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THE REAL ESTATE MARKET AND ITS SENSITIVITY TO MACROECONOMIC FUNDAMENTALS

A UNITED-STATES AND EURO AREA COMPARISON

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Introduction

In every continent and across time, many countries faced financial crisis more or less severe due to a sudden bust in real estate market as it was the case of the Nordic crisis and the Asian financial crisis during 1990s. The so called subprime crisis that happened in the United-States, in 2007, was thus not an exceptional event according Reinhart, Carmen, and Rogoff (2008) paper. While most of studies focused on how the housing market is affecting the global economy and other specific variables, little interest had been given to the opposite relation, so say, about how macroeconomic variables could affect house prices. Therefore, this work will try to understand whether there is a direct link between a change in macroeconomic fundamentals and the house prices evolution. The aim is to add more evidences to what is already known as important drivers of home price index and more precisely at comparing its dynamics between the United-States and Europe.

Moreover, real estate as part of everyone life can probably be considered as the most important market to understand. Notably, as Poterba 1991 claimed, real estate has a complex nature to be a commodity and an investment strategy at the same time. More particularly, Poterba among others found real estate to be the main part of household wealth. Indeed, the United-States are well known to be a speculative nation regarding stocks but Edward Glaeser (2013) also observed a strong speculation happening on the real estate market. Actually, the term “real estate” is very broad and encompasses different categories of immovable assets such as flats, houses, commercial buildings, farms.

Keeping this in mind, this thesis will focus only on one type of real estate: houses. More precisely, the market that implies a transfer of ownership from one household to another due to the distinction needed between the home-ownership market and the rental market. So say, this analysis leaves the rental market and shared houses out of the scope. This choice had been made concerning the fact that in both US and Euro Area (EA hereafter), households are in majority homeowners rather than tenants, an observation made by Adam, Füss (2010) for US and MNS (2011) for EA. In this regard, I will use the terminology of real estate when it will not cause misunderstandings and I’ll use the term of “housing market” to depict the particular segment of real estate investigated in this paper.

The motivation of this work lies within the understanding in house prices’ fluctuations at a dimension on which financial institutions are able to act on housing market thanks to several incentive and transmission mechanisms. As history had proven, booms and bursts in real estate markets usually generate high social costs and a more or less intense recession once busts occurred so that some macroprudential policies may be required to prevent new episodes of great bursts to happen. Also, since agents see real estate also as an investment, it is subjected to speculation, leading to price bubbles whenever the increase in real house price cannot be explained in terms of its fundamentals nor a permanent rise in global households wealth. Such rise should also be controlled in its intensity so as not to burst abruptly as in the US case. In this perspective, the short term interest rate will be assessed under this analysis to understand whether the monetary policy has a real impact on home prices and more particularly if it could be useful in controlling home price index fluctuations without interfering on its transmission mechanism on inflation.

The reasoning at the heart of its analysis is that if housing market can impact the macroeconomic situation of a country as the US faced, it may exist a relation in the other way around. Thanks to the already existing literature on the real estate market in the US and in some EU countries, we know that such evidence can be found empirically (the details is presented in literature review section). However, the intensity and the link vary depending on the geographical and time dimension. In this work, the

analysis will focus on finding evidences at the US and EA continental level. Indeed, the financial crisis of 2008 brought strong evidences of a spread mechanism from a sudden drop in house prices to a worldwide economic recession. If this had happened on one side of the Atlantic, is it possible to occur in our European Union ? This is one of the question this work would like to answer by observing if our real estate market is more or less volatile and sensitive than the US one.

Then, the analysis will focus on comparing the different degrees of responsiveness from US and EA markets to a same macroeconomic fundamental to better understand if US and EA housing markets are inherently different or quite similar. To perform such empirical analysis, the methodology used is based on the Vector Autoregressive model (VAR hereafter), firstly used by Iacoviello (2000) to analyse house prices then by Musso, Neri, Stracca (2011), the latter being one of the most relevant work regarding the research question of this paper as they compared VAR for US and EA. However, I performed differently from previous studies as I implemented stationary and level Vector Autoregressive models per area separately whereas the usual methodology was to use a VAR in level on panel data. The reason for such choice is detailed in the Methodology section.

One novelty of this work is the use of a particular measure of house prices instead of the usual transaction prices. The home price index is based on transaction prices of residential real estates for both newly and existing properties purchased by household and measures the changes in transaction prices (Eurostat definition). I chose the house price index which is a quite recent measure firstly created by Case and Shiller, posted by Standard& Poor for US. After that, institutions as OECD and European Central Bank built their own indexes, all based on Residential Property Price Indices documentation with some technical differences. A discussion on this matter is presented in the Data section. Nevertheless, since it is based on transaction prices, it should contain the same information while maybe being corrected for some seasonal or regional effects. In this way, the analysis performed should be consistent with previous studies findings.

The reader will therefore discover in this work some important linkages between housing market and the macroeconomy that can impact the home price index of a continent in the very short run and its effect to last for several years. Besides, this empirical analysis suggests important differences in the intensity a same shock can have on house prices in the United-States or in the Euro Area such as a stronger interest rate transmission mechanism into asset price in Europe while having no correlation with the level of private consumption and residential investment as it was observed in the US.

Moreover, this paper assessed a possible difference in dynamics between home price index with features some of its important drivers due to the subprime crisis. Such analysis was only performed for US because of technical issues and results in important evidences of a disconnection in housing price's evolution that does not react anymore as it did during 30 years before the crisis occurred. Those are interesting findings that stress the structural and hidden consequences this burst still has on the US housing market.

This paper's structure begins with an theoretical foundation and literature review part divided into three sections: Firstly, it explains why real estate market is an important sector to analyze regarding its remarkable properties and its implications in economy and welfare. Then, the following section details what are the already known drivers of real estates prices in US and EA from microeconomics and macroeconomics important features. This section also includes interesting findings as well as the different methodologies from some important researches in that field. The third section is devoted to a full comparison of United-States and Euro Area characteristics that could enter in the difference in home price index between both areas. It also includes some empirical evidences found in papers that closely examine those housing markets.

The second main part of this paper contains all the methodology detailed as well as the data selection process. Thus, this section contains theoretical knowledge about (S)VAR model selection process, structural breaks and Impulse response functions.

The last part is the core empirical section of this paper where statistical outputs from the final models are reported and linked with the economic theory. As a matter of clarity, the Results part is divided into stationary VAR analysis and level SVAR one, each of this section is itself divided between the US's case, the EA's case and a conclusion. At the end of the model selection process, I found a bunch of 5 models interesting to understand house price's dynamics. Unfortunately, reporting outcomes of all models for both areas was unreasonable, then 2 models are not reported in Annexes but are rather used in a robustness check subsection following US and EA results each time.

Finally, this paper ends by a short conclusions of the key findings and limitations of (S)VAR methodology in defining the housing market's dynamic. In addition, warm recommendations are given to further expand the research by using more advanced models like the Markovian process.

1. Theoretical Foundations & Literature Review

1.1. Why real estate market is important

Real estate has attracted economists' interest for many different reasons as it is related to wealth, the real economy and the financial sphere through different transmission mechanisms that will be detailed in the next section about macroeconomics real estate drivers. A first introduction into the subject can be done using Poterba (1991) definition of the real estate as having a complex nature to be a commodity and an investment strategy at the same time. Besides, it is a unique asset that is heterogenous in its qualitative characteristics (area, numbers of rooms, access to public services and shops …) and across geographical areas. Therefore, comparing two home price index may be found puzzling because the foundation on which prices are settled in the US may strongly differ from the ones in EA.

The real estate market has particular cycles made of booms and busts that are longer than usual cycles in economy where its stages impact the economy of a country through a consumption/wealth effect and a "financial" effect as it is well detailed by the existing literature as Case (2000) . Moreover, Poterba and others(Case, Muellbauer, Slacalek) found housing to be the main part of household wealth and the global economy. Indeed, its price fluctuations have important impacts on households consumption and investment as they feel richer in case of an increase in real housing prices. The rents are increasing which increase the income of housing activities and the value of the collateral is also greater, easing the condition to credit for house owners. As consequences, the real estate market is linked to a consumption and a financial effect on the real economy through housing wealth. This has been deeply analysed by an expert of real estate in the US, Karl E. Case in many of his papers like Case(2000) in which he set the basis of what are the macroeconomic determinants of US real estate market and he empirically showed in Case et al (2005) that a positive housing wealth shock has important impact on consumption , even greater than a positive shock from the stock market. This can be explained by the proportion of Americans owning real estate expand to different classes with a higher propensity to consume than upper classes that's typically owning its wealth in stocks.

Knowing that, housing is one particular niche challenging to model with important implications and some feedback transmission mechanisms. Therefore, such an important asset able to impact the economy through different mechanisms should also be affected by macroeconomic determinants like unemployment, consumer confidence, interest rates …

Moreover, Musso, Neri, Stracca (2011) found empirical evidences that a positive housing demand shock can boost the overall economy although those positive impacts may be found small. The transmission mechanism underlying this statement is simple: A positive shock of demand for housing creates two consequences on the supply that will rise in the end. The first implication is the urge for new dwellings therefore a shortage in housing inventory may attract new real estate investors and new constructions are taking place. Those new suppliers are injecting income in several sector of the economy, creating new jobs in case of important building plans. The second implication of a sudden pressure from the demand side can be a wave of homeowners that could decide to sell their real estate owned as investments at a higher price than initially thanks to the short run shortage of inventory. So say, a positive shock from demand boost the overall economy by boosting the income of initial homeowners as it rises the market price and in the long run, it boosts real activity by requiring goods and services from different sectors (industrial and financial) to construct new dwellings. The reader can easily understand how an important and unpredictable shock from the housing market may impact the overall economy through income distribution, real activity growth, employment but also on the financial sphere. Indeed, the pressure from demand can be transmitted to the credit sector that could

issue huge amount of loans during such period, creating a stronger risk of default in financial institutions and markets in case of distrust or disturbances in the economy.

On the other hand, a wide range of literature, Hartmann (2015), Vandenbussche and al (2012), Crowe and al (2013), Kuttner and Shim (2013) strongly advice for macroprudential policy to control for the intensity of booms and busts in real estate market to prevent any major social and economic impacts in the future although such discussion tend to be more advanced in Europe than in the US. Indeed, reducing aggregate demand for example using a contractionary monetary policy (increasing interest rates) can prevent house prices to soar as it usually cut inflation and gives incentive to agents to save or invest in financial products (less expensive as investments than real estate). Because the inelasticity of the supply and the increasing demand on the housing market, both effects of a rise in interest rates can help at reducing the demand on the real estate market over a short period of time.

However, one main difficulty that prevent relevant macroprudential policies to be implemented is due to the local dimension of real estate market, meaning the national market to be a combination of market segments (by states, regions, or metropolitan areas) that often depend on specific set of local legislations. As examples, States of America have their own legislation and Belgium real estate legislation differs between Flemish and Wallonia region (cadastral and registration taxes are different). In this perspective, Maclennan, Muellbauer and Stephens (1998) stressed the consequences on housing differ across European countries because of their institutional differences.

Therefore, this particular asset can be analysed in both a microeconomics and a macroeconomics view depending on which dimension we want to focus on. Precisely because of such real estate's dynamic complexity, all relevant features can't possibly be captured at national and supranational level so that studies are usually limited in their interpretations.

1.2. What drives real estate market?

1.2.1. The microeconomics of Real Estate

In this short section, a summary of some key microeconomic drivers of real estate market is presented as some added information are crucial to be kept in mind while reading the following sections and results. These factors won't be empirically be assessed but the reader should be aware of these as they may be important in explaining the difference between US and EA housing market.

The microeconomics is helpful in defining how a house is valued from the demand perspective using hedonic or repeated-sales regressions. As such, a private house is priced according to its qualitative characteristics mainly like its surface, numbers of rooms and bathrooms, its location, access to particular services (schools, health, police, …) and so forth. In addition, the demand for real estate is obviously another price determinant and households demand is mainly driven by their financial capabilities to become homeowner. Thus, the disposable median and average income, credit conditions and mortgages rates directly impact the willingness to pay of households for a same house. Moreover, it is sensible that the size and the composition of demand are also a price determinants as its pressure for housing cannot be easily managed by the supply in the short run when there is not enough already built houses in a given area to fit the demand.

From a supply side perspective, price determinants are more financials and administrative and are more related to cost of dwellings rather than housing prices. Indeed, land costs is always increasing as its available stock diminishes and building houses is typically very expensive. Therefore, raising the funding required to increase the amount of houses (the inventory) is typically raised via particular long term lending called mortgages. Besides, building activities are always legislated in one way or another,

in terms of construction types, maximal surface and height, building concentration,… so that we can view the Urbanism Laws defining environmental and aesthetic constraints to building activities as one of the main constraint for the Real Estate offer to adapt to the ever increasing demand, resulting from the exponential rise in population.

This work won't detail these relationship further as the literature is already complete on the microeconomics behind house prices and so, I continue the definition of the housing market from a wider dimension.

1.2.2. The macroeconomics of Real Estate

This section summarizes some analysis performed so far by experts and economists to assess house prices' dynamic and what could be expected as important determinant in house prices. Literature is quite abundant regarding empirical analysis of regional or national real estate markets explained by macroeconomics fundamentals using either DGSE, panel regression, VAR models, Markov Switching models, … each of these methods have their own advantages and caveats regarding the dimension and the goal of the analysis.

The most common way used by economists to assess real estate dynamics is through panel data and regressions but such method has a strong drawback as it loses the difference amongst entities analysed, so say, the country-difference vanished. That's indeed a reasonable way to search for general relations between real estate and the macroeconomy but it doesn't take into account all local specificities tied up to the market and lose important part of the relevant information. Researches about house prices dynamics often focus on long-run relationships, cointegration and therefore apply what is called a (Vector) Error Corrected Model. The next most common model to assess macroeconomics impact on house prices is to implement (Structural) VAR such as in MNS (2013) work. They performed SVAR in levels on both US and EA areas, assuming a particular ordering following the Cholesky identification scheme where the logarithm of real house prices is contemporaneously impacted by the evolution of both private consumption and residential investment as well as the CPI but that the short term interest rate and the mortgage lending rate do not immediately impact real house prices.

One particular working paper, Neiji, Brook, Ward (2013) (NBW hereafter), has implemented a Markov Switching Process (MSP) to account for the different regime the US real estate market can face (steady, boom, bust) as they correctly thought this market would not respond the same to a particular shock depending on the cycle's period. This study investigates house price sensitivity to macroeconomic fundamentals in the United-States. More specifically, it assesses how this sensitivity is different whether the real estate market is in an expansion, constant or downward period. Notice this model is much more advanced than VAR and requires a probability framework or a complete model to determine in which phase of the housing cycle is currently in place. They compared results and confirmed the improvement of MSP with respect to traditional OLS and VAR models. NBW (2013) paper used the following variables: inflation (from CPI series), disposable income growth, the short-term interest rate (3-month treasury bills), term structure of interest rates (difference between 10 years treasuries yield and the short rate) and house prices. They first implemented an OLS regression which results are in line with Schnure (2005) concerning the CPI statistical insignificance and all other features were significant with sensible signs. Notice When looking at their Markov model results, signs do not change for any variables between regimes but the CPI significance is found during boom and steady state periods only. This makes sense since during bust, house prices decline very fast while the CPI may still rise at the beginning of the bust. One interesting outcome from the bust regime is the evidence of a disconnection of the real estate market from macroeconomic fundamentals as only the constant remains significant in explaining price changes. Regarding the boom regime, the model

correctly demonstrates the intense speculation around the housing market (reason of bubble creation) as both the increase in income and the decrease in short term interest rate are not statistically significant during booms. The rise of house prices is then not attributed to an increase in households' welfare but rather on the expectations they made about future. The steady-state found only the term structure to be insignificant. Concerning this term structure, an increase of the gap between interest rate may imply a decrease in house prices growth rate. The authors argue that this may be due to investors expectation of seeing the cost of borrowing to rise.

Because some data used in this paper were not assessed by previous literature, I cannot state at this stage what are the relationships between the home price index with variables like the confidence price index and unemployment in this section and if any important empirical evidence is found, then some hypothesis will be given as economic explanations in the result section of this paper.

To sum up the main results from these studies, real estate is theoretically driven by the financial sphere, the real activity, inflation and expectations where their respective importance in determining house prices differ across geographical area and time. In general, past studies already proved a relationship of the housing market with nominal and real interest rates, monetary policies, CPI, gross domestic product, private consumption and investment, income growth, … with different implications regarding countries analyzed. In the next section, those transmission mechanisms will be detailed regarding US and EA respectively with a particular attention for features depicting strong differences in this two regions that can imply important divergence in results.

1.3. The housing market: United-States and Euro Area comparison

The idea to compare housing market across the Atlantic had already been used by several researchers at different extends. Before going into any empirical analysis, it's crucial first to understand the similarities and differences in both populations and the continent's culture that could be at the heart of the market's sensitivity to certain shocks if we want a reasonable and accurate comparison. Therefore, a detailed survey about the most important studies' outcomes using different modelling methods for US and EA

1.3.1. Differences

A first introductory difference that could explain a divergence in the dynamic of home price index between US and EA, has been found by Christelis et al (2010) who observed the real estate to be the main form of wealth in Europe, showing a strong difference in culture with US where Americans prefer stocks that they find more valuable to them By linking the latter paper with the one of Glaeser (2013), who claimed that "America is a nation of real estate speculator", we easily understand the importance of real estate in European as the safe-keeper guardian of wealth as it is common to observe a sudden rise in housing transactions in trouble economic times in our continent. Moreover, Glaeser (2013) pointed that the culture of Americans and their history made the US housing market more volatile than the European one, meaning the home price index should naturally observe more volatility in the US than in EA. As Table 1 shows later in this paper, it is the case when considering real home price index where EA has the higher minimum and maximum real house price index value while US depicts the higher volatility. This difference in beliefs may have changed since the subprime crisis, leading stocks to become the most preferred investment in US . This paper will therefore assess the Consumer Confidence Index (CCI hereafter) as a factor of trust in the economic stability and see whether it has any significant impact on housing price in US and EA.

A crucial difference that does not seem so lies in the scale of the analysis itself as the United-States represent a larger area than Europe, meaning more land availability in the US and so the housing

market undergoes less pressure from demand on prices than in Europe. According the World Bank data, the US area today is about 9 831 510 km² for a population of 328 29 523 inhabitants whereas EA is 2 760 428, 889 km² for 342 671 033 inhabitants (data from World Bank Database, February 2021).[1] It is striking how the population density is much higher in Euro Area than in the US, then it should imply a higher home price index for EA with a lower volatility since increasing demand bring downward price stickiness in case the supply cannot adapt the inventory as it is nowadays the case in Europe (lack of land available and rise of immigration in specific area of Europe). So say, such feature does not suit for short run dynamic analysis but this density pressure is surely at the heart of housing market price, more specifically it may be the reason for the observed upward trend in both US and EA since their population are exponentially increasing during the same time period. As such, this determinant of house price is not evaluated in the empirical analysis but it surely contributes to the difference between home price indexes' volatility and therefore would be important its sensitivity to shocks impacting either the demand or the supply.

Surprising results regarding the CPI and GDP importance are found in Schnure (2005) paper which concluded those series to be irrelevant at national level. This result seems not sensible for GDP since the economic theory and literature already demonstrated the correlation between economic wealth (GDP growth), consumer expenditures (depending on consumer wealth) and housing prices. The rise of housing price is translated into a higher value of collateral and lead to higher income from rent, increasing perceived wealth for homeowners which in turn leads to higher consumption at national level, thus the GDP growth should increase (taking the assumption that there is no contemporaneous opposite change in GDP components that would compensate the rise in consumption expenditure). This reasoning can be applied for US as households are in majority homeowners.

Another difference is related to the Mortgage market (market for long term borrowing, usually in exchange of real estate collateral) that's obviously more developed in the US since they created extended mortgages, refinancing mortgage instruments and Mortgage Equity Withdrawal schemes which allows households to get an easier access to borrowing when home prices rise as it also raises the value of the collateral (i.e: the house) (MNS,2011). Concerning, the Euro Area, mortgages securitization and complex product are not that popular, especially since financial crisis thus except for the Netherlands, such financial products face legal restrictions. The two series of credit attributed to household as a GDP% depict this clear difference where US households are much more indebted than in EA (Annexes: Figures 1,2). This outcome has also been observed by MNS (2011). In addition, mortgage rates' definition vary between the two areas where in the US, the mortgage rate is typically tied up to long-term interest rate and fixed. Notice the exception of subprimes loans that were not fixed but variable according to the degree of solvency of the borrower (the less you are solvent, the higher is the interest rate). Many researchers and experts have blamed subprime mortgages as the main cause of the real estate bubble, and then of its bursting since it was, by its nature, a dangerous financial product for Banks to accumulate in great amount as they did. In the Euro Area, the mortgages rates vary from country to country with a majority of fixed rates although Spain and Italy rates are flexible.(MNS, 2011).

Besides, since the United-States has a more homogenous population than the Euro Area, Americans tend to be more mobile than Europeans and then are more active on the real estate market, thus the latter being more liquid even though they prefer to invest their wealth in another asset than housing. This fact had been shown in Musso, Neri and Stracca (2011, Figure 3) (MNS hereafter) where their series on housing transactions was much more important in US than in EU. Another advantage of US

[1] https://data.worldbank.org/indicator/AG.SRF.TOTL.K2

real estate market that may boost transactions is linked to VAT systems where such costs do not exist in Anglo-Saxon countries compared to the Euro where it also differs amongst EA countries. According to Daniel Gros (2007), this higher transaction costs in EA are one determinant leading the market to be less liquid because households are more constrained.

