative effect of an impulse of QE, controlling for Income, Interest Rates, GDP Growth, and Unemployment. Controlling for Income, GDP Growth, and Unemployment will remove the effect of the Fundamentals Channel. If QE is driving housing prices through the Fundamentals channel, even though the affordability ratio implies this is not the case, it will be accounted for.

Income is used as a control because it is the primary driver of how much demand there is from owner residents. As incomes rise, people who marginally could not afford to buy a house now can. This adds buyers to the market, increasing upward pressure on prices. This variable captures the primary way that QE would affect housing prices if it is stimulating the macroeconomy.

In the aftermath of the Great Recession, unemployment rose significantly in every country. If the economy then improves, one would expect that more people would return to work before wages are increased to entice workers. As long as there is a sufficiently large pool of unemployed, wages should not rise significantly. However, unemployed people cannot generally afford houses, so just the act of more people going to work, with no increases in per-capita wages, could still increase demand for homes. To account for this possibility, Unemployment is used as a control

GDP growth remains to capture the remaining distributional effects. While one would expect increased economic growth to be captured mostly by unemployment drops and median income increases, there is a possibility that only the top wage earners are capturing all the increased growth, and they are then putting that extra money towards housing. To account for this, GDP growth is also added as a control.

Interest Rates are included to capture two effects. The first is using them to capture the effect of Mortgage rates. As shown above, they are extremely highly correlated. The second is to capture the effect of very low-interest rates on the whole financial environment. Low-interest rates cause the portfolio rebalancing effect to apply to different asset types. Luciani, 2013 finds Federal Reserve rates to be influential in housing prices, as a part of their work determining if the low-interest rates after the Dot-com bubble led to the housing bubble that followed.

# 5 Results

## 5.1 US Analysis

An Impulse Response Graph shows the predicted effect of a 1 unit shock on the variable of interest as part of a system, over the time horizon specified. This means the graph will that 1 "unit" of Quantitative Easing has the displayed predicted effect on housing prices, with the effect lasting as long as the horizon is specified. While one could extend the horizon as long as one has computing power, the accuracy of the prediction drops the further out you are predicting, and most shock effects fade over time.

Turning first to the United States, I run a LLP on the effects of Quantitative easing on housing prices with Mortgage Rates, GDP Growth, Unemployment, and Median Incomes as controls. The analysis runs for 15 quarters as the horizon and uses a unitary impact of 100 billion dollars of QE over a quarter. Over the course of the QE program in the US, the Federal reserve spends a bit over 3 trillion dollars on QE over 6 years, so that is 30 of these shocks in total.

I will run it again for four max lags as a robustness check, but it's difficult to find a way in which it could extend longer. When the Federal Reserve buys bonds, that money is put into the financial system immediately. However it flows, there is no theoretical basis to believe it would take longer than a year to affect housing prices, without flowing through the channels outlined earlier and being reflected in the controls.

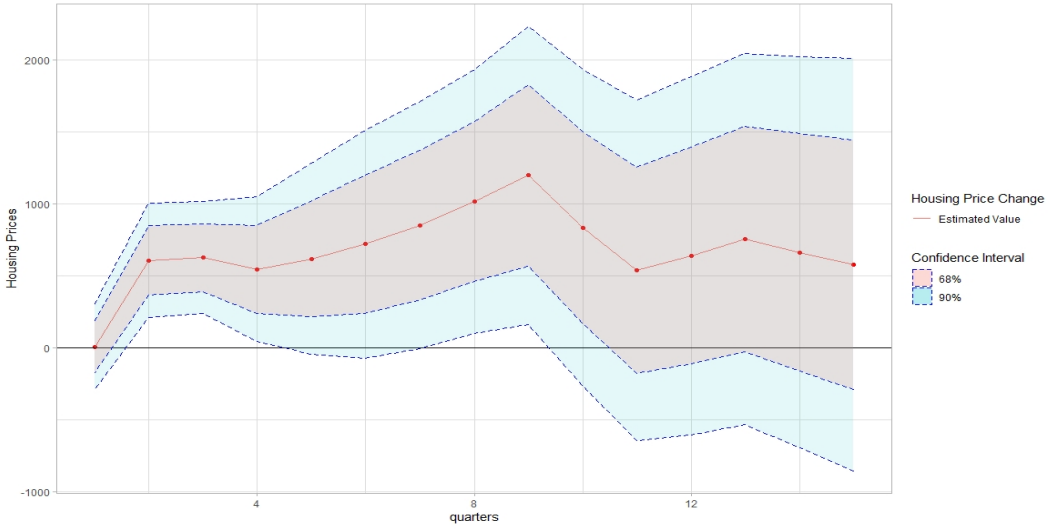


Figure 6: US Housing Price Impulse Response

From figure 6, one can see that with 90% confidence, QE has a positive cumulative impact on the housing price index, which lasts for over 2 years. The effect takes a quarter to manifest but is present for sure in quarters 2,3,4, and 8,9 after the shock, losing significance after that. However, the effect size is very small.