Based on the argument above, it is sensible to think unemployment as an important factor for changes in housing demand especially in the US as Americans are moving more often from state to state than Europeans living in another member states. In this perspective, we expect regions with high unemployment rate to have low house prices as its population's income is decreasing and people are moving away to find new job opportunities so that the inventory in rising in a time where the demand reduces. Indeed, Schnure (2005) confirmed the importance of unemployment in nine US regions. Before that, Abraham and Hendershott (1992) ended up with the same result from a metropolitan dimension. It seems that the unemployment's impact is not absolute and may depends on more local specificities of the housing market. The analysis conducted in this paper will then determine whether the unemployment has a real importance at the US country level but also in the Euro zone where national and regional studies lead to different conclusion.

A last key difference lays within financial deregulation where it is expecting to observe a weaker impact of monetary policy instruments on prices in areas with important financial institutions. So say, when a country with high financial deregulation like the US experiences an interest rate shock, the latter strongly expands to asset price with a greater intensity in case of financial instability. This is because financial liberalization offers more possibility and eases the access of borrowing from different sources which allow agents to quickly adapt their choices leading asset markets prices in general to fluctuate more strongly. As examples, Iacoviello and Minetti (2003) claimed that financial liberalization in Europe led to a greater sensitivity with respect to interest rate fluctuations. Also, the paper from Maclennan, Muellbauer and Stephens (1998) (MMS hereafter) defined countries that are more likely to experience high house price volatility, leading to a greater importance for real estate within the interest rate transmission mechanism. According to these results, it is reasonable to assume EA home price index to be less sensitive to a short term interest rate shock since US main credit's source is found in financial markets on which the interest rate is often flexible, whereas the main credit in EA come from financial institutions and are typically fixed interest rates.

Turning into the Euro Area case, literature focused on individual countries rather the Monetary Union dimension because financial institutions and housing legislations are heterogenous. Indeed, since the very beginning of the EU, strong institutional differences within member States in housing contributes to increase the difference in housing price volatility that may mislead the VAR model once aggregated at the Euro zone level. In this perspective, experts often focus their analysis on panel data where the differences across regions is neglected in front of the broad picture. The alternative being VAR model, it must be interpret with care due to the high heterogeneity between countries, a response from a shock observed at the EA level cannot say anything about the response at national level. As an example**,** Germany was found to be a great exception considering its housing markets according to MNS (2011). One consequence of this caveat can be a poor estimation of the transmission mechanism that should occur via housing of the short term interest rate on consumption. In MMS (1998), a list of these key differences is assessed in 15 EU countries such as the mortgage fund systems using fixed mortgage rates versus variable rates, the differences in policies adopted to boost the real estate market as well as variation in the tax system create market distortion amongst those countries and it is reasonable to think these differences are consistent throughout the Eurozone. This way, MMS (1998) defined EU countries that are more likely to experience high house price volatility, leading to a greater importance for real estate within the interest rate transmission mechanism.

In general, Englund and Ioannides (1997) showed in some European countries the positive impact of GDP growth and the negative one of increasing interest rates (lagged values) on house prices but they do not provide evidence on the dynamics once a shock occurred. Here we have a first empirical contrast with Schnure (2005) results for US, therefore the model in this paper is aiming to check what is the dynamic behind for EA and whether the conclusion of divergence in true between the two areas. Another VAR analysis from Sutton (2002) determined a positive relation of income and equity prices with housing prices and the latter have also a negative relationship with long-term and short-term interest rates where the real estate prices rises 3 years after a negative shock occurred.

1.3.2. Similarities

From a macroeconomics perspective, it is usually observed that demand for housing tends to increase in case of economic instability or consumers distrust about future because houses are seen as safe assets to place wealth. Indeed, Poterba (1991) among others highlighted this tendency to move from stocks to real estate when investors are feeling less confident about future financial stability.

In addition, there is a strong culture of housing and the market is well developed on both side of the Atlantic where we observe more home owners than rentals households, 64% for EA and 68% for US according Gros (2007). Indeed, housing constitutes the main part of households expenditures in both areas (ECB 2003 , Gros 2007)

One noticeable similarity is the correlation between the two home price index that follows the same trend with of course, a stronger drop in US during the financial crisis than EA experienced (Figure 4, p.21). Despite all the important differences among the two continents listed previously, one may think about the reason behind this similar pattern in both nominal and real prices.

Regarding the financial sphere impact on house prices, we already know from late XXth century thanks to Miles(1994) that easing the access of credit leads to increase in both house prices and credit outstanding. Indeed, if one central bank decided to reduce interest rates, population would like to consume rather than saving their income and an attractive low rate implies credit becomes an available option for funding to more agents, therefore a rise in the amount of credit outstanding is observed in general. Relying on MNS (2011) results between 1986-2009, a positive monetary shock, so say a contractionary monetary policy, has a greater impact on real house prices and on residential investment in the US.

Because it impacts investment decisions of entrepreneurs and households, the real interest rate is found a key determinant of both the supply and the demand side of housing market. However, there is no clear evidence of an equivalent impact for nominal interest rates, even though the key role of monetary policy on house prices through the interest rate transmission mechanism and the asset price mechanism have already been demonstrated more than once in both areas (Goodhart, Hoffman 2008, ECB2003, NBW2013). In this matter, interest rates used in the following empirical analysis will be in nominal terms while house price indexes are deflated by the Consumer Price Index.

Since the US is well known for its high financial deregulation with respect to EA, the findings of Iacovello and Minetti (2003) that financial liberalization increases house prices sensitivity to interest rates movements can also be applied across the Atlantic. In this perspective, the relation between house prices and interest rates should be similar between EA and US with differences in intensity of shocks and responses.

Moreover, Reinhart, Carmen and Rogoff (2009) assessed the protracted property (bubble shocks can last many years) of house prices once the related bubble burst in the US. The financial crisis along other

similar historical examples depict high duration of shocks on asset prices, this would imply some issues to reach stationarity in data and will be explained in methodology section if it exists.

In a nutshell, literature has proven many important differences between Euro Area and the United-States to let us think those markets to be fundamentally different in their dynamics but the Home price index series are depicting a very similar pattern despite all. Because the linkage with the financial sphere through interest rates fluctuations was not found to be significant enough to explain it by its own, this paper may find new storytelling to understand why this market is acting similarly between our two continent regarding our difference in History.

2. Methodology

2.1. Data selection

The home price indexes (HPI hereafter) series are on quarterly basis and are collected from OECD database for both geographical areas, starting in 1970 and ending in 2019 so they can be compared with no issue regarding a possible difference in the computation of indexes. Indeed, the first definition of such index was created by Case and Shiller, reported by Standard & Poor but it is only available for the US. Another HPI exists for Europe, constructed by European Central bank but it is in nominal term only. Based on the discussion made by Gros (2007), it is reasonable to use OECD home price index series when analysis the real estate market since it exists substantial differences between the S&P and the ECB index. Moreover, those reflect more volatility than OECD series with evidence for overevaluation by ECB computation. In the light of these differences in HPI the OECD index is preferred since the others would have made the comparison of VARs less clear and accurate.

HPI and the other indexes are defined according the same base year, 2015. I chose this particular year because the HPI level of 2015 is the same as 2003's EA level and also the same as at the beginning of US housing bubble's boom. This way, the series depict the great impact the subprime crisis had on housing market in both sides of Atlantic.

Concerning the data sets for United-States and Euro Area, the timespan differs because some data for Europe are not available before 1999, especially monetary and financial variables. This raises some issues for an ideal comparison of the dynamic and it reduces the amount of observations for Euro Area thus estimates may suffer from a lack of information and may imply difficulties in performing analysis using subsamples. The way it has been managed will be explained in the methodology section later on.

In order to perform a complete survey of possible interrelations with home prices, I built a wide database with macroeconomics variables that can be easily compared between US and EA. The selection was done according the already found evidences and what could be think of as possible determinants for home prices.

The complete list of features assessed to define home price index is:

Feature	Unit of measure	Source
Nominal Gross Domestic Product (GDP)	In current prices, US: billion USD, EA: million Euro	US: U.S. Bureau of Economic Analysis EA: Eurostat
Consumer Price Index (CPI)	Index, base year 2015=100	US, EA: OECD
Unemployment rate	Percent change	US: U.S. Bureau of Labor Statistics EA: Eurostat
Broad money supply (M3)	Index, base year 2015=100	US, EA : OECD
3 months T-Bill interest rate	Percentage	US: Board of Governors of the Federal Reserve System (US)
3 months EURIBOR	Percentage	EA: ECB data warehouse
10 years interest rates	Percentage	US, EA: OECD
Total Credit attributed to households and NPISHs	Ratio, GDP percentage	US, EA: Bank for International Settlements.
Private Final Consumption Expenditure	US: in USD	US: OECD

Final consumption expenditure (households and NPISH)	EA: current prices, million euro	EA : Eurostat
Private residential fixed investment	US: in billions USD	US: U.S. Bureau of Economic Analysis
Gross investment rate of households	EA: Percentage	EA: Eurostat
All sectors, Total Home and Multifamily Residential Mortgages	Asset Flow, million USD $	US: Board of Governors of the Federal Reserve System (US)
Federal Government; Total Mortgages;	Asset Flow, million USD	US: Board of Governors of the Federal Reserve System (US)
30 years mortgage fixed-rate	Percentage	US: FannieMae&FreddieMac
Consumer Confidence Index (CCI)	Long-term average = 100	US, EA : OECD

Majority of data are seasonally adjusted but there are some exceptions such as interest rates and total credit to households and NPISHs. Notice that both short term interest rates as well as Consumer Confidence Indexes are on a monthly basis which have been transformed in quarterly data through averaging. The reader can find the analytical view of these raw series for both area on Annexes (Figures 1, 2). I would like to stress the need for more variables to assess especially data related to unconventional policies. It should be more important in post crisis models since the short term policy rate lost its monetary policy transmission power that I failed to find such as a time series about shadow rates and asset repurchase programs.

2.2. Structural break analysis

One first statistical check that must be done is to look after the stationary property of the features used in a Vector Autoregressive process (VAR) typically using two tests: the Augmented Dickey Fuller (ADF hereafter) and the Phillips Perron tests ('adf.test' and 'pp.test' functions from 'tseries' package, respectively). In this analysis, those tests did not conclude the nominal home price indexes for both geographical areas not to be stationary even in its first difference on the whole time period. One reason of this failure can be the presence of structural breaks in time series. It is reasonable to assume that because of the time period assessed which notably includes the Great Moderation and the Financial Crisis which are important historical periods where substantial changes had been taken place in financial institutions, products and legalisations of the real estate market on both side of the Atlantic.

Therefore, I implemented a structural break analysis before VAR to get a better understanding about these home price indexes and trying to find a way to reach stationary series by splitting the whole period in samples big enough to perform VAR between the different structural breaks I may find. Recalling the Euro Area dataset starts at 1999, the test is performed from this date and not from 1970 as for US.

The test used to account for structural breaks come from Bai Perron (1998) and has the great advantage to find multiple breaks at unknown dates. The framework allows some parameters (not all) to break at m possible break points, the size of subsample depending on a fraction the total one, where the theoretical accepted value is 15% of total observation. Using Bai Perron test, the dependent

variable is modelled as linear combination of covariates vectors (x_t, z_t) with both a time invariant (β) and a time variant, (δ_t) coefficients respectively and ε_t is the error term.

$$y_t = x_t\beta + z_t\delta_j + \varepsilon_t$$

With $t = T_{j-1} + 1, \dots, T_j$ and $j = 1, \dots, m + 1$

The data generating process of this test is assumed to be the above linear regression expressed in matrix form where β, Z and δ are true values.

Applying this test using R with the 'breakpoints' function from 'strucchange' package, the Bai Perron test's results are assessed using the Empirical Fluctuation Process (EFP from 'efp' function). We can observe 5 structural breaks of US and 4 for EA knowing the difference in timespan, the US having a reasonable break during the great moderation by the end of 1970s. Since the test assumed unknown dates, structural breaks defined between 2004 and 2011 are certainly related to the financial crisis where we should observe those breaks at the premises in 2007 and at the end of financial crisis where it consequences on housing market was maximal around the year 2010. Notice that the United-States faced a particularly important wave of foreclosure at national level where the intensity differ across cities which surely had contributed to the drop in prices in US whereas we did not see identical consequence in EA because only mortgages from US real estate market was securitized and spread worldwide among investors as it was forbidden in most of EU national banking systems.

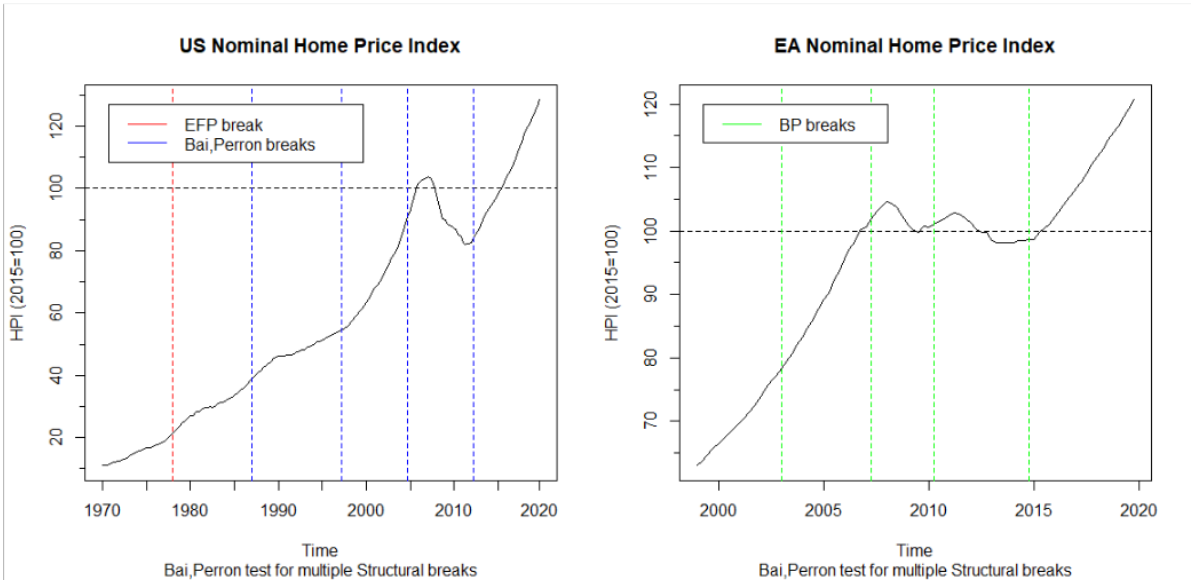

Figure 3: Structural break analysis on nominal HPI series from OECD

Due to structural breaks' existence, ADF can't state the series would be stationary in its first difference since it assumes a constant variance over time. From the quarterly growth rate graph, we know it is not the right assumption as it fluctuates across periods. Instead, the stationarity of HPI is assessed under the Phillips Perron test that accounts for heteroskedasticity in variance. Here, the results are satisfying for EA as it is found to be stationary under 99% confidence level for the 1999-2019 period whereas the test concludes the US nominal home price index cannot be stationary by considering the whole timespan. Nevertheless, these tests conclude to stationary data for the difference of natural logarithm of HPI in real terms, especially for the US that is stationary according both ADF and Phillips Perron tests (Annexes: Table 1). This outcome will matter for the core section of VAR modelling as it allows to perform stationary VAR on subsamples and therefore to obtain some insights about the determination of real house prices.

2.3. Vector Autoregressive model

The Vector Autoregressive model was constructed in 1980 by Christopher A. Sims in his paper Macroeconomics and Reality and has become one of the main model in empirical macroeconomics to test for long run relationships. A traditional VAR with n endogenous variables and p lags takes the compact form of

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + e_t$$

Where $y_t = (y_{1,t}, y_{2,t}, \dots y_{n,t})$ is a $n \times 1$ vector of time series, A_i is a $n \times n$ matrix of coefficients, c is the constant $n \times 1$ vector and e_t is a $n \times 1$ vector of white noise process of innovations.

This methodology has many advantages as it can be easily estimated and it performs well in forecasting. Moreover, VAR doesn't require to set which variables are exogenous or endogenous since it assumes all features to be endogenous. However, VAR's methodology does not work well if the dimension is too high as it computes one equation per variables that each depends on all others variables in the model. Thus, if we have K variables from which we have p lag values, then, the VAR would need to estimate $K+pK^2$ parameters. The amount of observation available for Euro Area constrained the dimension of the VAR as it never ended up in a stable process using all chosen features listed in previous section. Then I assessed the model performance and the significance of variables in determining the home price index only since this work does not focus on how macroeconomics fundamentals are impacted by the real market. Notice that I could just performed an Ordinary Least Squared regression using lag values since the analysis only care about the real house prices equation but I wouldn't be able to construct Structural VAR to account for temporary shocks nor the orthogonal Impulse Response Functions.

Before implementing the VAR as such, we must assessed the right length of lag values to consider so as to construct the best VAR according the log-likelihood and the parsimony principle which states that amongst two models with same explanatory power, the one that should be kept is the model with lowest dimension, here, the lowest numbers of lag values.

The commonly used selection criteria model are based on same information but their definition differs a bit. These models are the Akaike Criterion (AIC), the Bayesian Criterion (BIC) also called the Schwartz Criterion (SC) and the Hannan Quinn Criterion (HQ):

$$AIC(p) = \ln\left|\sum(p)\right| + \frac{2}{T}pn^2 \qquad BIC(p) = \ln\left|\sum(p)\right| + \frac{\ln(T)}{T}pn^2 \qquad HQ(p) = \ln\left|\sum(p)\right| + \frac{2\ln\ln T}{T}pn^2$$

Amongst the different criteria for Lag order selection, AIC criterion often overestimates the order of lag asymptotically while the more conservative ones are SC(n) and HQ(n) criteria thus whenever those 2 agreed on lower lag order than Akaike or FPE criterion, we must select their choice to satisfy the parsimony principle. However, AIC is still the preferred criterion to follow when using small sample and it sometimes happens the selection criteria mislead the proper lag order and advice for an explosive process not useable.

In practice, the R package 'vars' is used for VAR analysis as it contains the function to apply lag order selection with 'VARselect' and allows to compute VAR with 'VAR' function. Since the analysis is based on quarterly data, I decided to implement VAR model with 4 lags to account for 1 year of possible significant effects on house prices whenever it led to stable process so that the results depict the dynamic of home price index regarding previous levels of macroeconomics variables up to the year before.

Theoretically, VAR models can be performed under different approaches using level variables or stationary ones. The latter has the advantage of having trustworthy coefficients from regression that allow us to get a first hint about what could be the key drivers of real house prices' dynamic. However, implementing the right stationary VAR can become difficult as it requires data transformation and assumptions about cointegration that could be wrong and therefore could add a bias in results. Indeed, a well-known econometrics expert, Eric Sims, highlighted in his lecture notes from the University of Notre-Dame, an important discussion about caveats of such techniques and has demonstrated the advantage of implementing level VAR where some transformations of data are required to get them stationary. He strongly advices to use level VAR whenever series are non-stationary or may be cointegrated since it would result in mis-specification. If we didn't use appropriately the differencing and the cointegration concepts, it will result in spurious regression whereas this issue is neglected in level VAR once we include lags of variables in regression. Besides, Sims emphasises his claim showing that cumulating the response of variables in first differences lead to very similar impulse response functions (IRF hereafter) using levels because it does not bring bias through wrong assumptions. This advice cannot be used if we are interested in inference but as it is not our aim in this work, part of the analysis will be based on IRF using level SVAR.

This being said, most of past studies used level VAR such as MNS (2013) that surely used it because they noticed that usual unit root tests (ADF and Phillips-Perron tests) were inconclusive for some of their variables. In my particular case, ADF and PP tests for unit root did not conclude the home price indexes to be stationary on the whole sample because of the presence of structural breaks. Therefore, I decided first to perform stationary VAR on subsamples of US, leaving the subprime crisis aside. By doing that, I am able to observe the "natural" dynamic of HPI according to macroeconomic fundamentals before and after the financial crisis occurred between end of 2007 until 2010 as it takes one year for US economy to get back to normality. Notice that the EA's case is very different in the sense that Philips-Perron test concludes the nominal HPI series is stationary whereas Figure 3 is obviously depicting a linear trend until 2007 and after 2015. It is therefore more difficult to find how to subsample the series into stationary samples also due to the lack of observations that is also an issue as such for VAR estimation.

In order to conduct the most complete analysis possible, I implemented different VAR on different periods of time. The aim was to understand if one VAR specification is more efficient than another and whether its performance has changed after the crisis. By firstly applying stationary VAR, I was able to determine which features are the most important parameters in the explanation of home prices fluctuations by selecting the independent variables having both a statistical and an economic significancy for at least two lag values. I have to stress the caveat that the subprime crisis is therefore ignored by those VARs because this short period contains non-stationarity that prevents any model to be stable or relevant and systematically leads to spurious regression. Since VAR and SVAR suffer from over-parametrization when considering too many variables at a time, I decided to limit the VAR dimension up to 5 variables maximum per model. Therefore, a wide bunch of specification possibilities have been appraised and the most important ones are presented with a few models used as robustness checks. So say, this paper will be based on 5 VAR models for both US and EA with different compositions as I found more features to study the US case.

However, I also look after the same VAR models but using variables in levels this time as the impact one shock may have on the dynamic of housing price fluctuations is what matters the most in this paper. Indeed, the debate in literature about the two methods does not forbid the level alternative once we take into consideration that it cannot be used to infer HPI but rather to understand the overall dynamic over the whole timespan. In this perspective, coefficients and their significances won't be

interpreted and level SVAR will be used to construct impulse response function according structural restrictions on contemporaneous impact of variables to observe the dynamics. This is based on the discussion from Eric Sims that level (S)VAR prevent from obtaining misleading outcomes. The reason why implementing SVAR in front of VAR for impulse response function is that SVAR allows the model to estimate a contemporaneous relation (or not) between the dependent variable and the explanatory one, called the response and the impulse variables respectively whereas VAR cannot.