The graph shows the cumulative effect after each quarter, extending outward from the shock. The shock has a positive impact after two quarters, and mostly cumulatively

increases until the 9th quarter. After that, it falls. However, only the estimations whose confidence interval remains outside the 90% confidence interval band can be seen as statistically significant. While the effect in quarter 6 is still positive, the 90% interval includes zero, so we cannot say with 90% confidence that the result is statistically significant.

From figure 4 earlier, I know the Federal Funds rate and 30-year Mortgage rates are extremely correlated. In figure 6, I am controlling for mortgage rates in the analysis. Next, that will be switched to the Federal Funds rate. It's possible that the zero interest rate has a different effect than just a low rate. I cannot do both at once due to Multicollinearity.

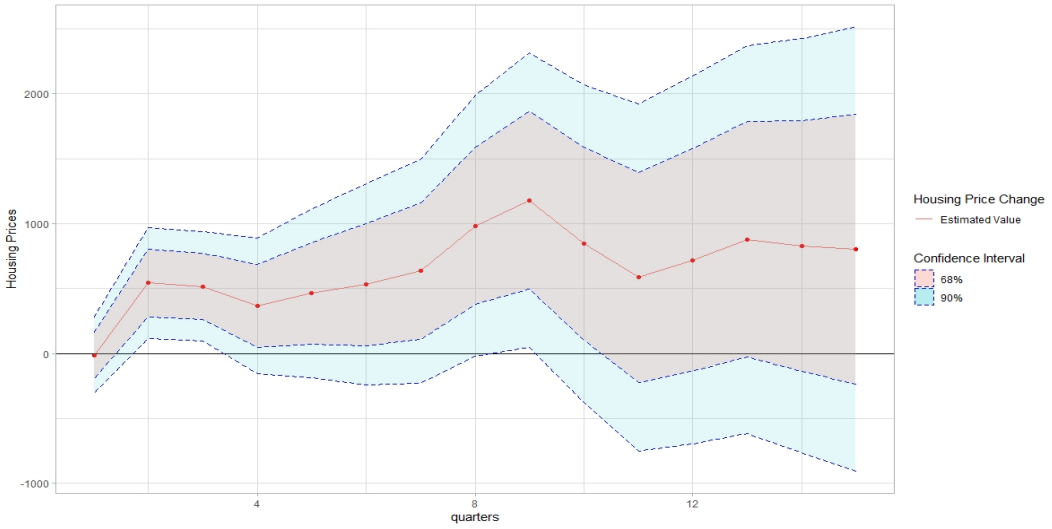


Figure 7: US Housing Price Impulse Response with Federal Funds Rate as Control

One can see that in figure 7, the same overall characteristics are displayed as when I used the 30-year mortgage rates. It is still significant in quarters 2,3 and 9 and has a similar max cumulative effect of just over $1000. I therefore conclude that using the Federal Funds rate instead does not significantly impact the result, and will continue using the mortgage rates at the default control.

There is the possibility that the analysis did not allow for enough lags in the effect of a QE impulse. I will extend this out to four quarters, allowing there to be a full one-year delay in the impact. This could be the case if there are significant delays in the house-buying process. Given the length of the process in the US, it's plausible.