Introduced by Sims (1980), a structural VAR can take the form of a Moving Average (∞) process :

$$X_t = C_0\epsilon_t + C_1\epsilon_{t-1} + C_2\epsilon_{t-2} + \cdots$$

Where C_0 ,the matrix of coefficients associated with X_t , is included in the equation and account for contemporaneous shocks between variables. Notice the variable contained in X_t must be ordered following the intuition and assumptions made to construct this matrix of coefficient C_0 based on specified restrictions. The way this restrictions are implemented is commonly known as the Cholesky decomposition so that the first variable won't be contemporaneously impacted by the shock of any features and we order the variables so that the last one is assumed as the most endogenous, so say, the variable that will react contemporaneously to all variables, everything else remaining constant.

SVAR to assess short run dynamics without exogenous variable can also be written as:

$$\tilde{A}\big(I_K - A_1 - A_2L^2 - \cdots - A_pL^p\big)y_t = \tilde{B}\varepsilon_t$$

Where $\tilde{A}, A_1, \ldots, A_p \; and \; \tilde{B}$ are $K \times K$ matrices of parameters with , L is the lag operator, ε_t is the innovations vector that is also vector of orthogonalized shocks that follows a particular normal distribution. $\tilde{A}$, the lower triangular matrix with a diagonal composed of one (see below) and $\tilde{B}$ is simply a diagonal matrix, both are often called the equality constraint matrices, respectively written by the left matrix and the right matrix here below where letters are variable names and dots are non-zero estimates related to contemporaneous impact of one variable on the others according the Cholesky scheme. This way, restrictions are simply defined by a lower triangular matrix where the diagonal is composed of 1 and restrictions for contemporaneous changes are set to zero.

	a	b	c	d	e
a	1	0	0	0	0
b	.	1	0	0	0
c	.	.	1	0	0
d	.	.	.	1	0
e	.	.	.	.	1

	a	b	c	d	e
a	.	0	0	0	0
b	0	.	0	0	0
c	0	0	.	0	0
d	0	0	0	.	0
e	0	0	0	0	.

The Cholesky decomposition matrix (C) is obtained by multiplying the two constraint matrices with their estimates leading to $C = \tilde{A}^{-1}\,\tilde{B}$ which is represented with the third matrix here front:

	a	b	c	d	e
a	.	0	0	0	0
b	.	.	0	0	0
c	.	.	.	0	0
d	.	.	.	.	0
e	.	.	.	.	.

One method used to analytically assess a temporary (one unit) shock from one variable on another over time is named the Impulse response function. Impulse response function (IRF hereafter) was firstly defined by Koop, Pesaran and Potter (1996) and allows to understand the dynamic of one time series with respect to a temporary (one period) shock of another variable ceteris paribus. An important parameter in IRF is the orthogonalization as it bring information about contemporaneous relationship between the two variables. We should set the IRF to be orthogonal whenever the covariance matrix is

not diagonal. If we want to get rid of the contemporaneous response, we may set this parameter to false leading the IRF to start at zero. Notice that I prefer to assume all IRF as orthogonal because when the covariance matrix is diagonal, this method also returns an IRF starting at zero. Therefore, not using the orthogonal parameter would mislead in some outcome if we do not check the covariance matrix according to Pfaff (2008) discussion on that topic. Using R code, the commonly used package 'vars' contains the function 'irf' that uses the estimated standard deviation of the impulse variable as the shock faced by the response variable. One can retrieve the value of shocks in the VAR result of the related impulse's equation estimated standard deviation of residuals.

As explained above, we firstly need a comprehensive ordering to implement SVAR regarding US and EA where the assumptions about the lead-lag relationship may differ. Therefore, this paper will perform different ordering where the first one will be based on economic intuitions and the second ordering will assume HPI to be the most endogenous variable so say, the one that is the most sensitive to a shock in another one from VAR. Then, the first ordering tested is based on the following economic knowledge:

If the SVAR satisfies the Keynesian view of prices, then the real home price index should only be impacted by its own shock contemporaneously since prices needs some time to adapt to any other shocks. Indeed, the housing prices are well known for their stickiness property.

However, doing only this ordering won't allow the IRF to depict any contemporaneous impact that may exist in case the assumption is wrong. Therefore, the same analysis has been conducted using a second ordering with the home price index placed always in last position. Assuming it as the most endogenous should allow to see significant contemporaneous response of real home price index to a shock if the area depicting the 95% confidence interval agree on a clear positive or negative direct effect. If not, then we get the evidence of the home price stickiness regarding certain shocks.

When thinking about the relation of other features contained in SVAR such as the one between interest rates, it is obvious that the short term rate is contemporaneously impacting the long term one but not the opposite since the interest rate transmission mechanism is implemented by central banks through its short term key policy rate. Moreover, Christiano, Eichenbaum and Evans (1998) claimed the short term policy rate can be contemporaneously affected by GDP and CPI. However, they have found that monetary policy shock does not affect GDP and CPI the period it occurs. Following their results, GDP and long term rate should be ordered after (on the right of) the short term rate as a matter of completeness even if it should not change anything to the response of real HPI from structural shocks.

In addition, I assume in the ordering of variables that private consumption is chosen first and residential investment come after that where they both contemporaneously impact GDP since they are its components. Unemployment is assumed to have a direct effect on private consumption and investment but not on the financial sphere. Notice the policy rate in the US is also used to maintain the output gap near a target level although the short term interest rate does not does not immediately react since its fluctuations are set up by financial institutions.

Before getting in the core of VAR and SVAR analysis, it is useful to get a first analytical insight about what are the variables used and more particularly how their different patterns seem to move with each other. In this perspective, the next section starts by assessing and comparing US and EA home price index time series in depths.

3. Results

2.1 Analytical first sight

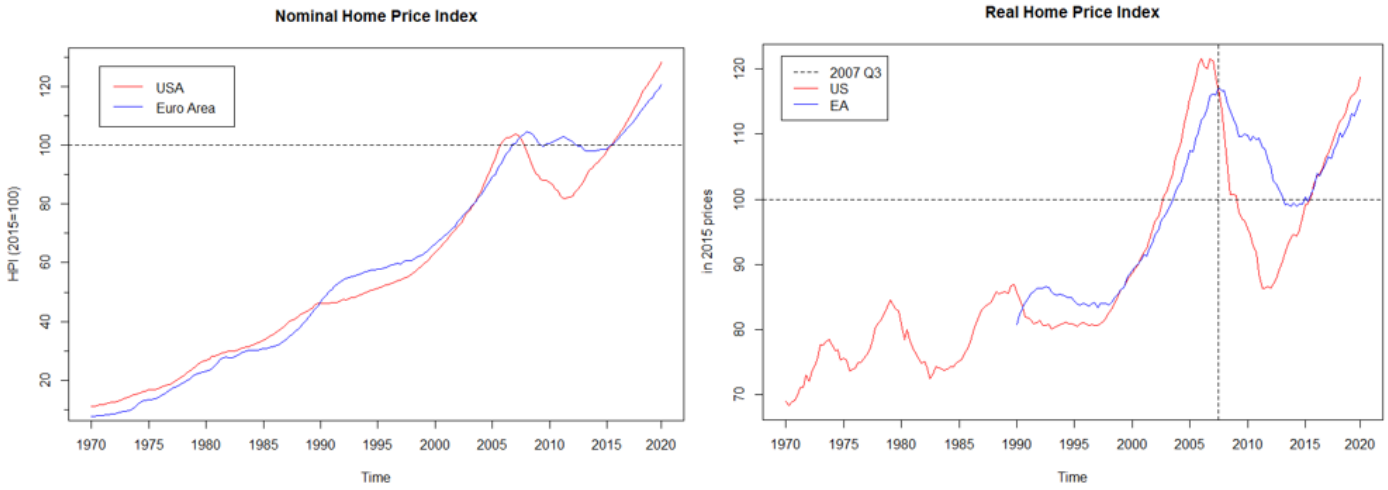

Figure 4: OECD data. Real HPI are computed by deflating OECD series using the OECD CPI series with same base year

To get smoothly into this study on housing markets, let's begin by comparing which one between US and EA has the highest level of nominal home price index. It appears that except for two time periods (1990-2002, 2007-2015) the US housing market depicts higher prices, meaning houses are more valued in US despite it has lower population density and so a lower pressure of demand on prices. Looking at real home price index series strengthens its first intuition where the periods of underperformance of the US housing market are reduced and the price bubble cannot be ignored as the boom period of 2000-2007 was extraordinarily more important than ordinary boom from the typical housing cycle.

Figure 4 (above) does not bring much information but looking at the nominal quarterly growth rates gives us better insight on how these HPI are evolving from period-to-period. Indeed, while we observe clear positive trend in both markets, growth rates are depicting the volatility of prices that, on average, are growing at 1%. It is striking how EA housing market was more volatile in the 1970s and early 1980s.

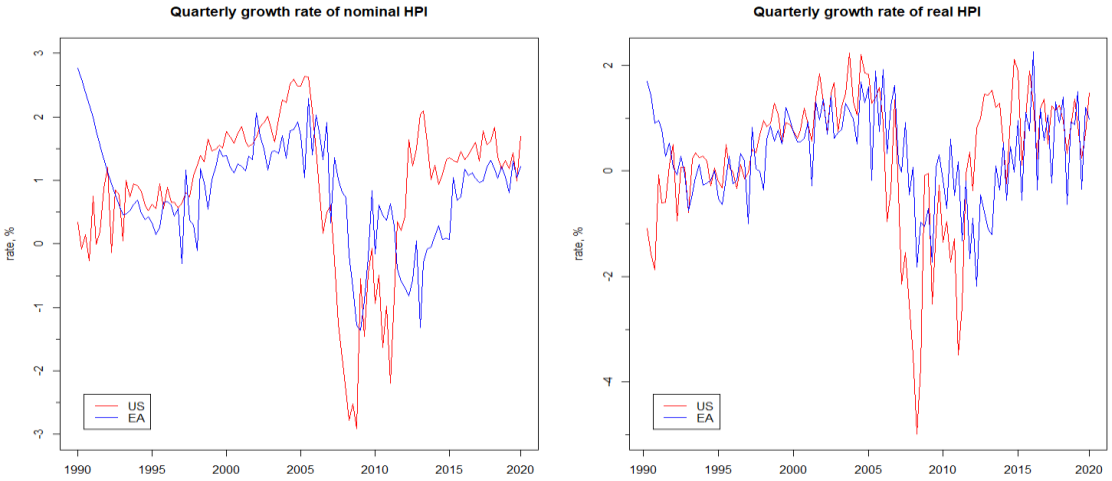

Figure 5: Quarterly Growth Rates of HPI (OECD data)

Figure 5 (above) also advocates in the theory of downward price stickiness in real estate market as it rarely depicts a negative nominal growth rate where it falls below zero only during the financial crisis for both US and EA. However, quarterly real growth rate are showing much more period of price's drop for both areas where the negative rate was around -5% for US and only -2% for EA in the most severe quarter of the financial crisis.

Notice also that EA's housing market prices continued to drop even once US's market had already recovered which may be explained by the fact that it took some time for Euro Area's assets to be impacted by US's crisis so the negative consequences persisted. Such analytical finding is in line with the observed lead lag relationship from D. Gros (2007) paper.

Regarding the real home price index time series, we can better see the bubble's creation and expansion followed by its burst as the real HPI was at the same level in the middle of the bubble's expansion than in 2015 level when the market has begun to recover from the crisis. As the graph also depicts, it seems the real HPI for US is sharply increasing again which is one of the main concern of real estate's investors and households since they think US is going to experience a new housing price bubble in the near future. However, experts are agree to attribute this new rise of house price to an overall lack of supply since the US supply for houses is very low and does not meet the actual demand according Lane S. (2021). It is no more attributed to credit market risk which was very high during the financial crisis due to the high proportion of low interest rate on mortgage or variables as in subprimes. Indeed, to prevent another set of foreclosures, a law was established in 2010 to restrict credit requirements for mortgages called the Dodd-Frank Wall Street reform.

Regarding Daniel Gros (2007), the EA home price index follows the US one with a lag between one to two years and therefore he expected the EA real estate market to follow the downturn to enter in the depression stage of its cycle for several years which is not what happened since the real estate market on both sides quickly recovered from crisis.

Notice the time span of these descriptive statistic starts at 1990 since the CPI series for EA cannot go further in the past so I take an equal time period for each in order to compare them correctly. Based on the descriptive statistics from 1990s (Annexes: Table 2) , it is clear that the more volatile housing market is the US one since both nominal and real series have the highest standard deviation, variance. Moreover, the US housing market faced stronger drop in house prices which is striking from the real perspective with a quarterly growth rate of - 4.98 % that is attributable to subprime crisis for sure whereas EA experienced a - 2.18% in its worse situation only.

Table 2 also depicts the maximal home price index in both nominal and real term has been reached in the US whereas it is in EA that we observe the highest mean and median value. In addition with its lower volatility, this suggests EA real estate market has performed better since 1990's in general. Notice it would have been nice to assess real home price index series back to 1970 until early 2000's to see whether the performance of US housing market was indeed lower than EA before the subprime crisis which I sincerely doubt regarding the analytical view of nominal indexes as US HPI is higher than EA all along except for the period 1990-2010. A great reader would see the difference in slope of the deterministic trend between the two nominal HPI where the US one is slightly stronger than in EA meaning the growth of US HPI should be faster than EA in future as the end of 2019 is suggesting. From my own perspective, the covid 19 crisis will for sure impact the housing prices since it has a real effect households wealth and has typically contracted the credit market due to a sudden increase in the probability of default of all agents because they couldn't work. However, covid 19 will also have some boosting impact on real estate once the economy can start its activity again as it has created an exceptionally strong demand for greater houses in countryside and city peripheries at the detriment

of city centres, boosting transactions in both US and EA. Speaking of real estates, it is worth to point out that covid 19 will not only impact the private sector but also the commercial real estates because companies that have successfully adapted their activities and have improved the teleworking do not require the same amount of buildings than before which would lead to shocks in transactions and inventory available on that particular sector of real estates. A striking example is how the European Commission has intended to leave one half of its office by 2030 to cut their fixed asset costs while connecting workers in centralised, shared buildings amongst different departments in the centre of Brussels next to the European Parliament according a newspaper article, Deglume P. (2021).

3.1. Housing prices determinants

3.1.1. United-States stationary VAR analysis

Beginning with the US housing market, the reader can find in the Annexes the adjusted R^2 of stable stationary VAR processes for ante crisis period (1970 Q1 - 2007 Q2), the post crisis period (2010 Q1 - 2019 Q4) and the full sample (Annexes: Tables 3,4,5) respectively. As a first statement, the US real home price index from 1970 until 2019 is not significantly changing regarding either inflation, unemployment, the asset flow of mortgages owned by private sector nor the long term interest rate according all samples neither in subsamples nor in full sample. Indeed, even if they may depict some statistical significance in some VAR, the fact that their coefficients are changing signs from one period to another do not lead to a powerful interpretation. Besides, it appears for US that private credit and LT interest rate are superior than M3 and the 30 years mortgage fixed rate because the latter lead to lower R^2 so final selected models do not include them.

All reported VAR highlight the positive effect of lag values of real HPI on itself current value no matter the time period which suggest that some key drivers are missing in all specifications which is sensible regarding the discussion about the bunch of housing price determinants that were left aside of this analysis. Also, this paper advocates that the real HPI is linked to economic activity such as most previous researches concluded. Notice however that results suggest an overall negative impact of real GDP lag values on real home price index which is difficult to interpret as such. Nevertheless, the ante crisis period models assessed (1970 Q1 - 2007 Q2) (Annexes VAR 2, 3) are in line with previous studies as it depict a positive relationship in “normal” times of the economy. Then, the negative impact observed from full sample come from the post crisis period (2010-2019), which can be seen as the demonstration of the disconnection between the housing market and the rest of the US economy that happened because of its bubble’s burst and the foreclosures’ wave that occurred after that. It is sensible to understand that this sudden rise in supply on housing market associated with the drop in demand has prevented housing prices to rise in line with the economy until the financial situation of Americans households is not stabilized. This economic interpretation is supported by the analytical view of both home price index and GDP for the USA as they both share a common trend until the financial crisis. At the end of the Great Recession, the GDP increased quite fast once Obama’s administration had established the American Recovery and Reinvestment Act (ARRA) on February 2009, leading to boost the economy and more particularly consumer expenditures whereas home prices were still facing the consequences of the real estate crash. One may explain the final negative impact of real GDP on home price index observed on full samples by the extraordinary drops in both GDP and HPI during the crisis added with difficulty to get back to usual levels after that, meaning the subprime crisis had a structural and long lasting effect on this relation that exceeds the one from the past.

While the long term interest rate is inconclusive when assessed under the whole period, the analysis found a negative impact of the short term interest rate on real home prices. Notice interest rates are both included in the specification so that the model might suffer from cointegration but still, an

unexpected change in estimates' scale between ante and post crisis period is worth to stress. Indeed, results suggest LT interest rate impact on real HPI was greater than the ST interest rate one before 2007 whether these forces has been reversed from after crisis models to depict much more importance in ST interest rate changes. We should reasonably observe both rates to have a significant negative impact on real HPI since both are closely related. Also, the long term interest rate is determined by the policy rate and sets the basis for mortgage rates and acts as a constraint on soaring prices because higher interest rates prevent some households to buy on housing market because they are not able to contract loans at higher rates. As such, this paper gets evidence only for the short term interest rate relation and It is difficult to explain why models (ante crisis and full samples) are inconclusive regarding the long term one. However, the post crisis period VAR proved a change in importance of interest rates in defining the HPI as both rates lose their statistical significance after 2009. This lack of evidence after crisis may be explained by the zero lower bound reached by the policy rate that lost its transmission power which forced the Federal Reserve to use unconventional policies, not related to interest rates to restore economic stability. In addition, even if long term interest rates were attractive to boost demand and easing transactions, households either have no financial capabilities to enter on real estate market nor enough trust in the US economy to invest in housing. Then, the connection usually observed between the financial sphere and house prices has been broken and doesn't seem to be fixed yet since the full sample IRF looks closer to post crisis than before, suggesting these last 9 years takes more importance in house price dynamics than the several decades taken into account in the ante crisis period.

Another candidate as key determinant of real home price index from 1970 until 2019 is the proportion of private credit but their relationship may have faced a substantial change because of the financial crisis. Indeed, the first VAR using real HPI, real GDP, both interest rates and private credit shows negative effect of the latter on house prices whereas it demonstrates a positive relationship with real HPI on the subsample before the financial crisis and is insignificant after. In "normal times" (before 2007), an increase in private credit implies an easier access to loans in general, including mortgages that are tightly linked to the housing market demand. Then, more credit attributed to agents may increase prices as more and more households enter on the market where the supply is known to be sticky in the short run whereas demand's fluctuations can be strong. Because the full sample states for the opposite relationship and the post crisis period is insignificant, a robustness check has been performed (but not reported) and is developed later on.

Let's turn now into a different VAR specification for US using real GDP and LTR again with new variables as the Asset flow of total home mortgages and the Consumer Confidence Index (CCI) (Annexes: US VAR 3). This different specification from the first VAR demonstrates the significant positive effect that the CCI has on real house prices on the whole time period, meaning expectations of consumers are playing an important role in the housing market prices. Looking at subsamples models, it appears the CCI to be a determinant of real HPI only since the financial crisis as it was insignificant regarding historical data before 2007. One can advocate it is precisely because the financial crisis of 2008 proved a burst in US real estate market to deeply affect Americans wealth and the economy. It is true that the US faced others financial crisis by the past but none of these were directly linked to the housing market as it was the case in 2008 so it is understandable that this new dynamic surpass the nonexistent past relationship.

The last US VAR specification (Annexes: US VAR 5) was performed to understand what components from GDP is more or less related to housing prices so that it includes the private consumption and the residential investment with private credit and the unemployment rate as endogenous variables. This particular demand-side VAR leads to strong evidences for both GDP components and discredit

unemployment as a potential determinant of house prices. In this regard, a robustness check has been performed and is explained (but not reported) later on.

Firstly, the model retrieves the positive effect from residential investment on real home price index. This relationship is sensible between household residential investments and the housing market in US since they represent a large proportion of households expenditures which often have a direct effect on the intrinsic value of the real estate as such investments are used to renovate, expand, embellish the current real estate. Notice also the analysis does not find any change in the importance of residential investment meaning the implication of mortgages in the subprime crisis had no structural impact on how households are investing and more precisely on how do residential investments are reflecting in house prices.

Secondly, the private consumption of Americans is significantly found to impact negatively the home price index in all time periods assessed. This is a strong result explained by the tradeoff faced by households between consuming typical goods and services or to housing activities. Indeed, households must choose in which they spent most part of their income so that we can view both as substitutes where the importance of the substitution effect should depend on consumers' preferences and on their income (amongst other features). Indeed, households expenditures can be separated between the part attributed to housing (buying, renovation, expansion) and the rest to consumption as such (food, leisure, goods, …). Then, traditional goods and services markets act as competitors of the housing market and the pressure from its demand can decrease in the advantage of all other sectors. This being said, an increase in private consumption may imply less income available so the demand in the real estate market is reduced, leading prices to drop few times later, all the rest remaining equal.

3.1.2. Robustness Check of stationary VAR models of United-States

This paper performed more model specifications (not reported) in order to check for the relevance of VAR estimates, replacing one or two variables and compare whether results significantly change.

Concerning the US VAR models, the first robustness check replaces the real GDP by the unemployment rate to account for real activity into the specification including short term interest rate, long term interest rate and private credit used to define real house prices. The model depicts two significant lags of real HPI which may imply omitted variable in models and its results for both interest rates are consistent with others, corroborating the negative impact of short term interest rate on real HPI. This VAR is interesting because Unemployment depicts a surprising negative impact on house prices that is significant only for the post crisis period, suggesting that the financial crisis led to intense unemployment that impacts the housing market whereas they were independent before. Notice its last lag is apparently significant although it is not reasonable to think that more unemployment lead to higher prices. This result is not supported by other VAR specification (Annexes: US VARs 3, 5) and therefore unemployment is not found to be a key determinant of the US real HPI.