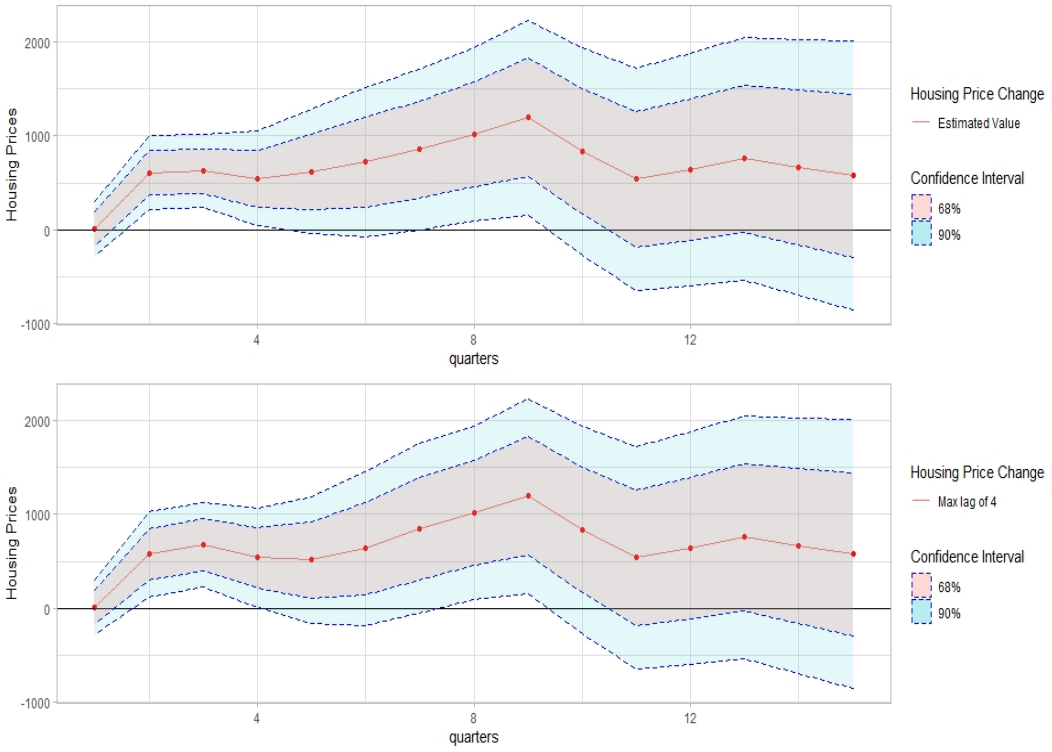


Figure 8: US Housing Price Impulse Response with 3 and 4 max lags

In figure 8, I compare the upper graph with 3 maximum lags to the lower graph with 4 maximum lags. Increasing the maximum lags slightly alters the values, but does not change the conclusions about where it is significant, and what magnitude of effect is seen. I will continue with the original specification as the increase does not change anything meaningful.

## 5.2 Swedish Analysis

Turning now to Sweden, I replicate the same test used on the US overall from both the methodology and results sections, beginning with an examination of the affordability ratio. As covered in the data section on Sweden, I will be smoothing the affordability ratio graph to account for the season income spike in Q2. The non smoothed graph will be viewable in the appendix here (add reference link)

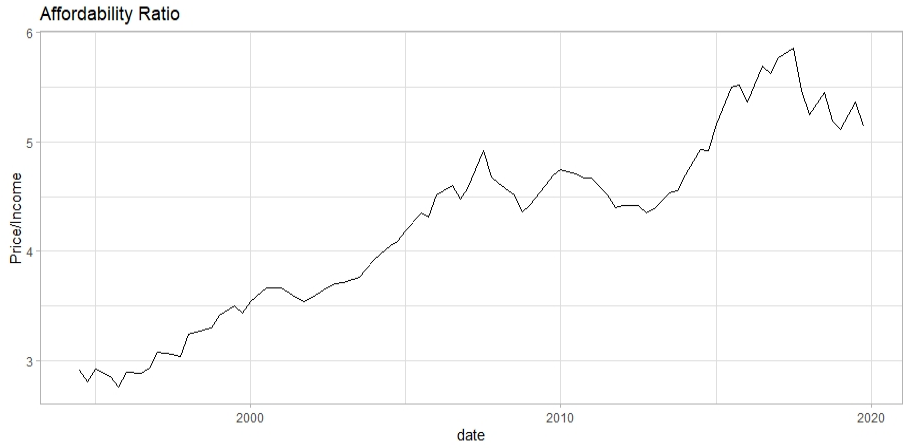


Figure 9: Sweden Smoothed Affordability Ratio

As demonstrated in figure 9, the affordability ratio in Sweden since 1995 has been climbing fairly steadily, peaking during the world housing boom briefly, then climbing again. While still very elevated compared to 2 years ago, it has stopped climbing temporarily. Unfortunately, Corona massively distorts the housing market after this point, so I don't know if this was a temporary dip or the beginning of a long adjustment.

However, I can say that the 5+ value of the affordability ratio, in contrast to the value of 3 twenty years ago, is a serious change. While not proof of a bubble, it merits continued investigation with structural break analysis and the IRF.

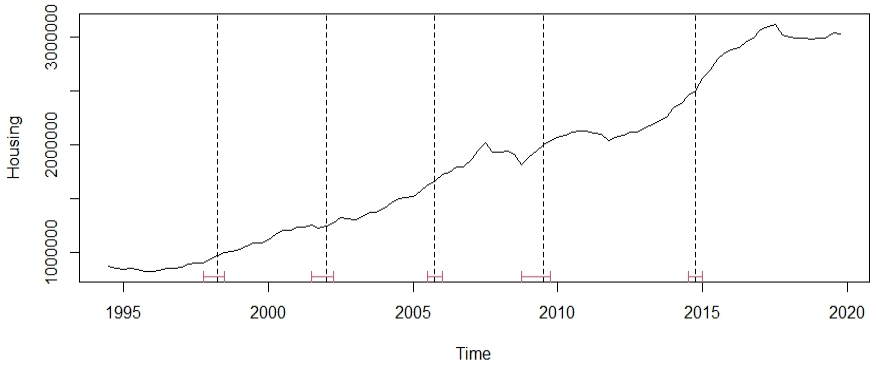


Figure 10: Sweden Housing Structural Breaks

For Sweden, I have five potential structural breaks in figure 10. Of most interest are the last two. One is dated in 2009, during the height of the Great Recession. This supports the supposition from the US breaks that the break around the same time could be the recession and not the implementation of UMP. The second, in the second half of 2014, lines up with the beginning of Sweden's implementation of UMP. This is suggestive that the bond-buying activity impacts housing prices, but requires rigorous examination.

For the Swedish IRF, I will use a maximum of three lags, and the central bank interest rate. The Impulse will be 10 billion SEK, of which the central bank has spent about 360 billion of by the end of 2019.

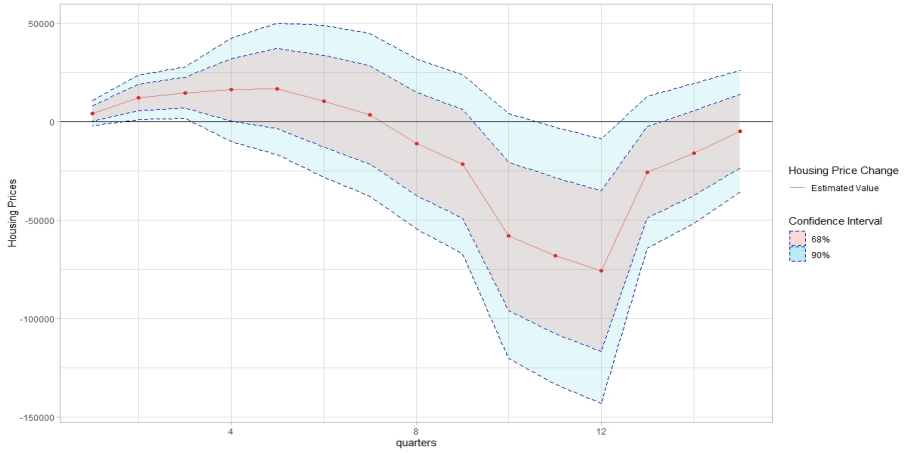


Figure 11: Sweden Housing Impulse Response

I show in figure 11 that there is an initial positive impact in quarters 2 and 3, a long period of uncertainty, and a negative impact in quarters 11 and 12. The negative cumulative impact during the later quarters is a difference from the US data, but caution should be exercised here. The results are not highly significant, and the effect fades quickly afterward.

Similar to the US results, I see a positive impact about half a year after the QE buy, which fades by half a year after that. The following is a comparative table of the effect magnitude.

## 5.3 Comparative results

| | USA | Sweden |
|---|---|---|
| Max positive IRF value | 1198.86 | 14693 |
| House Price | 248287.9 | 2120037.3 |
| Percent change | 0.4829% | 0.6931% |
| Positive Duration fades after | 9 quarters | 3 quarters |

The maximum IRF is taken from the analyses in figures 6 and 11. It is the highest IRF value that is significant at the 90% level. The housing price is the lowest price that is measured during the period of the Unconventional Monetary Policy in each country. This is to show the maximum possible effect, under all the assumptions leading into the analysis. Therefore, I can estimate that the maximum percentage effect on housing prices of 100 billion US, and 10 billion SEK are 0.48 and 0.69 percent respectively.

In the case of the US, the effect lingers for 9 quarters. This means that the cumulative effect of many QE shocks could overlap, but the effect size is quite small. Even if 20 of these shocks overlapped at once, that's still only about a 10% total increase in the price

of a house. This sounds like a lot, but that's over half the entire QE program's budget, and the effect would be gone after 10 quarters, or 2.5 years

For Sweden, the percentage increase is a bit larger, but the effect fades much more rapidly, after one year. Even more than in the US, it seems that the positive effects of QE fade very quickly. Different from the US is the negative impact about 2 years after the shock. While this also fades over the horizon I examine, it further undermines the likelihood of QE being a major driver of increased housing prices in Sweden.