Regarding the total credit attributed to private sector, the VAR for robustness check (VAR 2, not reported) shows a substantial change in its impact on house prices as a negative effect is observed. So say, this VAR comparison seems to show a structural change in credit happening during the financial crisis that substantially changes the dynamics between credit and house prices. It appears that more loans attributed to private sector decreases the real house price index in the US since 2008. Maybe it is linked with the stylized fact that banks are issuing more loans in periods of booms and financial stability thus banks may require less collateral in these periods, decreasing houses' value and their

prices. This result would also suggest that the US was already recovering in 2010, at least its financial sector. However, this explanation cannot explain the positive relationship before the early 2000s.

Indeed, The US VAR model that includes unemployment, private consumption and investment in its specification is used as second check corroborates previously reported VAR results except for unemployment. Including the long term interest rate from VAR also leads the adjusted R^2 from real HPI equation to increase substantially from 40,1% to 50,2% (Annexes: Table 3) for the ante crisis period while changing nothing for the post crisis. This again advocates for a disconnection between financial institutions and housing market after the crisis as it was a key driver before that has lost all its explanatory power since 2010. Notice the long term interest rate remains exceptionally low in the end of 2019 compared to its past values so it could imply less implication in the access for borrowing to households in case of a rise in interest rates since it is already low, the impact may be very limited knowing it was above 6% on average until 2000 with a peak at 14% in 1980's.

Knowing what are the actual drivers of the real home price index evolution in the United States, the following sections will focus on the Euro Area. Next, a first conclusion will compare stationary VARs outcomes between the two geographical area at the end of section 2.

3.1.3. Euro Area stationary VAR analysis

One drawback of this section is due to the lack of data which prevented this work to compute subsample analysis as models using smaller samples either led all features to be insignificant or unstable processes. As a consequence, the actual VAR analysis for EA is quite limited relatively to what was performed for the US but processes obtained on the full period are stable and Phillips Perron test verifies the weak stationarity. Therefore, it is still useful to have a look at HPI's relations from 1999 until end of 2019 and compare it with results from US analysis afterwards.

Besides, every VAR has at least a highly significant constant and/or trend parameter, implying there is still some important trend with meaningful information that not taken into account by the model specification and is missing to properly estimate the real HPI's evolution.

It appears that the best VAR specification for the Euro Area according to adjusted R^2 of VAR equation of real house prices (Annexes: Table 6) includes real GDP growth, the long term interest rate, the growth rate of the broad money supply and the Consumer Confidence Index (CCI) with a lag order of 4 and two parameters to account for deterministic and stochastic trend. However, its estimates (Annexes: EA VAR 5) are not convincing because only the long term interest rate and the broad money supply are found to be relevant determinants. Notably, the real GDP does not show clear effect on house prices even if it is obviously an important feature to explain house price variation. Therefore, another VAR has been performed and will be detailed in the robustness check section.

In addition, this VAR depicts insignificant real HPI's past values suggesting the model contains sufficient relevant variables to determine house prices and its own lag values becomes meaningless. However, this is surely wrong intuition since the other model specifications are not consistent with it.

One key result from this paper is the evidence of the broad money supply importance in determining house prices in EA. The fact that M3 decreases the real house prices when it rises is more linked to the explanation of Füss (2010): because agents owned more money in many forms, they are tended to consume and invest in another types of asset rather than real estate, whereas private credit series is more related to mortgages, long term loans attributed to private sector which are typically used in housing activities only. Due to this possible substitution initiated by a greater money supply, pressure on real estate market supply decreases and the market price is reduced later on.

However, it appears that the CCI is never significant (Annexes: EA VAR 5) and this result is repeated no matter what is changed within the model which is another difference with the US: the Consumer Confidence Index reflecting the degree of trust and willingness to consume from agents has a positive impact on house prices in the United States whereas we found no evidence for a similar relationship in EA, meaning the European real estate markets are less sensitive to consumers expectations. As such, it is important to keep in mind that some countries faced crisis linked to their real estate market and others have never experienced it. It would have been interesting to look at this relationship by separating the two kinds as we might observe a positive impact of the CCI like in the US for countries such as Spain, Ireland, Greece but certainly not in Germany, France, Belgium which typically do not faced any severe crisis.

Another key findings from the two other VAR specifications (Annexes: EA VAR 2, 5) is that, EA real house prices are depicting negative relationship with long term interest rate which could be explained in two manners. From Füss (2010) an increase in this interest rate pushes upward the attractivity for other fixed assets and therefore decreases house prices as there is less demand for it. As far as I am concerned, I rather see this relationship as stronger financial constraints for households because mortgages also rise so that the market adjusts the house price to get back to equilibrium after the reduction of the demand induced by the initial rise in financial cost. This finding is different from what is found regarding the US where there is no clear negative impact due to significant and positive coefficient of long term interest rate.

More surprisingly, the VAR specification including the short term interest rate, unemployment and private consumption (Annexes: EA VAR 4) depicts a positive effect of short term interest rate that is explained by Füss (2010). This way, the short term interest rate is more acting as a cost from the supply side rather than from the demand side since investments in buildings are typically of shorter term than the ones of buying. In this perspective, a rise in the short term interest rates decreases the supply as the inventory of dwellings becomes insufficient due to lower construction investments leading the scarcity of houses to increase prices. Because this explanation could also be applied to US case, the fact that we observe opposite impact on the real home price index is puzzling and would require some robustness check. Nevertheless, one can advocate the Euro Area VAR coefficient to be correct assuming the density of population lead to great pressure on the supply for housing so as to surpass the negative effect from the financial sphere.

A third difference is related to unemployment effect (EA VAR 4) on house prices which is finally found negative and important for EA where a rise in unemployment has a rapid transmission in reducing house prices as the first and the second lags are significant. This last result suggest a stronger link between work availability and house prices in EA countries than it was initially assumed. It may also be explained by a greater wealth effect through a reduction of income that constraints financial access in the EA rather than the US.

One similarity found in this analysis between US and EA lies in the importance of private consumption in determining the real HPI as two VAR models from EA depict evidence of negative and significant coefficients.

The second VAR model (Annexes: EA VAR 2) using private consumption and residential investment to account for real activity shows also a negative impact but from residential investment which is puzzling to interpret since it is somewhat negative in the Euro Area and takes at least 9 months to occur. This relationship is unreasonable since a rise in residential investment is used in renovation or expansion of the real estate which typically increase the value of the asset and therefore its price. Normally, the series does include such activities but if it also contains investment related to building activities, then

one could see the obtained results as reasonable since it takes times for such investment to be fully realized where it would imply a higher inventory of houses (understand the supply) which in turn lead to lower prices assuming a constant demand. Then, it suggests the residential investments in EA to be mainly driven by building new houses rather than improving existing ones. Notice this explanation fit to the one made about the short term interest rate positive impact on real HPI that comes from an insufficient supply leading to investment opportunities which could attract new contractors able to bear the high interest rate.

Another divergence lies in the effect on the proportion of credit (Annexes, EA VAR 2) attributed to households since it is found positive for EA during the period 1999-2019 whereas the full sample for US demonstrate a negative impact. One economic intuition behind it could be that EA did not experience a structural changes in this relationship, maybe because the financial crisis consequences wasn't linked to EA housing market like it was in the US.

3.1.4. Robustness Check of stationary VAR models for Euro Area

Using the two following models (not reported in Annexes) as robustness checks for EA VARs:

- VAR 1: Δln(real HPI), Δln(real GDP), Δprivate credit, short term interest rate, long term interest
- VAR 3: Δln(real HPI), Δln(M3), Δln(residential investment), long term interest rate

Notice the first model (VAR 1) includes both long term and short term interest rates so the model might suffer from a cointegration relationship that is missing in the assumption made. Nevertheless, using only one interest rate decreases the explanatory power of VAR regarding house prices so I decided to keep it as reported notably because results are consistent among the different VAR specifications. This specification suggests an increase in past real GDP values to increase the real home price index as theoretically expected. However, this relationship is verified only in this VAR which is somewhat due to the combination with short term interest rate and private credit as changing one of these two erases this outcome. Again, more advanced statistical models should be more accurate in results. On the contrary, the VAR regression of real HPI reports the private credit attributed to households as important driver of home prices' evolution.

Surprisingly, it seems that the broad money supply (estimated by the third VAR) is significant and negative only when the long term interest rate is included in the model specification which may be due to a hidden correlation or common trend between the two that is more related to real house prices than M3 solely. Besides, while private credit and M3 should be nearly equivalent in terms of interpretation in this case, the Euro Area has consistent opposite outcomes where the first has positive effect and the latter a negative one. In addition, This same VAR for robustness check corroborates the unexpected negative impact of residential investment in house price.

Notice issues concerning this sometimes significance and sometimes not of coefficient estimates regarding different model specification is common in VAR as well as SVAR analysis. Therefore, it would be important to look at the consistence of results regarding more advanced econometric model.

3.1.5. Stationary VAR models: conclusions

So far, this paper gets evidences that there are quite important differences in how macroeconomic features can impact the home price index of US and EA respectively. Because there are few, let's first highlight similarities between the two continent which are the negative impact of a rise in private consumption and the positive impact lag values of real HPI, the latter indicates some important missing

variable in determining house prices which is obvious knowing the complexity of the real estate market and its price determination.

Looking at financial dimension first, a negative effect of long term interest rate at least for the EA as it was expected knowing its effect on the demand as well as a positive effect of short term interest rate whereas the US real HPI decreases as the policy rate has increased in the previous quarter. These findings are in line with Schnure (2005) for US and Englund and Ioannides (1997) for EA. The proportion of private credit is also found important in explaining HPI in both area but has opposite effect whereas M3 seems to matter only in Europe.

From the real activity, unemployment rate seems to have great implication in EA but not in this US , while it is the opposite concerning the Consumer Confidence. Residential investment results are also suggesting important differences in how it affect home prices but it is certainly due to a difference in the definition of data itself since both explanations cannot coexist while being correctly linked with the impact the short term interest has on HPI.

Now that we get a first intuition about some key determinants that drive the housing market price, an analysis has been conducted to better understand the future home price index dynamic's fluctuations when an unexpected one-time shock occurs.

3.2. Housing market's dynamic: Impulse response function

Using the ordering explained in the methodology related to Impulse response function, I applied SVAR on level VAR as it is advised by E. Sims and explained in previous section. This section presents the results from orthogonal IRF of both a short run and a long run impact of a one-time structural shock of the most relevant SVAR model specifications for US and EA, including an economic interpretation of the real house price indexes responses when feasible. Besides, comparing two orderings where the first assumes the real house price to be independent from direct shocks whereas it is considered as endogenous in the second allows to check for the presence of a direct link between house price and its macroeconomic determinants

3.2.1. US real Home Price Index's dynamic

First looking at the US housing market dynamic, we can observe some strong difference between the ante crisis and the post crisis periods for certain macroeconomic variables, depicting that a sudden structural change in their relation with house prices has indeed occurred. This has a first implication that the real HPI for USA may be sensitive to a different bunch of macroeconomic fundamentals or at least that a substantial disconnection with its determinants indeed happened and has long lasting consequences on housing price's dynamic. This first result is in line with what previous literature found using more advanced econometric models taking into account different regimes and therefore allowing the relation with a same feature to change depending on the cycle's phase of the housing market such as in NBW (2013). After a fastidious process so as to find the best SVAR specifications possible regarding the data collected, 3 level SVAR models have been kept and IRFs based on them are reported in Annexes. These are defined and ordered as follow according to first ordering, based on the Keynesian definition of prices:

- SVAR 1: : ln(real HPI), ln(private credit), short term interest rate, long term interest rate, ln(real GDP)
- SVAR 3: ln(real HPI), long term interest rate, total mortgage as asset flows, ln(real GDP), CCI
- SVAR 5: ln(real HPI), long term interest rate, Unemployment ,ln(private consumption), ln(residential investment)

Recall the second ordering is nearly the same except that home price index is placed in last position to assess for the statistical evidence for contemporaneous impact. All the rest of variables remain in their respective position. Notice SVAR 2 and SVAR 4 are used as robustness check evaluation models and are not reported in Annexes to keep this work clear. Same for full samples IRFs where this paper reports only the ordering that suits best for the majority of variables. The reader will soon learn that the assumption of price stickiness to immediate macroeconomic shocks may be wrong regarding some relationships.

In most level SVAR models performed on ante crisis and full periods, the real home price index has a contemporaneous positive shock on itself which does not die out even 2 years once it occurred or showing a very smooth convergence to its initial level. This is a typical result using level SVAR for this particular impulse response function since it reports a ceteris paribus shock. Therefore, such rising persistence may be attributed to homeowners' confidence in the value of their real estate, expecting it not to fall in the future, especially in case of a sudden rise in real prices not initiated by any external change. Nevertheless, post crisis models are rather showing clear convergence, faster in some specification than others where the last SVAR demonstrates the greatest dynamic's change between those two periods. This can reflect the drop in the housing market trust of households that are not as confident about the long lasting positive impact a one-time rise in real prices can have as they were before the US real estate bubble's burst.

From the three model specifications, outcomes reported proof that the financial crisis period has created a clear disconnection between the real home price index with both interest rates and private consumption. Indeed, in models specification including long term and/or short term interest rate, IRFs get evidences of a negative impact during that can remain one year after the shock has occurred in the period before 2007 for both rates (Annexes, US IRF: 1,3,5 ante crisis) whereas the relationship is completely lost since 2010 (Annexes US IRF: 1,3,5 post crisis), reflecting the expected disconnection that arises because of extraordinary low rates unable to induce any incentive to asset price's evolution anymore. This result suggests the monetary policy was able to prevent housing prices to soar when the interest rates were high enough to substantially impact households wealth.

More precisely, the short term rate is found as being the most important variable in the first SVAR (Annexes: US IRF 1) with evidences of no immediate transmission and of the long lasting negative impact a rise in short term rate may have on US real home price index's dynamic. There is no such proof regarding LT rate shock in both ordering which would imply a greater importance for short term rate than LT one regarding home price index dynamic in the US. Private credit has poor significance in increasing house price even in the short run as the 95% confidence band reaches the horizontal axis, thus a robustness check has been performed and will be explained in next section.

In third SVAR (Annexes: US IRF 3), the LT rate is finally significant at least after the shock occurred meaning the real house price index needs time to adapt as the second ordering leads to useless IRF for this impulse. Notice this last observation is in contradiction with another reported specifications (SVAR 1,5) so that no conclusion can be drawn regarding a possible immediate effect. Except for this outcome, the second ordering of SVAR 3 specification brings important information regarding contemporaneous impacts for all other shocks, meaning the home price index may not be as sluggish as transaction prices used in most previous studies. The full period analysis on this specification using the second ordering results in satisfying outcomes such as the rise in mortgages owned as asset by households which decreases the real home price index immediately to slowly die out within 2 year on average. The exception in the full sample is the long term interest rate impulse but it is sensible since it is the sole to suit best to first ordering and all other impulse variables have a contemporaneous

impact on real home price index with quite long lasting effect that slowly dies out during two years on average since the structural shock.

Unfortunately, this paper failed to find any significant relationship with the real GDP on the full sample (Annexes: US IRFs 1,3) which was also found by Schnure (2005) at the national level so this result is reasonable although it would imply that boosting real activity may not have a substantial impact on housing market so that this kind of policy may not be able to restore stability on housing prices after a burst. Nevertheless, this analysis found little evidence for a negative contemporaneous shock of real GDP on home prices on both subsample periods while depicting significant impact during 1 year. One reason to this finding may be that observing a boost in real activity increases aggregate demand immediately which in turns increases competition on the housing market, leading the price to rise then the shock's effect smoothly dies out.

In the last SVAR specification (Annexes: US IRF 5), the analysis clearly advocates for a no contemporaneous impact of private consumption since putting house price index in the last position from SVAR 5 (Annexes: US IRF 5) leads both the IRF and the confidence interval to start at 0. In addition, a private consumption shock is found to negatively affect the home price index for more than 2 years, suggesting that a rise in private consumption at one time is reducing the part of wealth households may put into housing because if they prefer to consume more goods and other assets today, their part of wealth attributed to housing should reduce and therefore the price follows because private consumption is the main part of households expenditures.

The analysis performed by subsamples before and after the Great Recession depicts also interesting changes regarding home price index's dynamic with CCI even though they are less significant in the long term but results suggest a sudden rise in CCI to have a positive immediate effect on real house price index. What is worth notice is the stability of the impulse response from the ante crisis period that reflects the stylized fact that before, Americans saw real estate as a safe asset that cannot lose value so any rise in their confidence had a long lasting impact on the price of houses. However, the post crisis period depicts a clear convergence despite its wide confidence interval. It is retrieved in the shape of IRF on the whole period, then, indicating a substantial one-time change in agents' behaviour and confidence about consumption in general, impacting its linkage with real estate price's evolution. While the initial shock remains in the same intensity, its diffused impact across time totally differs and can quickly die out or remains but this in much less importance than before 2007.

Another insignificant result appears regarding the unemployment shock's transmission into real home price index that is never found significant as its shock can impact house prices positively as well as negatively. Therefore, a robustness check is required in order to verify the fifth SVAR specification.

Residential investment shock (Annexes: US IRF 5) has a puzzling negative direct effect on home price index in the short run but as the rest of the IRF is uninformative, one can agree this result cannot be trusted especially regarding its counterpart when contemporaneous independence is assumed. However, before the financial crisis, a significant positive contemporaneous impact of investment with an increasing effect as time passes is observed which is more sensible economically speaking than a drop followed by random impacts. In fact, the post crisis IRF may depict a sudden change in investment behaviour related to real estate in the US that strongly differs from past Americans habits that disrupts the usual linkage between residential investment and real house prices. Nevertheless, the first ordering leads to clearer interpretation of a residential investment shocks as it depicts same overall results with better confidence interval so that this SVAR cannot advocate for a contemporaneous impact of residential investment on real home price index whereas it was striking regarding private consumption in both ordering. Besides, the private consumption shock can have an overall greater

negative impact than the positive one from investment which can be attributed to their respective weight into households expenditures. This last SVAR specification is therefore informative about residential investment and private consumption dynamics with home price index which depict same evolution on the full sample than in the ante crisis period, meaning the disconnection due to financial crisis has no important impact on the evolution of HPI yet.

3.2.2. Robustness Check of US Impulse response functions

In the same spirit as for stationary VAR analysis, more model specifications are used to check the relevance of results reported but those robustness checks models are not reported for a matter of clarity in the Annexes section.

In the US case, looking at the second SVAR (not reported) where real home price index was defined using private credit , short term interest rate, long term interest rate and the real GDP (in this specific ordering) permitted to check if results reported before are supported by other specifications because estimates in VAR and SVAR analysis are often observed not to be consistent in every models, certainly due to omitted variables that mislead results. This first robustness check has strong conclusions:

Firstly, short term interest rate is definitively a relevant driver of real home price index dynamic with evidences suggesting no contemporaneous effect but this shock has nonetheless a long lasting negative effect on housing prices. Notice its impulse on the post crisis period is completely different but it is again a proof of a disconnection with house price (and asset price in general).

Secondly, Unemployment is never significantly linked to real HPI dynamics if we rely on confidence interval but the IRF depicts an overall negative effect from a rise in Unemployment on future value of HPI. This corroborates its lack of significance in SVAR 5 and results from stationary VARs that do not recognized a clear positive nor negative effect. In addition, private credit in this SVAR remains uninterpretable but depicts an immediate negative impact on house prices that has greater intensity in post crisis period than before. I would rather expect this dynamic to arise in the long run but this finding may be wrong as the full sample depicts a interpretable IRF only assuming the home price index to be contemporaneously independent from a private credit's shock.

The fourth SVAR (not reported) using the following order: ln(real HPI), unemployment, ln(private consumption), ln(residential investment) was conducted to test unemployment, private consumption and investment to confront its results with the fifth SVAR which has the long term interest rate added in the specification. This test has corroborated the insignificance of unemployment as well as the dynamics observed after a shock in private consumption and investment with one little evidence for a negative immediate effect of a rise in residential investment on house prices in the post crisis period.

3.2.3. EA real Home Price Index's dynamic

This last results section is focusing on full sample SVAR using level VAR models and Cholesky decomposition as it has been done for the US. Unfortunately, this paper is not able to assess any differences in real home price index's dynamic due to financial crisis but IRFs performed on full sample (1999-2019) can still be compared with the similar ones from the USA to observe if there is any striking difference in which impulse truly drives real home price index's evolution. Besides, comparing the first ordering and the second ordering, where real HPI is assumed to be the most exogeneous and endogenous respectively, allows to assess whether one impulse variable has a significant contemporaneous effect on HPI under a 95% confidence interval.

A first little divergence with the US lies in the response of their respective real HPI to a shock from itself where US depicts smooth convergence to zero after 2 years on average according its confidence intervals from all models, the response for real HPI in EA depicts rather greater impacts with an

exploding trend or could be composed of up and down spikes with poor evidence of convergence. This outcome is puzzling to interpret without having precise information about how those home price index series are computed by the OECD. A complete documentation about Eurostat methodology supported by the OECD is available however, because of those indexes have been proved different by Daniel Gros (2007) there is surely some computational technicity that would be able to explain such difference in IRFs from US and EA real home price index, especially since their patterns look very similar (Figure 4, p.21).

Like the US analysis, this section is based on 3 main SVAR model specifications on which we assess the contemporaneous and short term impact of a one-time shock on real home price index. Those models have the following composition and ordering:

- SVAR 2: ln(real HPI), ln(residential investment), ln(private consumption), private credit, long term interest rate
- SVAR 4: ln(real HPI), ln(private consumption), unemployment, short term interest rate
- SVAR 5: ln(real HPI), CCI, ln(real GDP), ln(M3), long term interest rate

Notice that models called SVAR 1 and SVAR 3 are used in the robustness check section to verify the relevance of some impulse response function using a different but similar model specification.