# 6 Discussion

Returning now to the research question, I have an answer to the question: Is there a bubble in assets and is it caused by QE? I can now say that compared with recent history, housing prices seem elevated, but I have not found convincing evidence this elevation is caused by QE.

I did not find any significant effect at the 5% level. This effect is only significant at the 10% level. Because of this low degree of confidence, the most that can be said is that these results suggest there is a very small positive impact on housing prices, accounting for controls.

Comparing the two countries, I see an initially very similar effect for the first year, with a diverging path after. Two years after the shock, the effect persists as positive in the U.S., but negative in Sweden. Importantly, the confidence of this latter effect is quite low, so it's very possible that both effects are positive or negative, and the divergence is a noise error. Secondly, the history of QE in Sweden is shorter than in the US, so the model may not be well-calibrated. Were the effect size or precision much higher, this difference could be a source of future study. As is, both the difference and effect size are close to irrelevant.

This very small effect is also very important to keep in mind. While the results suggest it's non-zero, the effect size is small enough to not be a major problem for policymakers. This research fails to indicate that central bankers need to worry about QE causing a bubble in the housing market directly.

The last part of the previous statement is important to unpack. This analysis controlled for inputs like interest rates and broad income growth. While QE may assist economic recovery, I do not find it inflates housing assets beyond its fundamentals. All its significant impacts on housing prices, if any, may flow through the channels discussed earlier.

Given the very low median income growth in the US, it is a fairly uninteresting channel in housing price growth. It has not been a major driver since 1980, given its extremely small increase. In contrast, interest rates are a channel of interest for future research in this area.

This research has moderate external validity. Quantitative Easing has been implemented across many countries in the recent past and continues to occur with Covid-19. It is likely to do so again when there is another financial crisis. In this light, central bankers will want a full understanding of the potential risks they are running versus the benefits. This research should be straightforward to replicate in other nations that have

implemented QE, and the results should apply to all of them. The lack of significant findings however may preclude the need for it to be done.

Returning to the analysis of breakpoints done earlier, I did find several breakpoints that line up with the beginnings of QE programs. As I mentioned at the time though, QE programs are usually initiated around when central banks drop interest rates to zero, and it is inadequate. For comparison, I overlay the breakpoints in housing prices on graphs of the central bank rates for each country in the figures below:

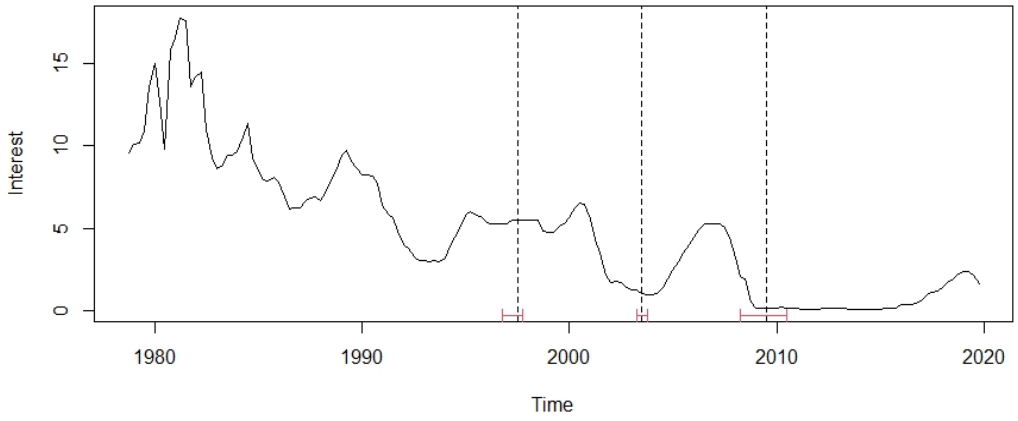


Figure 12: US Housing Price Structural breaks on a graph of the central bank rate

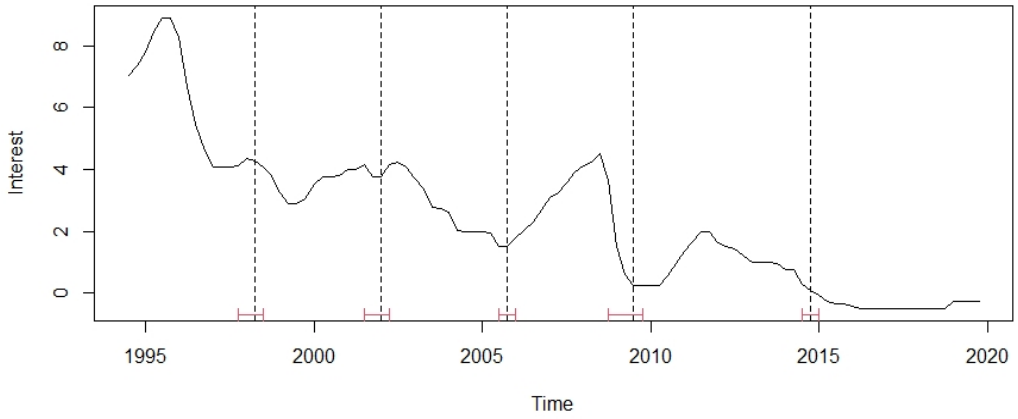


Figure 13: SWE Housing Price Structural breaks on a graph of the central bank rate

From figure 12, we see both the 2004 and 2009 breakpoints occurring at a time of low

and zero interest rates in the United States. In Sweden, figure 13 shows that the 2009 and 2015 breaks happen as interest rates become very low or 0. While not rigorous in any way, these points are a coincidence that bears further examination.

## Conclusion

Both the housing bubble before the Great Recession and the climb in prices afterward took place in an environment of very low-interest rates in the U.S. If housing prices are being driven through this channel, QE will show up as having no effect, because they were controlled for. Further research into the effects of prolonged periods of extremely low-interest rates on housing prices is warranted, given that state seems likely to reoccur again in the United States at least.

This paper left aside all the other effects of QE, only examining one dimension. Past research shows significant effects and spillovers on equities markets and bond markets. Other effects of QE will be essential to understand, given the policies increased usage during Covid-19.

Of specific interest is the mechanisms of money flow from QE in highly unequal societies. The impacts may be very heterogeneous between societies like the US and Sweden. Knowing exactly how money flows from the central bank is key to analyzing the effects of this money. If that money stays in the investment space, it would not drive inflation or income growth, but could still drive GDP or asset price growth.

Overall, there are two primary avenues of further research that this paper leads into. The weak effect significance requires a much more powerful study to produce conclusive results. Having more countries, or a longer time period with QE are potential options. Other models may be better in this case. It would be helpful to reach a more decisive answer.

The other operates on the assumption there is little or no "direct" effect to observe. If this is indeed the case, as this research suggests, then I am still left with the following questions: Is there a structural change in housing fundamentals, creating a new equilibrium of a much higher affordability ratio, or is something else driving a distortion from fundamentals. I do not know how one would study the former, but the latter question should be much more straightforward to study.

As a starting point, Luciani, 2013 finds that the low-interest rate of the early 2000s contributed to, but was not the main driver of the housing bubble. Figures 12 and 13 above indicate there is some interaction at low-interest rates with housing markets. Both Portfolio Rebalancing and the importance of Mortgage rates to borrowing support this theory. Some method would need to be devised to detangle those two effects if we want to know the precise interplay there.

This will continue to be relevant in the future if the industrial and post-industrial economies are entering a prolonged period of low growth and low inflation as has been seen in Japan since about 1990. If this is the case, knowing the potential risks of extremely low-interest rates will be vital to preventing future asset distortions. It's possible that central banks will need to look at different tools for addressing the problem, especially if QE does not deliver the desired results, despite having no significant effect on housing prices.

# References


Bai, J. & Perron, P. (1998). Estimating and testing linear models with multiple structural changes. *Econometrica*, *66*(1), 47. https://doi.org/10.2307/2998540

Bai, J. & Perron, P. (2003). Computation and analysis of multiple structural change models. *Journal of Applied Econometrics*, *18*(1), 1–22. https://doi.org/10.1002/jae.659

Bétin, M. & Ziemann, V. (2019). How responsive are housing markets in the oecd? regional level estimates. *OECD Economics Department Working Papers*. https://doi.org/10.1787/1342258c-en

Chow, G. C. (1960). Tests of equality between sets of coefficients in two linear regressions. *Econometrica*, *28*(3), 591. https://doi.org/10.2307/1910133

Cournède, B., Sakha, S. & Ziemann, V. (2019). Empirical links between housing markets and economic resilience. *OECD Economics Department Working Papers*. https://doi.org/10.1787/aa029083-en