The second SVAR (Annexes: EA IRF 2) supports the evidence of a contemporaneous and negative effect on real HPI from an long term interest rate as well as the no immediate effect of private credit. Assuming the home price index to be the most endogenous leads to a possible contemporaneous relationship with credit but it becomes too inaccurate after that to be trusted. Looking at the same model assuming the home price index to be sticky, IRF is more informative, showing that the shock can either have nearly no impact or an increasing positive effect. Concerning residential investment in EA, it appears poorly linked in time and the confidence interval is near zero so that a robustness check is required before writing any conclusion as it can be due to the specific set of variables chosen.

The fourth SVAR (Annexes: EA IRF 4) using unemployment and private consumption as economic activity features and short term rate to account for the financial policy brings strong evidence for a contemporaneous and long lasting negative impact of the short term interest rate on real home price index. This result is more significant than what was found by MNS (2013, Figure 8) that didn't observe such immediate impact. Notice this assumption of contemporaneous relation is sensible since the first ordering leads to inaccurate IRFs. In addition, this specification suggests less importance of unemployment than what VARs in previous section depicted as it give only poor evidence for either no or small negative impact on real house price for less than a year and then the dynamics related to the rise in unemployment becomes random.

The last SVAR specification (Annexes: EA IRF 5) shows no contemporaneous impact possible from a shock initiated by either the broad money supply or the CCI but has little evidence for a small but positive impact of real GDP and becomes inconclusive. However, such contemporaneous relationship can be criticized since the first ordering IRF depicts a long lasting relation if we do not consider the confidence interval. Making abstraction of the confidence bands, IRFs depict a positive effect from a rise in CCI on real HPI that dies out 2 years later and that money supply has the opposite effect that remains in the long run. One detail to notice is the difference in response from real HPI regarding whether the SVAR includes the private credit as proportion of GDP or the broad money supply. Because the first has a stronger implication in house prices than the latter according their IRFs and also because it is in line with Füss (2010) work, I understand the private credit as being more relevant than M3 which should be left out this analysis notably because it contains liquidities not related to housing market.

3.2.4. Robustness Check of EA Impulse Response Functions

There are two different SVAR models to test the relevance of EA's results which are SVAR 1 and SVAR 3 (Annexes: EA IRF 1, 3) with the respective first ordering:

- SVAR 1: ln(real HPI), ln(real GDP), private credit, short term interest rate, long term interest rate
- SVAR 3: ln(real HPI), ln(M3), ln(residential investment), long term interest rate

In the first SVAR using natural logarithm of real HPI and real GDP, private credit, short term and long term interest rates in this particular order, IRFs (not reported) bring evidences that private credit and LT interest rate have either no contemporaneous impact or a negative impact on real house prices which are sensible results regarding the economic theory. Notice however that IRF become uninterpretable just after the shock occurred especially for private credit and real GDP which has a significant positive immediate impact. Because of the lack of accuracy from those impulses, I do not make any conclusion based on these findings that must be corroborated in other SVAR specifications. Regarding interest rates, a rise in LT rate has a long lasting negative impact on real HPI and it can either immediately impact real house prices or not whereas this model lost its explanatory power concerning the dynamic with the short term interest rate which is certainly due to the presence of the long term interest in this specification compared to SVAR 4.

The third SVAR (not reported) is again showing an important impact of one time shock of LT rate on RHPI and so for several years as the IRF is exploding downward, also found by the last SVAR. Residential investment is found to be insignificant in this specification as well which may indicate such investment in EA is not important enough to impact the housing market price on its own as it does in the US. Replacing private credit by the broad money supply does not improved our understanding of linkage between the proportion of credit attributed to household and the home price index.

3.2.5. Housing market's dynamic: Conclusions

Now that the real home price index's dynamics has been widely assessed using different macroeconomic fundamentals for United-States and Euro Area individually, some similarities and differences can be highlighted.

Beginning with the similarities, this empirical work concludes of a common opposite dynamic of real home price index with the long term interest rate in both US and EA except the lack of strong statistical evidence for the immediate transmission of the long term interest rate's shock regarding US. The nearly same conclusion arises with the short term interest rate but this time, it is proven not to have an immediate impact in this United-States. Notice this key findings suggest therefore the Euro Area housing market to react more strongly to interest rates fluctuations which is in contradiction with the theory stated by Iacovello and Minetti (2003).

In addition, this paper failed to find any relevant linkages with private credit, real GDP and unemployment in both areas meaning these not to be macroeconomic fundamental determinant of house prices as it was assumed at the beginning of this analysis. So say, something prevent this analysis to retrieve the positive relationship between real GDP and house price in EA found by Englund and Ioannides (1997).

Regarding the substantial differences between those two continents that arise in their home price index's evolution, this paper has demonstrated a positive impact of CCI and residential investment in the short runs for both and a long lasting effect for residential investment in the US whereas no relationship has been found for EA. Also, it seems the housing price index of US is tightly link to private consumption in the reasonable way where we do not find any evidence of a significant dynamic in Euro Area. These results can be criticized knowing the hidden heterogeneity of countries within the Euro Zone compared to the homogeneity of States in America for some of these variables such as the level of consumption, residential investment. Therefore, taking into account all real estate properties explained in theoretical foundation section are useful in arguing why EA results should be interpret carefully.

Conclusions

This work has been managed using a similar methodology as previous analysis with the particularity of including the subprime crisis in a greater sample and to use the home price index constructed by the OECD instead of transaction prices as it is usually performed in similar analysis. A first nice implication is the ability to find evidences of substantial changes in what drives housing prices since this period. However, it also implies statistical issues using SVAR so that one solution to obtain more accurate results may be to perform same analysis using more advanced models able to separate the analysis between 'normal times' and 'recession or crisis times'. This analysis allows to stress some key determinants of housing prices in the US that saw their dynamics perturbated for a long period due to the financial crisis linked to the burst of a real estate bubble. This also suggests new features should be important in defining house prices since 2008 as such unconventional financial policies and flexible mortgage rates that started to gain in importance since the XXth century.

Still, this paper succeeded in proving some key differences in macroeconomic factors of real home prices between the United States and the Euro area such as its fluctuations due to short term interest rate, private credit, residential investment, CCI and unemployment. There is also evidence that private consumption has the same impact on both continent, implying our consumption not to be that different from Americans' consumption. On the other hand, real GDP and long term interest rate implications are puzzling to interpret if we consider the stationary VAR results. However, it appears that using SVAR and IRF lead to different outcomes for several determinants that are found insignificant such as shocks in private consumption or investment that have no accurate impacts on housing market price.

Moreover, outcomes suggest a greater sensitivity of real home price index in the Euro Area regarding a shock in interest rates fluctuations whereas the United-States housing market seems to strongly react to consumer confidence and consumption. The negative impact of increasing interest rates is also retrieved in US but with less intensity since its home price index doesn't react immediately.

In light of these outcomes, it would be very interesting to continue this analysis by a variance decomposition analysis for a deeper understanding of a shock transmission into other variables. taking into account the different stages of the economic cycle and/or the ones from real estate cycle would also be useful to corroborate the observed switch in some dynamics with house prices regarding the global economic situation. Moreover, the structural changes observed following the financial crisis indicate that new variables that were not at all relevant in the past could appear to be important during a crisis. For example, unconventional policies such as the repurchase of mortgages and other toxic assets by financial institutions in order to alleviate market stress are difficult to access over a long period of time, making it impossible to use them in the analysis conducted in this paper. Therefore, performing different model specifications for different time periods could lead to a better understanding and estimation of the housing market's evolution. Also, the home price index was found useable in VAR and SVARs but its methodology should be assessed more deeply to understand if it is indeed a useful instrument in housing price's analysis aiming at defining what are the key drivers of its dynamic.

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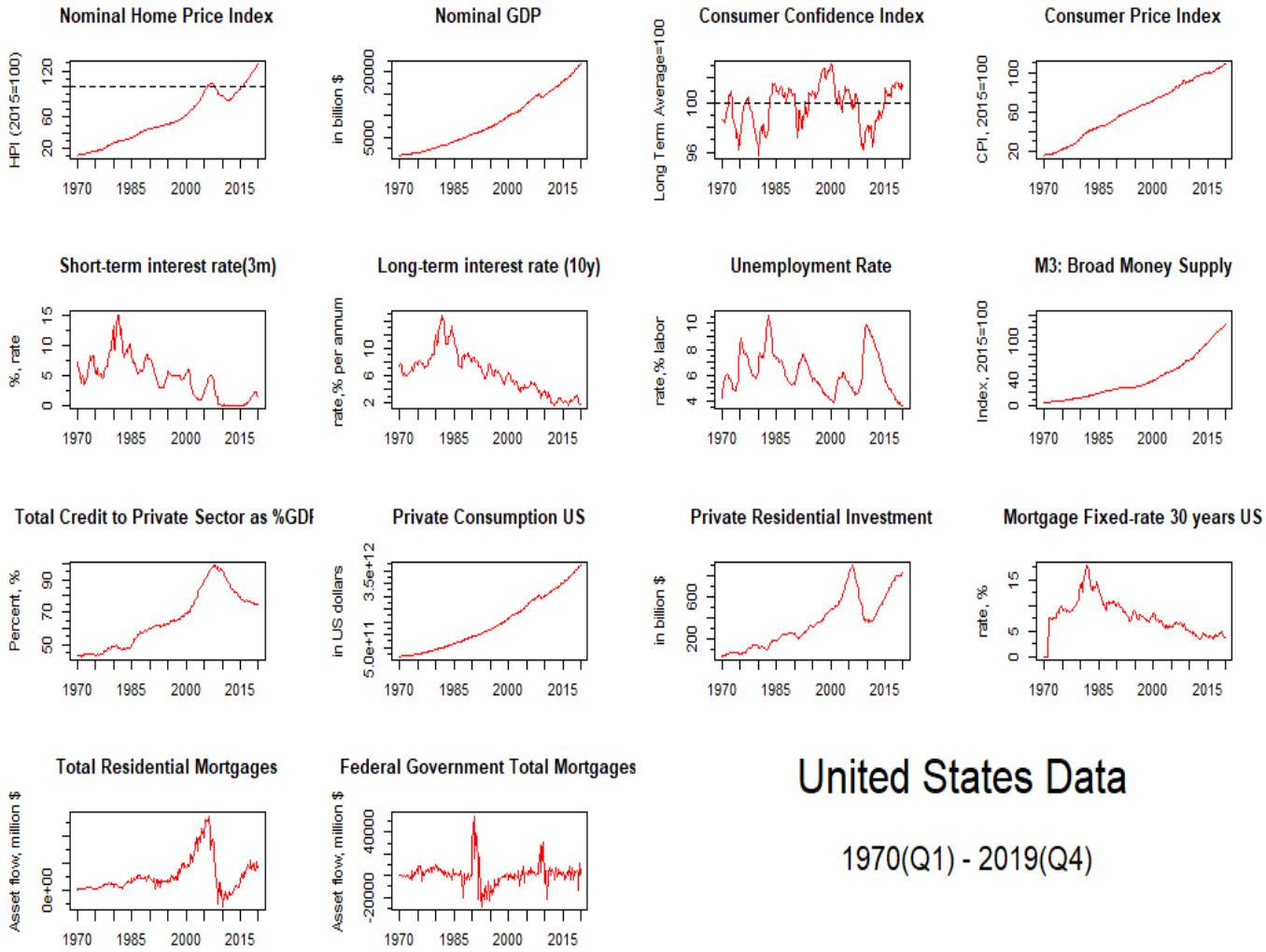
Annexes

Figure 1 : Data collected for United-States



United States Data

1970(Q1) - 2019(Q4)

Figure 2: Data collected for Euro Area

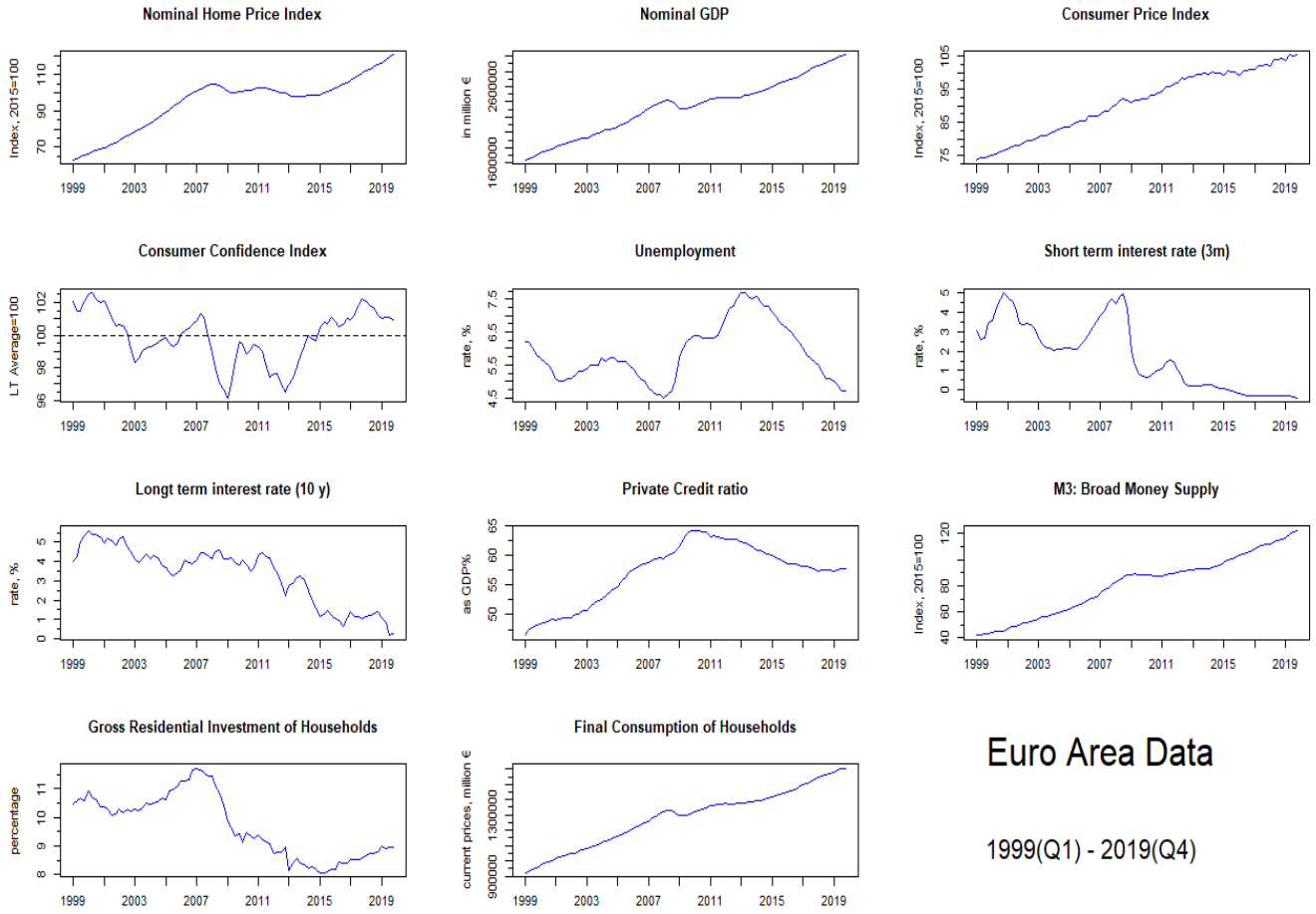


Table 1: Stationary assessment of real home price index series (H_0: non stationary)

	Augmented Dickey-Fuller Test			**Phillips-Perron Unit Root Test**		
	Lag order	Statistics	p-value	Lag order	Statistics	p-value
$Ln(RHPI_{US})$	5	-3.6875	0.02651	4	-6.5555	0.7404
$Ln(RHPI_{EA})$	4	-3.6135	0.03504	4	-3.0382	0.9314
$\Delta Ln(RHPI_{US})$	5	-3.4968	0.04439	4	-81.098	< 0.01
$\Delta Ln(RHPI_{EA})$	4	-1.5386	0.7651	3	-58.455	< 0.01

Table 2: Descriptive Statistics of Nominal (N), Real (R) and first differences (Δ) of Home Price Indexes

Statistics	United-States Home Price Index				Euro Area Home Price Index			
	NHPI	RHPI	ΔNHPI	ΔRHPI	NHPI	RHPI	ΔNHPI	ΔRHPI
Min	46.087	80.088	-2.911	-4.989	46.691	80.816	-1.362	-2.185
Max	128.433	121.629	2.638	2.227	120.670	117.146	2.590	2.256
Mean	79.389	95.832	0.870	0.273	83.143	98.296	0.804	0.298
Median	82.698	93.919	1.189	0.510	88.547	99.409	0.971	0.327
Std. dev	23.456	13.149	1.153	1.301	21.490	11.305	0.796	0.864
Variance	550.192	172.898	1.329	1.693	461.818	127.810	0.634	0.746

Table 3: Stationary VAR US: R^2 adjusted ante crisis period

R^2 adjusted for real HPI equation	**US VAR ANTE crisis: 1970-2007Q2**	**Lag order**	**Deterministic parameters**
0.562	$\Delta\ln RHPI$, ΔlnRGDP, LTR, STR, ΔlnCredit	3	Constant and trend
0.52	$\Delta\ln RHPI$, ΔU, LTR, STR, ΔlnCredit	3	Constant and trend
0.53	$\Delta\ln RHPI$, ΔlnRGDP, LTR, ΔPrivate Mortgage Asset Flows, ΔCCI	3	Constant and trend
0.502	$\Delta\ln RHPI$, ΔU, LTR, ΔPrivate Consumption , Δ Residential Investment	3	Constant and trend
0.401	$\Delta\ln RHPI$, ΔU, Δ Private Consumption , Δ Residential Investment	3	Constant and trend

Table 4: Stationary VAR US: R^2 adjusted post crisis period

R^2 adjusted for real HPI equation	**US VAR POST crisis: 2010-2019Q4**	**Lag order**	**Deterministic parameters**
0.589	$\Delta\ln RHPI$, ΔlnRGDP, LTR, STR, ΔlnCredit	2	Constant and trend
0.693	$\Delta\ln RHPI$, ΔU, LTR, STR, ΔlnCredit	2	Trend
0.665	$\Delta\ln RHPI$, ΔlnRGDP, LTR, ΔPrivate Mortgage Asset Flows, ΔCCI	3	Constant
0.816	$\Delta\ln RHPI$, ΔU, LTR, Δ Private Consumption , Δ Residential Investment	3	Constant and trend
0.816	$\Delta\ln RHPI$, ΔU, Δ Private Consumption ,	2	Constant and trend

	Δ Residential Investment		

Table 5: Stationary VAR US: R^2 adjusted full period

R^2 adjusted for real HPI equation	**US VAR 1970-2019**	**Lag order**	**Deterministic parameters**
0.538	$\Delta\ln RHPI$, ΔlnRGDP, LTR, STR, ΔlnCredit	3	Constant and trend
0.536	$\Delta\ln RHPI$, ΔU, LTR, STR, ΔlnCredit	4	Constant and trend
0.524	$\Delta\ln RHPI$, ΔlnRGDP, LTR, ΔPrivate Mortgage Asset Flows, ΔCCI	3	Constant and trend
0.569	$\Delta\ln RHPI$, ΔU, LTR, Δ Private Consumption, Δ Residential Investment	3	Constant and trend
0.525	$\Delta\ln RHPI$, ΔU, Δ Private Consumption , Δ Residential Investment	3	Constant and trend

VECTOR AUTOREGRESSIVE MODELS: OUTPUTS

US VAR n°1: ante crisis, post crisis and full period samples

US VAR ante-crisis US using Δln(RHPI), Δln(RDGP), Δln(Credit), STR, LTR

	Dependent variable:				
			y		
	(1)	(2)	(3)	(4)	(5)
DlnRHPI_US.l1	0.028	0.085	14.604	-0.033	7.572
	(0.085)	(0.098)	(9.239)	(0.097)	(6.002)
DlnRGDP_US.l1	0.129*	0.131	17.421**	-0.133	8.406
	(0.077)	(0.088)	(8.359)	(0.088)	(5.430)
STR.l1	-0.003***	-0.001	1.195***	-0.003**	0.097
	(0.001)	(0.001)	(0.112)	(0.001)	(0.073)
DlnCR_US.l1	0.101	0.082	1.707	-0.098	-3.185
	(0.072)	(0.083)	(7.827)	(0.082)	(5.085)
LTR.l1	-0.005***	-0.001	0.118	0.003	1.106***
	(0.002)	(0.002)	(0.174)	(0.002)	(0.113)
DlnRHPI_US.l2	0.153*	-0.037	-16.884**	0.291***	-8.845
	(0.079)	(0.090)	(8.527)	(0.090)	(5.539)
DlnRGDP_US.l2	0.023	0.135	5.887	-0.071	2.044
	(0.079)	(0.090)	(8.546)	(0.090)	(5.551)
STR.l2	0.00004	-0.003	-0.415**	0.001	-0.114
	(0.002)	(0.002)	(0.169)	(0.002)	(0.110)
DlnCR_US.l2	0.170**	0.028	-12.150	-0.036	-4.645
	(0.070)	(0.081)	(7.621)	(0.080)	(4.951)
LTR.l2	0.009***	0.003	-0.181	-0.004*	-0.176
	(0.002)	(0.003)	(0.254)	(0.003)	(0.165)
DlnRHPI_US.l3	0.204**	-0.022	13.104	0.412***	2.475
	(0.081)	(0.093)	(8.802)	(0.093)	(5.718)
DlnRGDP_US.l3	0.290***	0.027	-7.999	-0.027	-3.600
	(0.076)	(0.088)	(8.274)	(0.087)	(5.375)
STR.l3	0.002	0.002	0.255**	0.001	0.141*
	(0.001)	(0.001)	(0.126)	(0.001)	(0.082)
DlnCR_US.l3	-0.020	-0.150*	9.205	-0.068	11.763**
	(0.071)	(0.081)	(7.637)	(0.080)	(4.961)
LTR.l3	-0.003**	-0.001	-0.014	0.004**	-0.092
	(0.002)	(0.002)	(0.176)	(0.002)	(0.114)
const	0.004	0.007*	0.399	-0.006	0.564**
	(0.004)	(0.004)	(0.395)	(0.004)	(0.257)
trend	-0.00002	-0.00003	-0.002	0.0001***	-0.002
	(0.00002)	(0.00002)	(0.002)	(0.00002)	(0.001)