Curcuru, S. E., Kamin, S. B., Li, C. & Rodriguez, M. (2018). International spillovers of monetary policy: Conventional policy vs. quantitative easing. *International Finance Discussion Paper*, *2018*(1234). https://doi.org/10.17016/ifdp.2018.1234

Dell'Ariccia, G., Rabanal, P. & Sandri, D. (2018). Unconventional monetary policies in the euro area, japan, and the united kingdom. *Journal of Economic Perspectives*, *32*(4), 147–172. https://doi.org/10.1257/jep.32.4.147

Di Maggio, M., Kermani, A. & Palmer, C. J. (2019). How quantitative easing works: Evidence on the refinancing channel. *The Review of Economic Studies*, *87*(3), 1498–1528. https://doi.org/10.1093/restud/rdz060

Fabiani, A., Heineken, J. & Falasconi, L. (2020). Monetary policy and corporate debt maturity. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3945615

Girouard, N., Kennedy, M., van den Noord, P. & André, C. (2006). Recent house price developments. *OECD Economics Department Working Papers*. https://doi.org/10.1787/864035447847

Hamilton, J. D. & WU, J. C. (2012). The effectiveness of alternative monetary policy tools in a zero lower bound environment. *Journal of Money, Credit and Banking*, *44*, 3–46. https://doi.org/10.1111/j.1538-4616.2011.00477.x

Ivanova, M. N. (2018). Quantitative easing: A postmortem. *International Journal of Political Economy*, *47*(3-4), 253–280. https://doi.org/10.1080/08911916.2018.1517461

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review*, *95*(1), 161–182. https://doi.org/10.1257/0002828053828518

Jordà, Ò., Singh, S. R. & Taylor, A. M. (2020). The long-run effects of monetary policy. *Federal Reserve Bank of San Francisco, Working Paper Series*, 01–74. https://doi.org/10.24148/wp2020-01

Karadi, P. & Nakov, A. (2021). Effectiveness and addictiveness of quantitative easing. *Journal of Monetary Economics*, *117*, 1096–1117. https://doi.org/10.1016/j.jmoneco.2020.09.002

Katz, L. & Bokhari, S. (2022). Real-estate investors bought a record 18% of the u.s. homes that sold in the third quarter. https://www.redfin.com/news/investor-home-purchases-q3-2021/

Koijen, R. S., Koulischer, F., Nguyen, B. & Yogo, M. (2017). Euro-area quantitative easing and portfolio rebalancing. *American Economic Review*, *107*(5), 621–627. https://doi.org/10.1257/aer.p20171037

Lombardi, D., Siklos, P. L. & St. Amand, S. (2019). Asset price spillovers from unconventional monetary policy: A global empirical perspective. *International Journal of Central Banking*, 43–74. https://www.ijcb.org/journal/ijcb19q2a2.pdf

Luciani, M. (2013). Monetary policy and the housing market: A structural factor analysis. *Journal of Applied Econometrics*, *30*(2), 199–218. https://doi.org/10.1002/jae.2318

Luck, S. & Zimmermann, T. (2017). Employment effects of unconventional monetary policy: Evidence from qe. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3002047

Matousek, R., Papadamou, S., Šević, A. & Tzeremes, N. G. (2019). The effectiveness of quantitative easing: Evidence from japan. *Journal of International Money and Finance*, *99*, 102068. https://doi.org/10.1016/j.jimonfin.2019.102068

McCracken, M. W. (2022). Fred qd. https://research.stlouisfed.org/econ/mccracken/fred-databases/

Michaelis, H. & Watzka, S. (2017). Are there differences in the effectiveness of quantitative easing at the zero-lower-bound in japan over time? *Journal of International Money and Finance*, *70*, 204–233. https://doi.org/10.1016/j.jimonfin.2016.08.008

Miyakoshi, T., Shimada, J. & Li, K.-W. (2017). The dynamic effects of quantitative easing on stock price: Evidence from asian emerging markets, 2001–2016. *International Review of Economics & Finance*, *49*, 548–567. https://doi.org/10.1016/j.iref.2017.03.002

Plagborg-Møller, M. & Wolf, C. K. (2021). Local projections and vars estimate the same impulse responses. *Econometrica*, *89*(2), 955–980. https://doi.org/10.3982/ecta17813

Sjögren, H. & Iversen, M. J. (2018). The state as the investor of last resort: A comparative study of banking crises in denmark and sweden. *Scandinavian Economic History Review*, *67*(2), 171–189. https://doi.org/10.1080/03585522.2018.1557075

Swanson, E. T. (2021). Measuring the effects of federal reserve forward guidance and asset purchases on financial markets. *Journal of Monetary Economics*, *118*, 32–53. https://doi.org/10.1016/j.jmoneco.2020.09.003

Ueda, K. (2012). Japans deflation and the bank of japans experience with nontraditional monetary policy. *Journal of Money, Credit and Banking*, *44*, 175–190. https://doi.org/10.1111/j.1538-4616.2011.00485.x

# Appendix A - Data Source Details and Citations

## US

The Majority of US Data will come from the St. Louis Federal Reserve at https://fred.stlouisfed.org/. One of the researchers there, Michael McCracken has created a quarterly database of macroeconomic data. That spreadsheet is found here: McCracken, 2022 The datasets used from this source are as follows:

| Series Name | Fred Series Code | Fred series name |
|---|---|---|
| GDP | GDPC1 | Real Gross Domestic Product, 3 Decimal (Billions of Chained 2012 Dollars) |
| Unemployment Rate | UNRATE | Civilian Unemployment Rate (Percent) |
| Prices | PCEPILFE | Personal Consumption Expenditures Excluding Food and Energy (Chain-Type Price Index) (Index 2012=100) |
| Fed rate | FEDFUNDS | Effective Federal Funds Rate (Percent) |
| 30 Yr Rate | MORTGAGE30US | 30-Year Conventional Mortgage Rate (Percent) |

**Quantitative Easing**

The Fed's total Asset purchases, or "Assets: Total Assets: Total Assets (Less Eliminations from Consolidation): Wednesday Level" WALCL, comes directly from the FRED, here:

Board of Governors of the Federal Reserve System (US), Assets: Total Assets: Total Assets (Less Eliminations from Consolidation): Wednesday Level [WALCL], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/WALCL, Jan 15, 2022.

**Median income**

Median Income will come from the "Employed full time: Median usual weekly real earnings: Wage and salary workers: 16 years and over" (LES1252881600Q) found here:

U.S. Bureau of Labor Statistics, Employed full time: Median usual weekly real earnings: Wage and salary workers: 16 years and over [LES1252881600Q], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/LES1252881600Q, Jan 15, 2022.

**Housing Prices**

Housing Prices come Through FRED from the US Federal Housing Agency. The All-Transactions House Price Index for the United States (USSTHPI) It can be found at:

U.S. Federal Housing Finance Agency, All-Transactions House Price Index for the United States [USSTHPI], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/USSTHPI, March 22, 2022.

The median home price used for valuation is found here:

U.S. Census Bureau and U.S. Department of Housing and Urban Development, Median Sales Price of Houses Sold for the United States [MSPUS], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/MSPUS, Jan 20, 2022.

## Sweden

### Quantitative Easing

Government Bonds come from the Riskbanken Website. The data can be exported from here: https://www.riksbank.se/en-gb/monetary-policy/monetary-policy-instruments/purchases-of-government-bonds/

### GDP

GDP come from FRED, and can be found at:

Eurostat, Real Gross Domestic Product for Sweden [CLVMNACSCAB1GQSE], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/CLVMNACSCAB1GQSE,Jan16th,2022.

### Unemployment

Unemployment from:

Organization for Economic Co-operation and Development, Harmonized Unemployment Rate: Total: All Persons for Sweden [LRHUTTTTSEQ156S], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/LRHUTTTTSEQ156S,April29,2022

### Consumer Price Index

CPI comes from Statistics Sweden. Using the CPI Fixed Index numbers. Consumer Price Index (CPI), total 1980=100. Month 1980M01 - 2022M03

https://www.statistikdatabasen.scb.se/pxweb/en/ssd/START___PR___PR0101___PR0101A/KPItotM/

### Central bank Rate

The Repo rate comes from the Riksbank database, from: https://www.riksbank.se/en-gb/statistics/search-interest--exchange-rates/repo-rate-deposit-and-lending-rate/

### Incomes

Incomes are the Household disposable income (ESA2010) by transaction item. Quarter 1980K1 - 2021K4, using the B6real Disposable income, net, real values.

https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START___NR___NR0103___NR0103C/HusDispInkENS2010Kv/

**Housing Prices**

Housing Prices are found through FRED, from the Bank for International Settlements, found here:

Bank for International Settlements, Real Residential Property Prices for Sweden [QSER628BIS], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/QSER628BIS, Jan 16, 2022.

The average house price, used to adjust the index to familiar numbers can be found here: https://www.statistikdatabasen.scb.se/pxweb/en/ssd/START___BO___BO0501__BO0501B/FastprisPSRegAr/