Observations	146	146	146	146	146
R2	0.610	0.329	0.934	0.374	0.964
Adjusted R2	0.562	0.246	0.926	0.296	0.960
Residual Std. Error (df = 129)	0.007	0.008	0.782	0.008	0.508
F Statistic (df = 16; 129)	12.608***	3.957***	114.810***	4.811***	216.142***

Note: *p<0.1; **p<0.05; ***p<0.01

US VAR post crisis using Δln(RHPI), Δln(RDGP), Δln(Credit), STR, LTR

	Dependent variable:				
	y				
	(1)	(2)	(3)	(4)	(5)
DlnRHPI_US.l1	0.567**	0.273	-0.053	-0.082	-1.885
	(0.221)	(0.169)	(2.427)	(0.134)	(8.209)
DlnRGDP_US.l1	-0.116	-0.065	3.211	-0.311*	11.303
	(0.268)	(0.205)	(2.940)	(0.162)	(9.946)
STR.l1	-0.016	-0.007	1.874***	-0.004	0.553
	(0.013)	(0.010)	(0.145)	(0.008)	(0.491)
DlnCR_US.l1	-0.379	-0.040	1.411	-0.037	21.179*
	(0.313)	(0.239)	(3.431)	(0.190)	(11.606)
LTR.l1	0.002	0.002	0.063	-0.004	0.909***
	(0.006)	(0.004)	(0.061)	(0.003)	(0.207)
DlnRHPI_US.l2	-0.109	-0.017	-3.766	0.257*	-1.524
	(0.222)	(0.170)	(2.440)	(0.135)	(8.254)
DlnRGDP_US.l2	-0.590**	-0.407*	0.494	-0.192	12.814
	(0.284)	(0.217)	(3.120)	(0.172)	(10.554)
STR.l2	0.009	0.004	-0.965***	0.003	-0.388
	(0.013)	(0.010)	(0.140)	(0.008)	(0.472)
DlnCR_US.l2	-0.459	-0.199	0.576	0.025	10.197
	(0.299)	(0.228)	(3.281)	(0.181)	(11.100)
LTR.l2	-0.005	0.003	-0.090	0.003	-0.326
	(0.006)	(0.004)	(0.061)	(0.003)	(0.205)
const	-0.007	-0.011	0.023	-0.010	1.413***
	(0.013)	(0.010)	(0.144)	(0.008)	(0.486)
trend	0.001**	0.0003	0.005	0.0003	-0.022
	(0.0004)	(0.0003)	(0.004)	(0.0002)	(0.014)
Observations	38	38	38	38	38
R2	0.711	0.324	0.992	0.583	0.746
Adjusted R2	0.589	0.038	0.989	0.407	0.639
Residual Std. Error (df = 26)	0.008	0.006	0.083	0.005	0.281
F Statistic (df = 11; 26)	5.822***	1.131	309.566***	3.308***	6.952***

Note: *p<0.1; **p<0.05; ***p<0.01

US VAR full-sample 1970-2019 using Δln(RHPI), Δln(RDGP), Δln(Credit), STR, LTR

	Dependent variable:				
	y				
	(1)	(2)	(3)	(4)	(5)
DlnRHPI_US.l1	0.387***	0.072	2.676	-0.023	3.959
	(0.083)	(0.074)	(6.200)	(0.067)	(4.466)
DlnRGDP_US.l1	0.119	0.193**	16.714**	-0.066	4.683
	(0.088)	(0.078)	(6.582)	(0.071)	(4.741)
STR.l1	-0.003**	-0.0004	1.233***	-0.003***	0.083
	(0.001)	(0.001)	(0.090)	(0.001)	(0.065)
DlnCR_US.l1	0.022	0.053	4.696	0.039	-0.331
	(0.077)	(0.069)	(5.774)	(0.062)	(4.159)
LTR.l1	-0.004**	-0.001	0.115	0.0001	1.140***
	(0.002)	(0.002)	(0.133)	(0.001)	(0.096)
DlnRHPI_US.l2	0.159**	-0.079	-7.073	0.199***	-2.756
	(0.080)	(0.072)	(6.025)	(0.065)	(4.340)
DlnRGDP_US.l2	-0.153*	0.037	4.495	-0.067	2.543
	(0.087)	(0.077)	(6.503)	(0.070)	(4.684)
STR.l2	0.001	-0.003**	-0.532***	0.002	-0.110
	(0.002)	(0.002)	(0.137)	(0.001)	(0.099)
DlnCR_US.l2	0.039	-0.006	-10.666*	0.054	-5.127
	(0.074)	(0.066)	(5.561)	(0.060)	(4.006)
LTR.l2	0.011***	0.003	-0.256	-0.002	-0.300**
	(0.003)	(0.002)	(0.195)	(0.002)	(0.140)
DlnRHPI_US.l3	0.224***	0.093	12.455**	0.180***	3.112
	(0.081)	(0.073)	(6.095)	(0.066)	(4.390)
DlnRGDP_US.l3	0.114	-0.006	-13.157**	-0.086	-4.866
	(0.087)	(0.077)	(6.501)	(0.070)	(4.682)
STR.l3	0.001	0.002	0.484***	0.0002	0.159
	(0.002)	(0.002)	(0.137)	(0.001)	(0.098)
DlnCR_US.l3	-0.155**	-0.126*	5.602	-0.004	7.989**
	(0.072)	(0.064)	(5.391)	(0.058)	(3.883)
LTR.l3	-0.006**	-0.001	0.380*	0.002	0.140
	(0.003)	(0.002)	(0.203)	(0.002)	(0.146)
DlnRHPI_US.l4	0.072	0.089	3.404	-0.055	0.446
	(0.082)	(0.073)	(6.115)	(0.066)	(4.404)
DlnRGDP_US.l4	-0.147*	0.053	-5.784	0.114*	-3.835
	(0.082)	(0.073)	(6.160)	(0.066)	(4.437)
STR.l4	-0.001	-0.0001	-0.261***	-0.0001	-0.052
	(0.001)	(0.001)	(0.096)	(0.001)	(0.069)
DlnCR_US.l4	0.046	0.031	-3.168	0.515***	-3.711
	(0.072)	(0.064)	(5.393)	(0.058)	(3.885)
LTR.l4	0.002	0.001	-0.220	0.001	-0.110
	(0.002)	(0.002)	(0.136)	(0.001)	(0.098)

const	0.0003	0.001	0.534*	-0.003	0.695***
	(0.004)	(0.004)	(0.309)	(0.003)	(0.223)
trend	-0.00001	-0.00001	-0.003**	-0.00000	-0.003**
	(0.00002)	(0.00002)	(0.001)	(0.00001)	(0.001)
Observations	195	195	195	195	195
R2	0.588	0.329	0.968	0.590	0.980
Adjusted R2	0.538	0.248	0.964	0.540	0.977
Residual Std. Error (df = 173)	0.009	0.008	0.646	0.007	0.465
F Statistic (df = 21; 173)	11.765***	4.044***	250.167***	11.845***	397.765***
Note:				*p<0.1; **p<0.05; ***p<0.01	

US VAR n°3 : ante crisis, post crisis and full period samples

US VAR ante-crisis using ΔlnRHPI, ΔlnRGDP, LTR, Δ Private Mortgage Asset Flows, ΔCCI

	Dependent variable:				
	y				
	(1)	(2)	(3)	(4)	(5)
DlnRHPI_US.l1	0.084	0.154	6.168	1,258,751.000	-10.418*
	(0.087)	(0.096)	(6.001)	(844,069.700)	(6.172)
DlnRGDP_US.l1	0.132	-0.004	4.268	-993,847.600	4.759
	(0.087)	(0.096)	(5.997)	(843,605.600)	(6.168)
LTR.l1	-0.009***	-0.004**	1.250***	-26,693.390**	-0.167*
	(0.001)	(0.001)	(0.088)	(12,443.940)	(0.091)
DtotM_AF.l1	0.000	0.000	0.00000	-0.444***	0.00000
	(0.000)	(0.000)	(0.00000)	(0.088)	(0.00000)
DCCI.l1	-0.0005	0.005***	0.161*	3,681.292	0.262***
	(0.001)	(0.001)	(0.089)	(12,513.760)	(0.091)
DlnRHPI_US.l2	0.133	0.009	-7.605	1,308,923.000	-10.647*
	(0.084)	(0.093)	(5.821)	(818,754.300)	(5.987)
DlnRGDP_US.l2	-0.045	0.025	2.275	-618,552.900	2.462
	(0.085)	(0.094)	(5.913)	(831,783.000)	(6.082)
LTR.l2	0.010***	0.002	-0.238	30,702.380	-0.057
	(0.002)	(0.002)	(0.147)	(20,728.690)	(0.152)
DtotM_AF.l2	0.00000***	0.00000**	-0.00000	-0.253***	0.00000
	(0.000)	(0.000)	(0.00000)	(0.093)	(0.00000)
DCCI.l2	0.001	0.003*	-0.179*	15,109.360	-0.233**
	(0.001)	(0.001)	(0.090)	(12,722.840)	(0.093)
DlnRHPI_US.l3	0.182**	-0.016	3.569	597,807.400	1.975
	(0.081)	(0.089)	(5.589)	(786,212.300)	(5.749)
DlnRGDP_US.l3	0.247***	0.027	-7.722	13,819.050	-8.080
	(0.079)	(0.087)	(5.479)	(770,618.300)	(5.635)
LTR.l3	-0.001	0.001	-0.056	-1,962.395	0.201*
	(0.001)	(0.002)	(0.100)	(14,097.880)	(0.103)
DtotM_AF.l3	0.00000**	0.00000*	-0.00000	0.005	0.00000
	(0.000)	(0.000)	(0.00000)	(0.092)	(0.00000)
DCCI.l3	0.001	0.003*	0.032	12,688.770	0.196**
	(0.001)	(0.002)	(0.096)	(13,498.600)	(0.099)
const	0.006	0.010**	0.491*	-12,270.210	0.280
	(0.004)	(0.004)	(0.263)	(36,970.240)	(0.270)
trend	-0.00001	-0.00003	-0.002*	52.128	-0.001
	(0.00002)	(0.00002)	(0.001)	(172.350)	(0.001)
Observations	146	146	146	146	146
R2	0.582	0.333	0.963	0.246	0.250
Adjusted R2	0.530	0.250	0.958	0.153	0.157
Residual Std. Error (df = 129)	0.007	0.008	0.518	72,908.980	0.533
F Statistic (df = 16; 129)	11.215***	4.021***	207.290***	2.633***	2.682***
Note:					*p<0.1; **p<0.05; ***p<0.01

VAR post-crisis US using ΔlnRHPI, ΔlnRGDP, LTR, Δ Private Mortgage Asset Flows, ΔCCI

	Dependent variable:				
	y				
	(1)	(2)	(3)	(4)	(5)
DlnRHPI_US.l1	0.625***	0.470***	-1.414	-1,807,808.000	-0.291
	(0.208)	(0.157)	(8.929)	(2,264,700.000)	(11.133)
DlnRGDP_US.l1	-0.274	-0.469**	15.101	2,035,021.000	46.922***
	(0.299)	(0.225)	(12.805)	(3,247,770.000)	(15.966)
LTR.l1	-0.001	0.008*	1.161***	-52,343.580	-0.264
	(0.005)	(0.004)	(0.226)	(57,388.940)	(0.282)
DtotM_AF.l1	0.000	0.000	0.00000	-0.921***	-0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.238)	(0.00000)
DCCI.l1	0.006	0.006**	-0.068	18,601.860	-0.343
	(0.004)	(0.003)	(0.169)	(42,974.080)	(0.211)
DlnRHPI_US.l2	-0.134	0.013	-7.609	477,948.300	-8.200
	(0.245)	(0.184)	(10.483)	(2,658,687.000)	(13.070)
DlnRGDP_US.l2	-0.616*	-0.760***	7.264	1,121,157.000	36.443*
	(0.342)	(0.257)	(14.634)	(3,711,670.000)	(18.246)
LTR.l2	0.004	-0.007	-0.599*	-54,310.820	-0.318
	(0.008)	(0.006)	(0.332)	(84,316.760)	(0.414)
DtotM_AF.l2	-0.00000	-0.000	0.00000	-0.500	-0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.315)	(0.00000)
DCCI.l2	0.008**	0.006**	-0.267*	-9,057.073	-0.375*
	(0.003)	(0.003)	(0.148)	(37,420.290)	(0.184)
DlnRHPI_US.l3	0.327*	0.087	5.287	1,142,873.000	-11.639
	(0.176)	(0.133)	(7.558)	(1,916,949.000)	(9.423)
DlnRGDP_US.l3	-0.586	-0.407	13.307	-1,588,161.000	13.565
	(0.355)	(0.267)	(15.198)	(3,854,577.000)	(18.949)
LTR.l3	-0.003	0.011**	0.103	56,531.920	-0.115
	(0.006)	(0.004)	(0.244)	(61,959.980)	(0.305)
DtotM_AF.l3	-0.00000	-0.00000	-0.000	-0.219	-0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.231)	(0.00000)
DCCI.l3	0.003	0.004	0.090	41,746.900	-0.142
	(0.003)	(0.002)	(0.139)	(35,339.020)	(0.174)
const	0.010	-0.020*	0.600	148,770.400	1.475*
	(0.013)	(0.010)	(0.578)	(146,586.300)	(0.721)
Observations	37	37	37	37	37
R2	0.804	0.599	0.790	0.555	0.679
Adjusted R2	0.665	0.312	0.641	0.237	0.449
Residual Std. Error (df = 21)	0.007	0.005	0.281	71,270.820	0.350
F Statistic (df = 15; 21)	5.757***	2.087*	5.280***	1.744	2.955**
Note:					*p<0.1; **p<0.05; ***p<0.01

VAR full-sample US using ΔlnRHPI, ΔlnRGDP, LTR, Δ Private Mortgage Asset Flows, ΔCCI

	Dependent variable:				
	y				
	(1)	(2)	(3)	(4)	(5)
DlnRHPI_US.l1	0.375***	0.133*	4.658	3,043,858.000***	1.199
	(0.077)	(0.070)	(4.148)	(771,321.900)	(4.591)
DlnRGDP_US.l1	0.099	0.065	1.178	-1,261,066.000	4.195
	(0.087)	(0.080)	(4.732)	(879,876.800)	(5.237)
LTR.l1	-0.008***	-0.003**	1.247***	-34,097.350**	-0.153*
	(0.001)	(0.001)	(0.076)	(14,146.830)	(0.084)
DtotM_AF.l1	0.000	-0.000	0.00000	-0.381***	0.00000
	(0.000)	(0.000)	(0.00000)	(0.076)	(0.00000)
DCCI.l1	0.0002	0.004***	0.144**	5,072.434	0.249***
	(0.001)	(0.001)	(0.068)	(12,632.820)	(0.075)
DlnRHPI_US.l2	0.127	-0.062	-4.526	1,346,377.000*	-3.022
	(0.081)	(0.074)	(4.369)	(812,398.200)	(4.835)
DlnRGDP_US.l2	-0.180**	-0.033	1.301	-537,352.700	-1.964
	(0.086)	(0.079)	(4.676)	(869,426.500)	(5.175)
LTR.l2	0.012***	0.001	-0.303**	54,359.030**	0.041
	(0.002)	(0.002)	(0.122)	(22,613.660)	(0.135)
DtotM_AF.l2	0.00000**	0.000	-0.00000	-0.107	0.00000*
	(0.000)	(0.000)	(0.00000)	(0.080)	(0.00000)
DCCI.l2	0.002*	0.002*	-0.141**	29,575.430**	-0.187**
	(0.001)	(0.001)	(0.069)	(12,839.020)	(0.076)
DlnRHPI_US.l3	0.199***	0.059	4.609	-517,395.100	-1.471
	(0.076)	(0.069)	(4.091)	(760,676.800)	(4.528)
DlnRGDP_US.l3	0.129	0.022	-6.802	73,471.240	-13.143***
	(0.082)	(0.076)	(4.462)	(829,715.100)	(4.939)
LTR.l3	-0.004***	0.001	0.014	-18,184.340	0.106
	(0.001)	(0.001)	(0.081)	(14,972.090)	(0.089)
DtotM_AF.l3	-0.000	0.000	-0.00000	-0.079	0.00000
	(0.000)	(0.000)	(0.00000)	(0.075)	(0.00000)
DCCI.l3	0.001	0.003**	0.071	5,323.056	0.220***
	(0.001)	(0.001)	(0.072)	(13,400.380)	(0.080)
const	0.005	0.010***	0.496**	-12,376.080	0.147
	(0.004)	(0.004)	(0.220)	(40,836.330)	(0.243)
trend	-0.00002	-0.00003*	-0.002**	6.916	-0.0004
	(0.00002)	(0.00002)	(0.001)	(184.756)	(0.001)
Observations	196	196	196	196	196
R2	0.563	0.281	0.978	0.242	0.221
Adjusted R2	0.524	0.217	0.976	0.175	0.151
Residual Std. Error (df = 179)	0.009	0.008	0.473	87,957.720	0.524
F Statistic (df = 16; 179)	14.393***	4.374***	503.931***	3.580***	3.167***
Note:					*p<0.1; **p<0.05; ***p<0.01

US VAR n°5: ante crisis, post crisis and full period samples

Table 6: Stationary VAR EA: R² adjusted on full sample only

R² adjusted for real HPI equation	EA VAR full period: 1999-2019	Lag order	Deterministic parameters
0.714	$\Delta \ln RHPI$, ΔlnRGDP, LTR STR, Δ Credit	4	Constant and trend
0.692	$\Delta \ln RHPI$, Δln (private consumption), Δln (residential investment),LTR, ΔCredit	5	Constant and trend
0.673	$\Delta \ln RHPI$, Δln (M3), Δln (residential investment),LTR,	4	Constant and trend
0.70	$\Delta \ln RHPI$, ΔU, Δ Private Consumption , STR	4	Constant and trend
0.72	$\Delta \ln RHPI$, ΔlnRGDP, LTR , Δ ln(M3), ΔCCI	4	Constant and trend

EA VAR n°2 : full sample

EA VAR full-sample using ΔlnRHPI, ΔlnInvestment ,ΔlnConsumption, ΔCredit, LTR

	Dependent variable:				
	y				
	(1)	(2)	(3)	(4)	(5)
DlnRHPI.l1	0.046	-4.071	6.768	0.082	-4.111
	(0.148)	(5.141)	(4.586)	(0.100)	(7.412)
DCR.l1	0.006	-0.062	-0.154	-0.002	-0.469**
	(0.004)	(0.143)	(0.127)	(0.003)	(0.206)
DINV.l1	0.002	-0.050	-0.379***	-0.0002	0.070
	(0.004)	(0.155)	(0.138)	(0.003)	(0.223)
DlnCons.l1	0.048	-39.767***	-1.076	0.153	-3.789
	(0.218)	(7.548)	(6.733)	(0.147)	(10.883)
LTR.l1	-0.004	-0.028	0.071	0.0003	1.151***
	(0.003)	(0.104)	(0.093)	(0.002)	(0.150)
DlnRHPI.l2	0.171	1.900	4.818	0.099	-8.323
	(0.131)	(4.552)	(4.060)	(0.088)	(6.563)
DCR.l2	-0.001	0.368***	-0.088	-0.0004	-0.046
	(0.004)	(0.134)	(0.120)	(0.003)	(0.194)
DINV.l2	-0.002	-0.068	-0.081	0.001	0.098
	(0.005)	(0.160)	(0.143)	(0.003)	(0.231)
DlnCons.l2	0.017	-13.337	-10.455	-0.102	-28.406**
	(0.264)	(9.143)	(8.156)	(0.178)	(13.182)

LTR.l2	0.005	-0.040	-0.038	-0.0004	-0.435*
	(0.004)	(0.154)	(0.138)	(0.003)	(0.222)
DlnRHPI.l3	-0.062	18.008***	2.264	0.035	-3.608
	(0.132)	(4.581)	(4.086)	(0.089)	(6.605)
DCR.l3	-0.006	0.326**	-0.022	-0.0002	0.370*
	(0.004)	(0.133)	(0.119)	(0.003)	(0.192)
DINV.l3	-0.003	0.012	0.052	0.002	0.148
	(0.005)	(0.157)	(0.140)	(0.003)	(0.227)
DlnCons.l3	-0.004	-8.476	-6.556	-0.145	3.258
	(0.261)	(9.051)	(8.074)	(0.176)	(13.050)
LTR.l3	-0.010**	0.158	-0.212	-0.002	0.174
	(0.004)	(0.150)	(0.134)	(0.003)	(0.216)
DlnRHPI.l4	0.345**	8.775	4.473	0.120	6.434
	(0.154)	(5.330)	(4.755)	(0.104)	(7.685)
DCR.l4	-0.006	0.375***	0.060	0.001	0.193
	(0.004)	(0.129)	(0.115)	(0.002)	(0.185)
DINV.l4	-0.006	0.157	0.241*	0.005	-0.215
	(0.005)	(0.157)	(0.140)	(0.003)	(0.226)
DlnCons.l4	-0.452*	12.010	-12.341*	-0.247	14.812
	(0.229)	(7.950)	(7.092)	(0.154)	(11.463)
LTR.l4	0.005	-0.134	0.198	0.004	-0.301
	(0.004)	(0.144)	(0.128)	(0.003)	(0.207)
DlnRHPI.l5	0.036	-0.606	5.047	0.057	7.182
	(0.163)	(5.637)	(5.028)	(0.110)	(8.127)
DCR.l5	0.007**	-0.271**	0.171*	0.002	0.088
	(0.003)	(0.108)	(0.096)	(0.002)	(0.155)
DINV.l5	-0.008*	0.111	0.230	0.003	0.226
	(0.005)	(0.156)	(0.139)	(0.003)	(0.225)
DlnCons.l5	-0.058	15.240**	-8.506	-0.142	-0.488
	(0.218)	(7.540)	(6.726)	(0.146)	(10.872)
LTR.l5	-0.005	0.103	-0.041	-0.002	0.232
	(0.003)	(0.097)	(0.086)	(0.002)	(0.140)
const	0.064***	-0.115	0.316	0.014	1.068
	(0.017)	(0.581)	(0.518)	(0.011)	(0.837)
trend	-0.001***	0.002	-0.002	-0.0001	-0.010
	(0.0002)	(0.006)	(0.005)	(0.0001)	(0.008)
Observations	79	79	79	79	79
R2	0.795	0.849	0.484	0.626	0.978
Adjusted R2	0.692	0.774	0.227	0.439	0.967
Residual Std. Error (df = 52)	0.005	0.187	0.167	0.004	0.269
F Statistic (df = 26; 52)	7.733***	11.282***	1.879**	3.350***	88.539***
Note:			*p<0.1; **p<0.05; ***p<0.01		

EA VAR n°4 : full sample

EA VAR full-sample using ΔlnRHPI, ΔUnemployment, ΔlnCons, STR

	Dependent variable:			
	y			
	(1)	(2)	(3)	(4)
DlnRHPI.l1	-0.096	0.079	0.444	-4.688
	(0.100)	(0.065)	(1.957)	(4.983)
DlnCons.l1	-0.395*	0.134	-12.012***	29.623**
	(0.225)	(0.146)	(4.415)	(11.244)
DU.l1	-0.020***	-0.005	0.164	-0.051
	(0.007)	(0.005)	(0.143)	(0.364)
STR.l1	-0.004	0.001	-0.003	1.259***
	(0.003)	(0.002)	(0.057)	(0.146)
DlnRHPI.l2	0.205**	0.106*	-3.934**	2.124
	(0.097)	(0.063)	(1.910)	(4.865)
DlnCons.l2	-0.297	-0.062	4.344	-0.593
	(0.234)	(0.153)	(4.602)	(11.719)
DU.l2	-0.015**	-0.005	0.143	-0.305
	(0.007)	(0.005)	(0.144)	(0.368)
STR.l2	-0.003	-0.002	0.018	-0.440*
	(0.004)	(0.003)	(0.088)	(0.224)
DlnRHPI.l3	0.030	0.078	-1.027	6.344
	(0.099)	(0.064)	(1.945)	(4.952)
DlnCons.l3	0.191	-0.105	1.627	-1.129
	(0.234)	(0.152)	(4.585)	(11.677)
DU.l3	-0.010	0.005	0.173	0.131
	(0.008)	(0.005)	(0.148)	(0.376)
STR.l3	-0.002	0.002	0.027	0.065
	(0.004)	(0.003)	(0.088)	(0.225)
DlnRHPI.l4	0.627***	0.060	1.427	-7.543
	(0.098)	(0.064)	(1.922)	(4.896)
DlnCons.l4	-0.174	-0.114	3.059	21.824*
	(0.223)	(0.145)	(4.367)	(11.122)
DU.l4	0.007	-0.00001	0.076	0.453
	(0.006)	(0.004)	(0.126)	(0.322)
STR.l4	0.007**	-0.002	-0.011	0.017
	(0.003)	(0.002)	(0.055)	(0.140)
const	0.019***	0.013***	-0.068	-0.049
	(0.006)	(0.004)	(0.124)	(0.315)
trend	-0.0002***	-0.0001**	0.001	-0.003
	(0.0001)	(0.00005)	(0.002)	(0.004)

Observations	80	80	80	80
R2	0.764	0.619	0.658	0.982
Adjusted R2	0.700	0.515	0.564	0.978
Residual Std. Error (df = 62)	0.005	0.003	0.104	0.265
F Statistic (df = 17; 62)	11.831***	5.927***	7.006***	204.219***
Note:		*p<0.1; **p<0.05; ***p<0.01		

EA VAR n°5 : full sample

EA VAR full-sample using ΔlnRHPI, ΔlnRGDP, ΔlnM3, ΔCCI, LTR

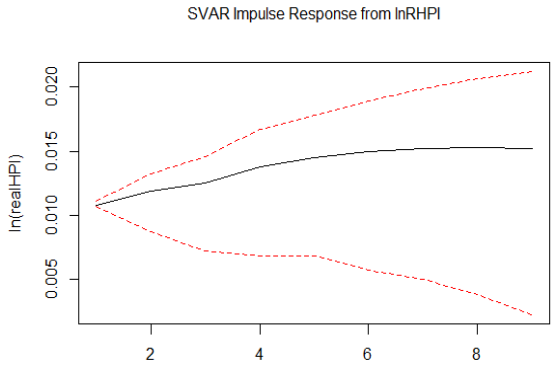
	Dependent variable:				
			y		
	(1)	(2)	(3)	(4)	(5)
DlnRHPI.l1	-0.049	-0.150	0.095	3.246	8.113
	(0.161)	(0.170)	(0.205)	(2.492)	(8.561)
DlnRGDP.l1	-0.107	-0.060	0.261	-3.637*	-0.471
	(0.132)	(0.140)	(0.168)	(2.049)	(7.039)
DlnM3.l1	-0.204**	-0.181*	0.338**	0.906	5.846
	(0.101)	(0.107)	(0.129)	(1.572)	(5.399)
DCCI.l1	-0.008	-0.006	-0.002	1.552***	-0.258
	(0.008)	(0.009)	(0.010)	(0.126)	(0.432)
LTR.l1	-0.007**	-0.002	0.00004	0.031	1.260***
	(0.003)	(0.003)	(0.003)	(0.040)	(0.137)
DlnRHPI.l2	0.240	-0.036	0.062	0.339	-11.740
	(0.151)	(0.159)	(0.192)	(2.336)	(8.022)
DlnRGDP.l2	-0.057	0.061	0.228	-1.647	0.893
	(0.136)	(0.144)	(0.173)	(2.105)	(7.231)
DlnM3.l2	0.071	-0.068	-0.147	-0.137	-1.683
	(0.109)	(0.116)	(0.139)	(1.693)	(5.815)
DCCI.l2	0.013	0.017	-0.002	-1.086***	1.345*
	(0.015)	(0.016)	(0.019)	(0.229)	(0.785)
LTR.l2	0.005	-0.001	0.001	-0.021	-0.438**
	(0.004)	(0.004)	(0.005)	(0.060)	(0.205)
DlnRHPI.l3	0.155	-0.040	0.132	-3.662	-12.101
	(0.147)	(0.155)	(0.187)	(2.274)	(7.813)
DlnRGDP.l3	-0.263*	-0.098	0.180	0.643	2.174
	(0.135)	(0.143)	(0.172)	(2.095)	(7.195)
DlnM3.l3	0.061	0.189	0.186	0.232	-8.347
	(0.109)	(0.115)	(0.139)	(1.688)	(5.798)
DCCI.l3	0.007	-0.007	0.007	0.383	-1.932**
	(0.015)	(0.016)	(0.019)	(0.231)	(0.794)
LTR.l3	-0.006*	-0.004	-0.001	-0.035	-0.027

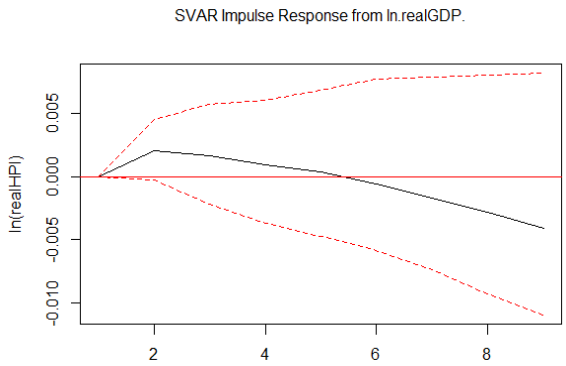
	(0.004)	(0.004)	(0.005)	(0.059)	(0.202)
DlnRHPI.l4	0.113	0.049	0.058	0.105	-0.239
	(0.146)	(0.155)	(0.186)	(2.266)	(7.782)
DlnRGDP.l4	0.309**	0.379***	0.097	0.219	4.951
	(0.132)	(0.140)	(0.168)	(2.049)	(7.038)
DlnM3.l4	-0.173*	-0.302***	0.327**	-2.043	7.460
	(0.099)	(0.105)	(0.126)	(1.534)	(5.270)
DCCI.l4	-0.004	0.011	-0.007	-0.135	1.036**
	(0.008)	(0.009)	(0.011)	(0.130)	(0.446)
LTR.l4	-0.001	-0.001	0.006*	-0.002	-0.002
	(0.003)	(0.003)	(0.003)	(0.042)	(0.143)
const	0.061***	0.061***	-0.031*	0.143	1.276*
	(0.014)	(0.015)	(0.018)	(0.215)	(0.737)
trend	-0.001***	-0.001***	0.0003*	-0.0003	-0.014*
	(0.0001)	(0.0001)	(0.0002)	(0.002)	(0.007)
Observations	80	80	80	80	80
R2	0.794	0.686	0.658	0.911	0.976
Adjusted R2	0.720	0.572	0.535	0.878	0.967
Residual Std. Error (df = 58)	0.005	0.005	0.007	0.079	0.272
F Statistic (df = 21; 58)	10.659***	6.022***	5.322***	28.144***	110.446***
Note:				*p<0.1; **p<0.05; ***p<0.01	

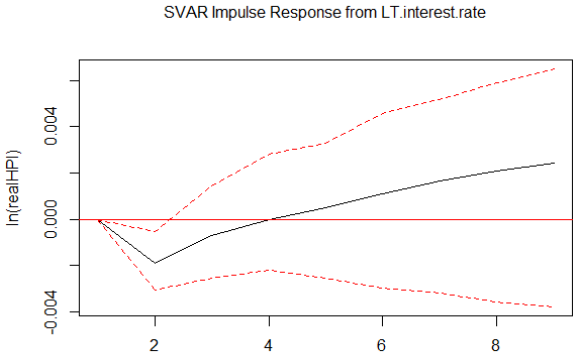
IMPULSE RESPONSE FUNCTIONS : OUTPUTS

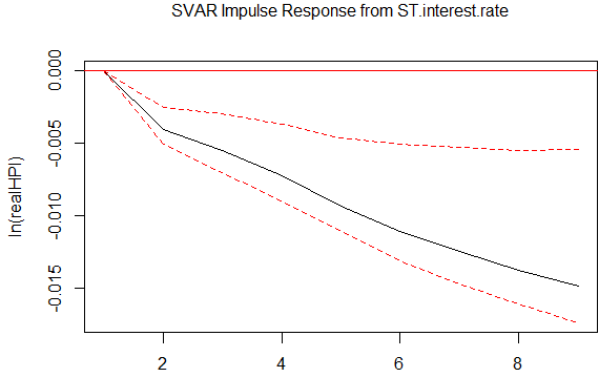
US Impulse response function 1 (level SVAR 1): ante crisis

ORDER 1

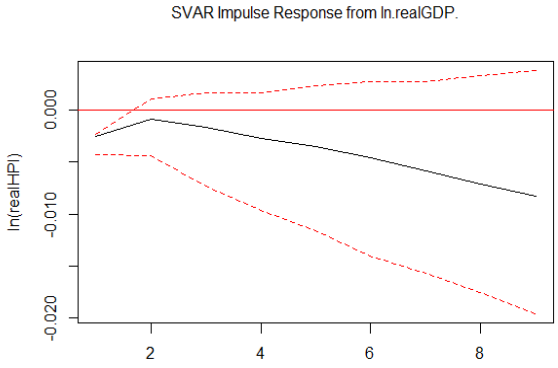


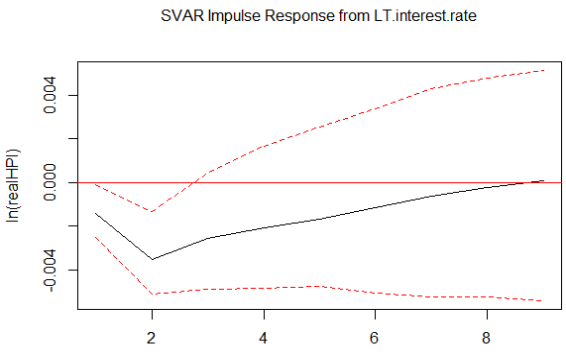


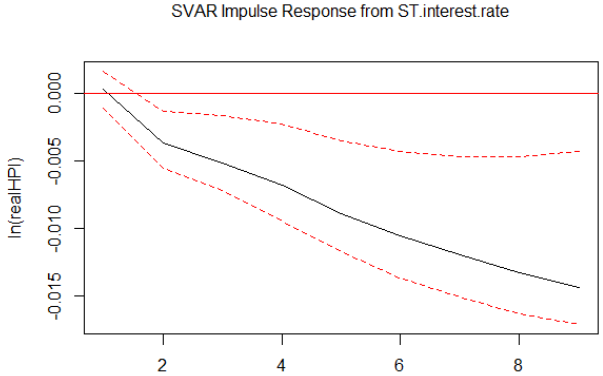


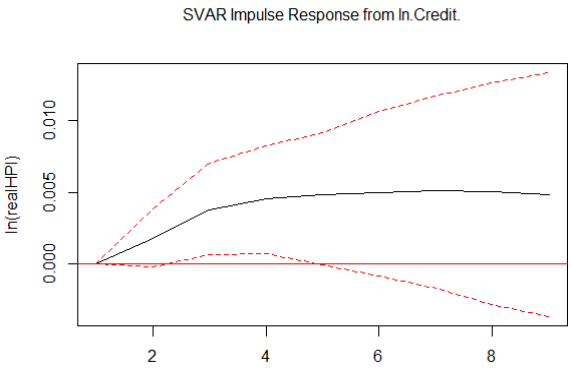


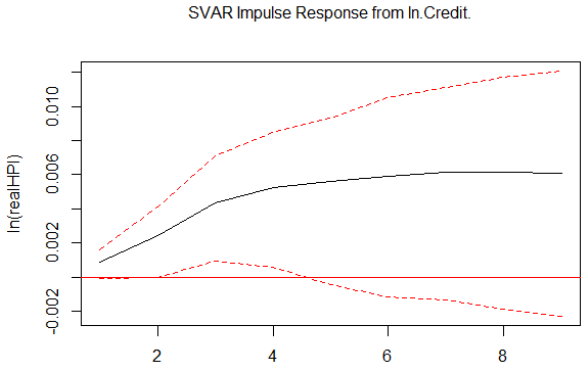
ORDER 2





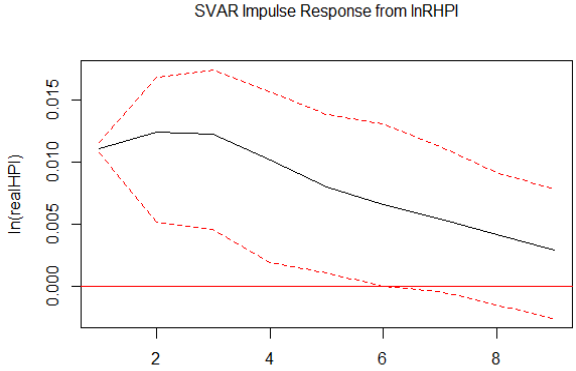


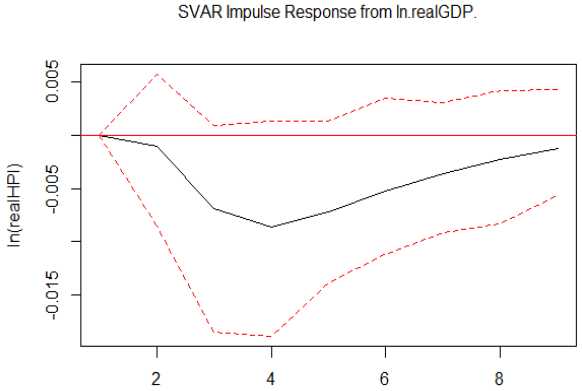


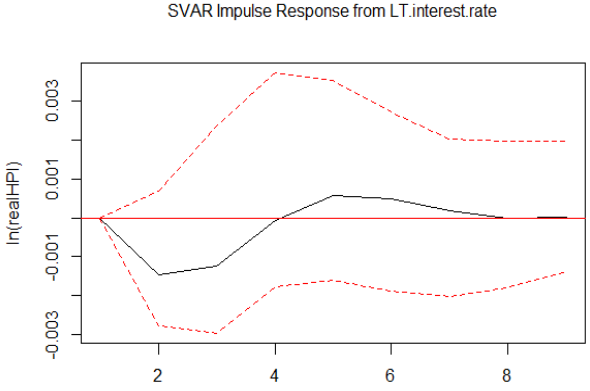


US Impulse response function 1 (level SVAR 1): post crisis

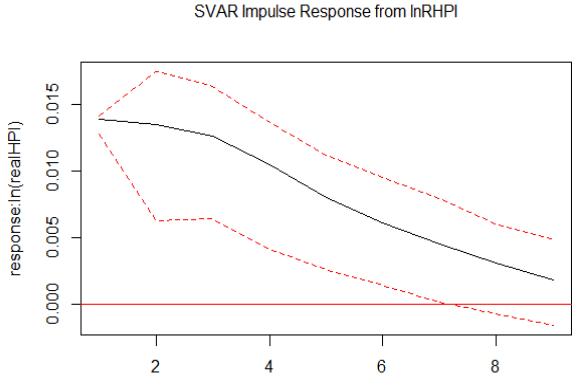
ORDER 1

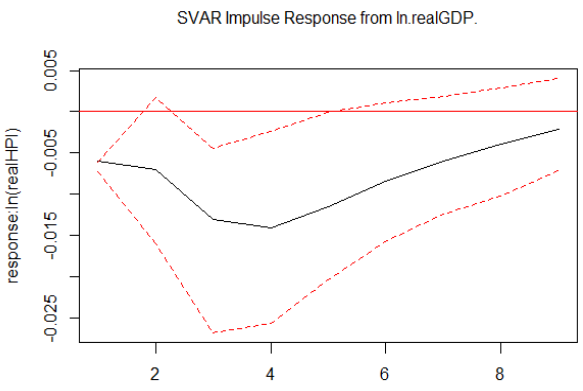


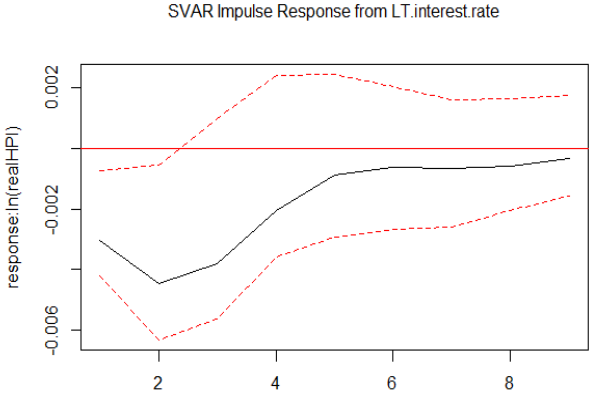


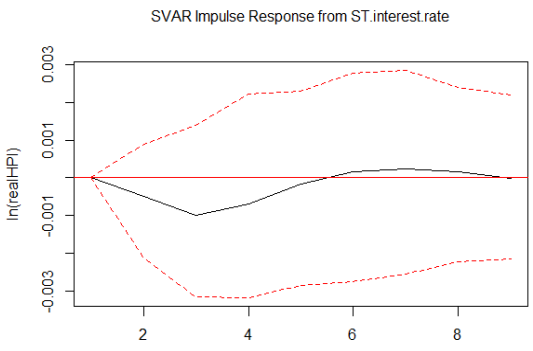


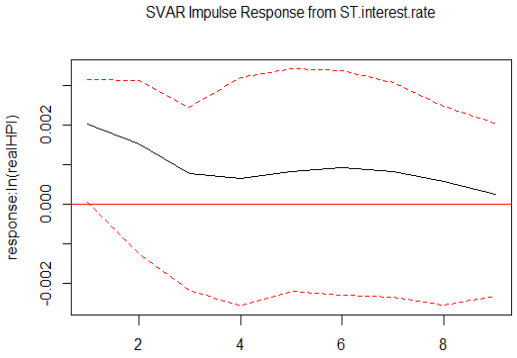
ORDER 2

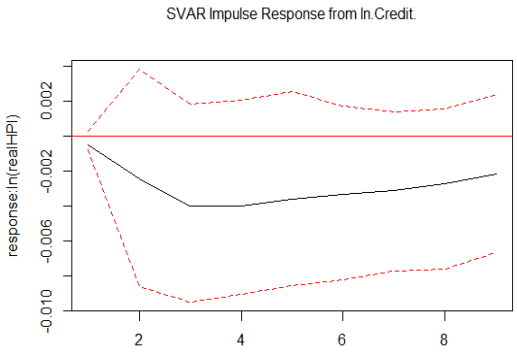




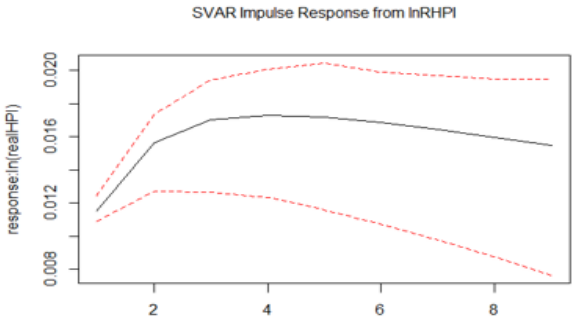


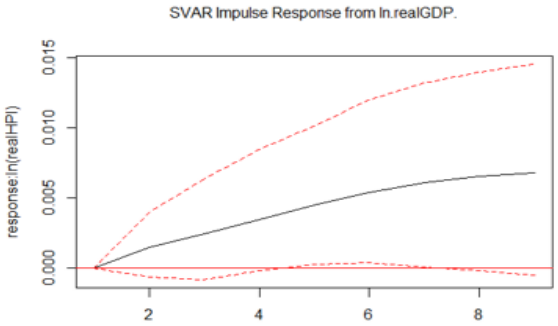


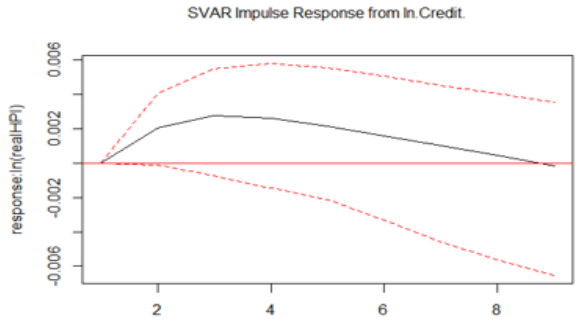


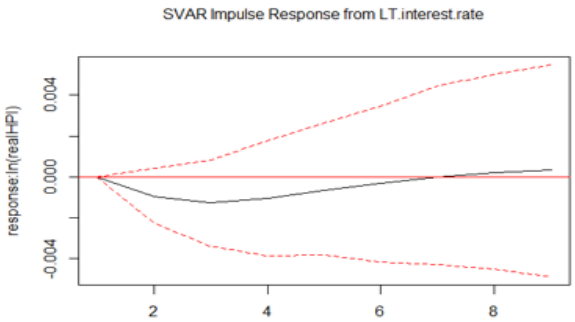


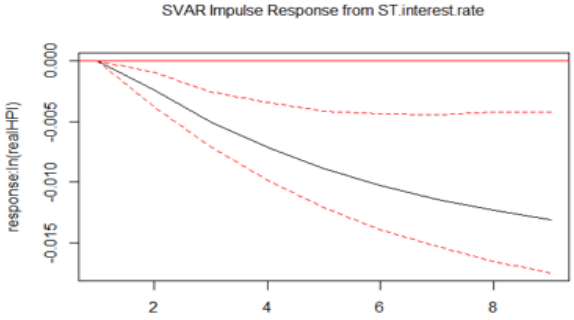
US Impulse response function 1 (level SVAR 1): full sample order 1







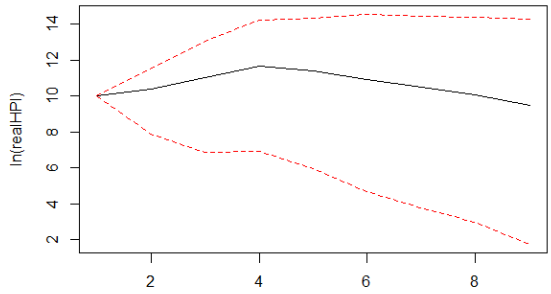




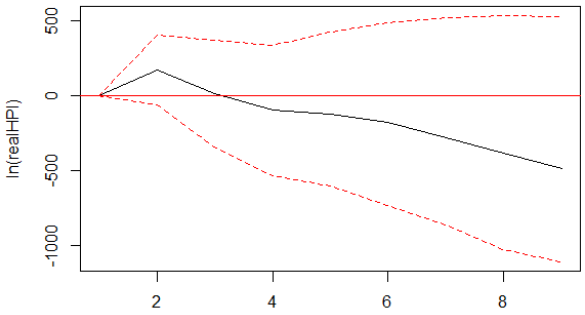
US Impulse response function 3 (level SVAR 1): ante crisis

ORDER 1

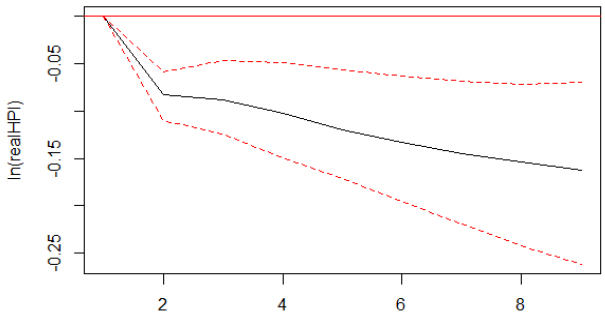
SVAR Impulse Response from lnRHPI



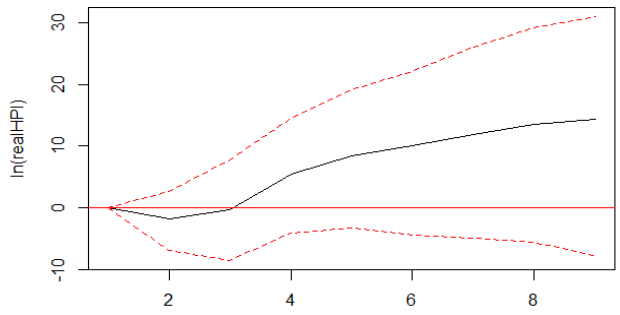
SVAR Impulse Response from ln.realGDP.



SVAR Impulse Response from LT.interest.rate

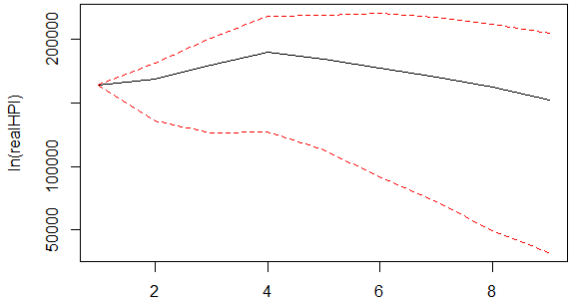


SVAR Impulse Response from CCI

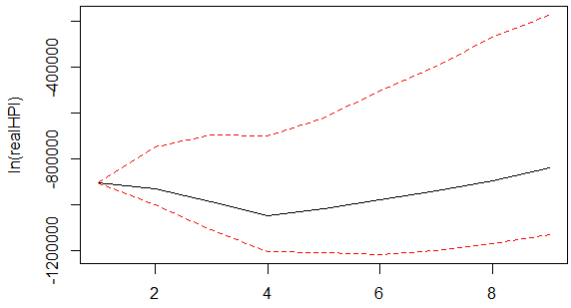


ORDER 2

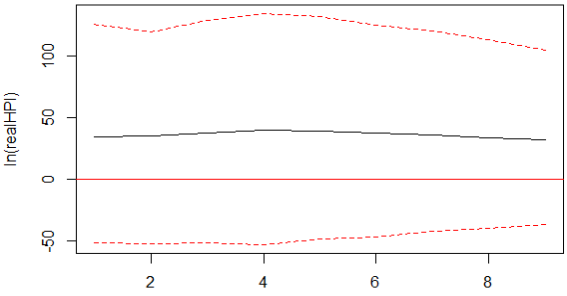
SVAR Impulse Response from lnRHPI



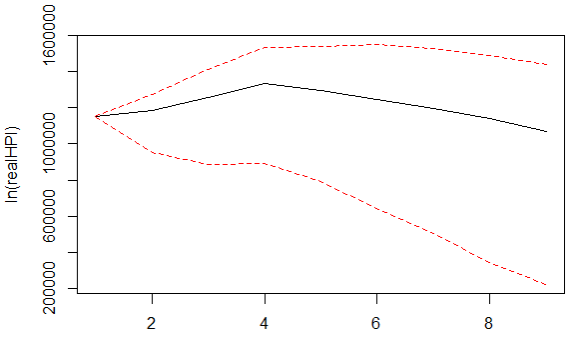
SVAR Impulse Response from ln.realGDP.



SVAR Impulse Response from LT.interest.rate

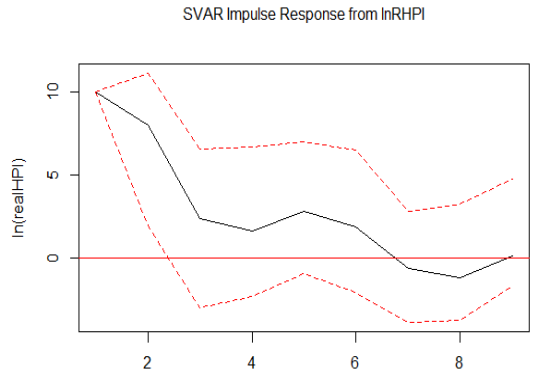


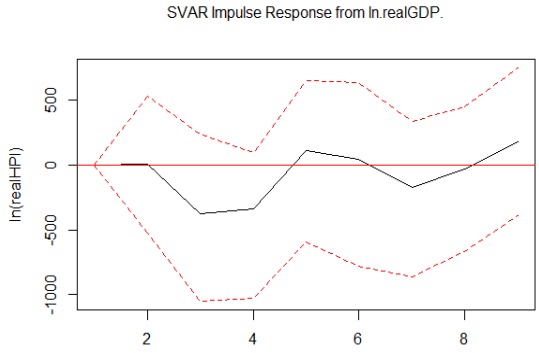
SVAR Impulse Response from CCI

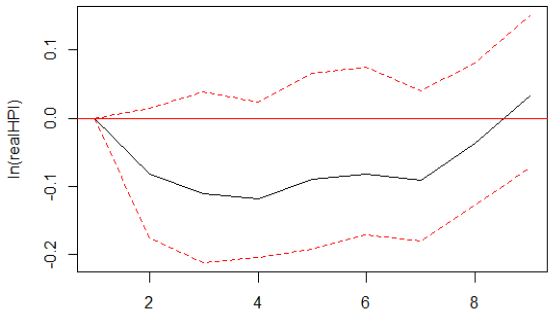


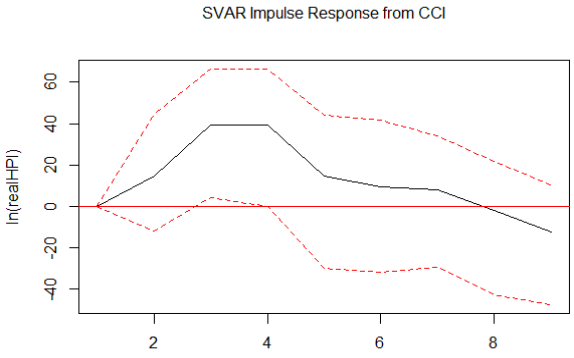
US Impulse response function 3 (level SVAR 1): post crisis

ORDER 1

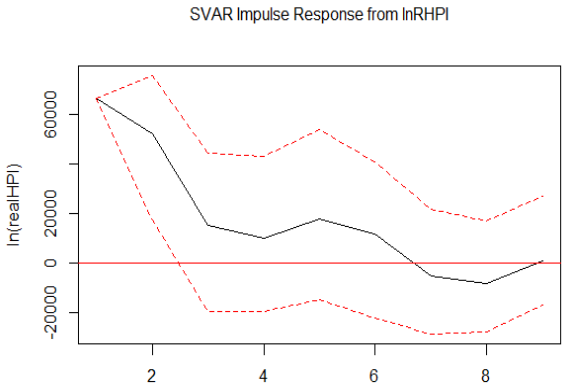


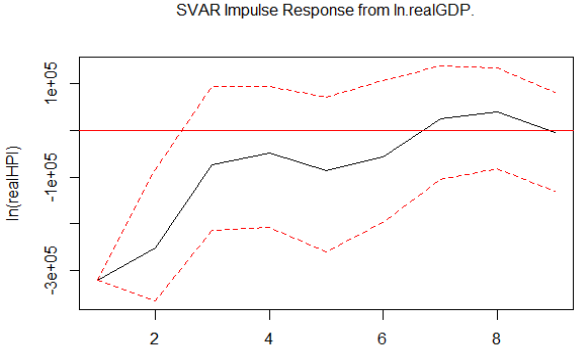


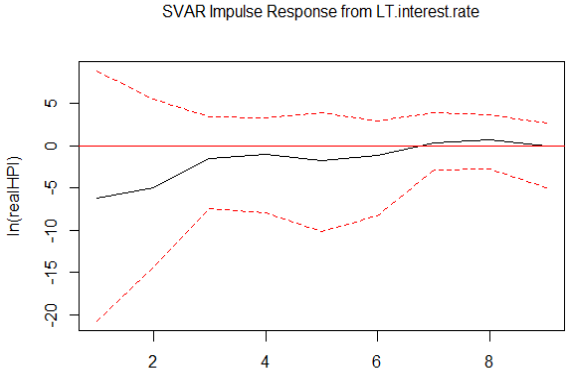


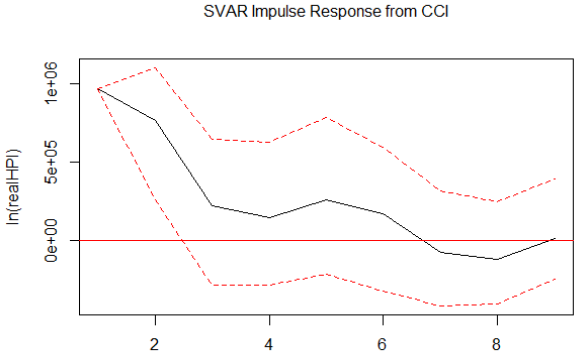


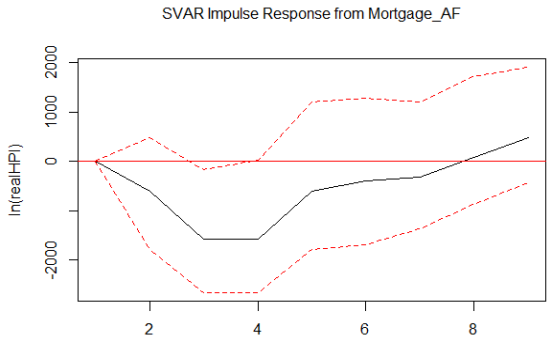
ORDER 2

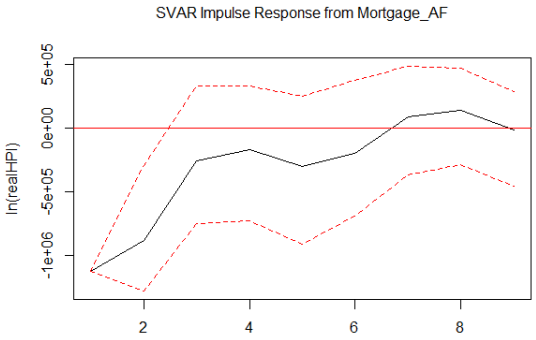




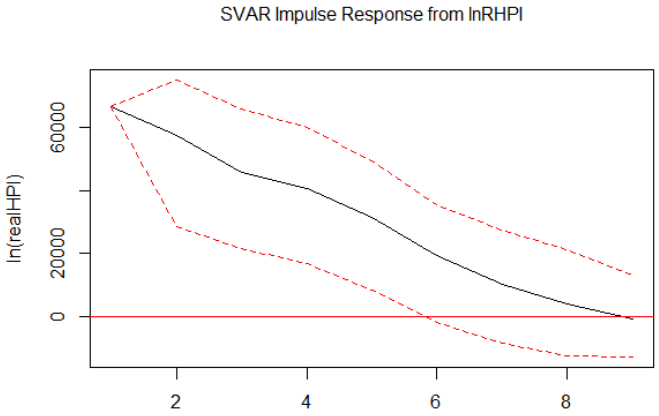


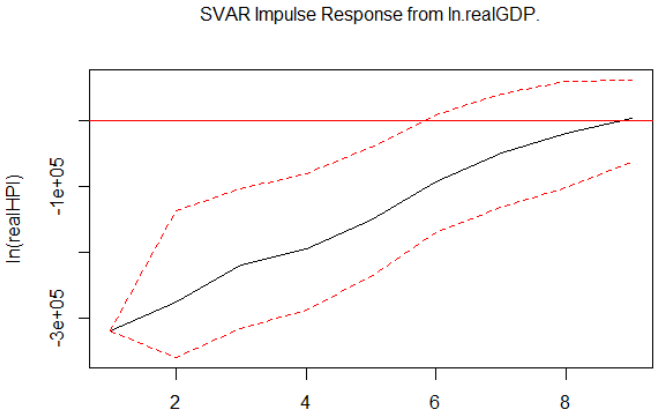


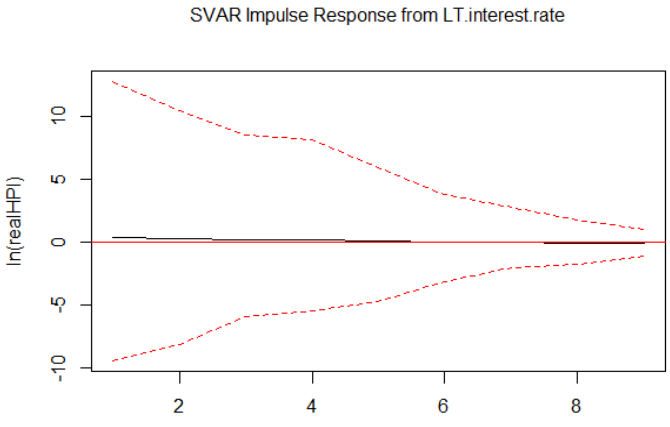


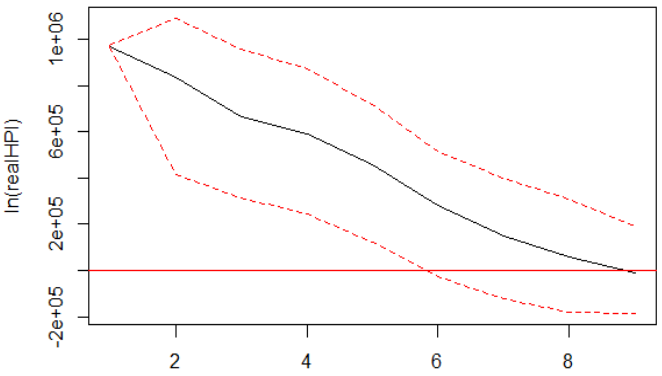


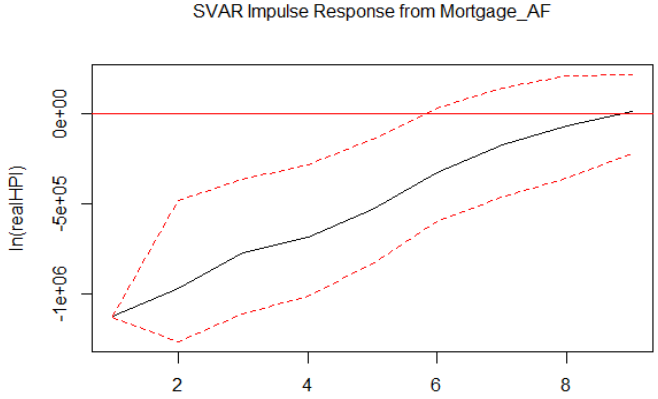
US Impulse response function 3 (level SVAR 1): full sample order 2





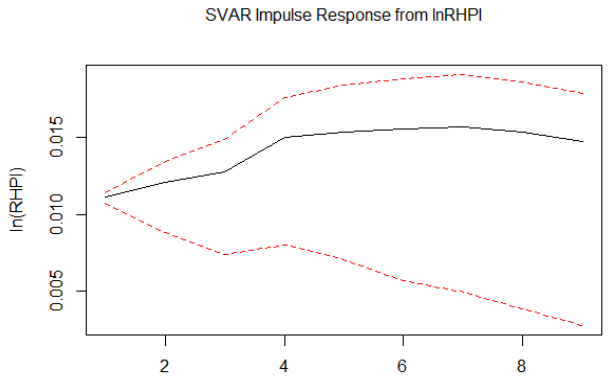


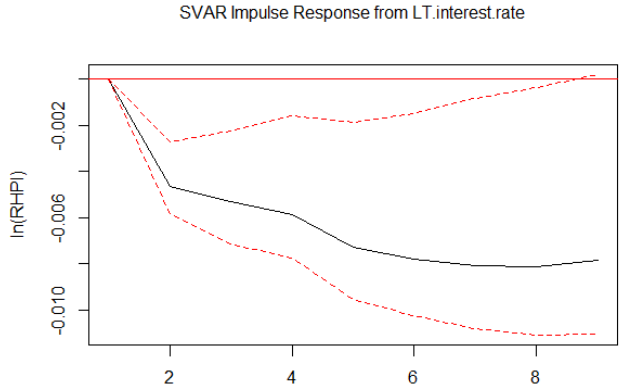


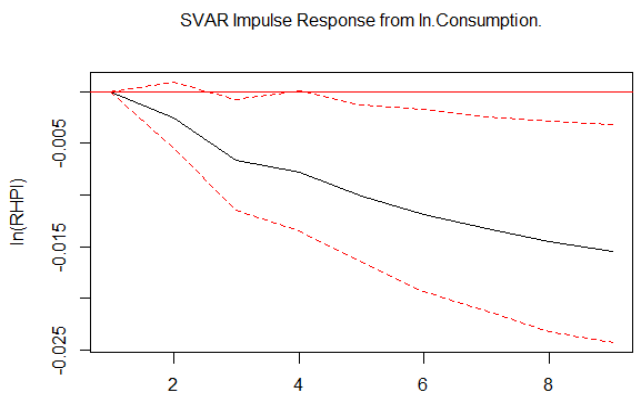


US Impulse response function 5 (level SVAR 5): ante crisis

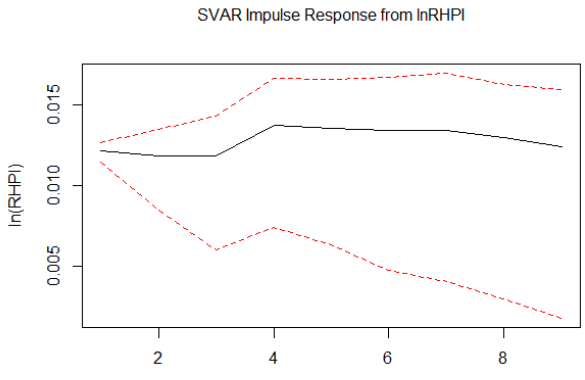
ORDER 1

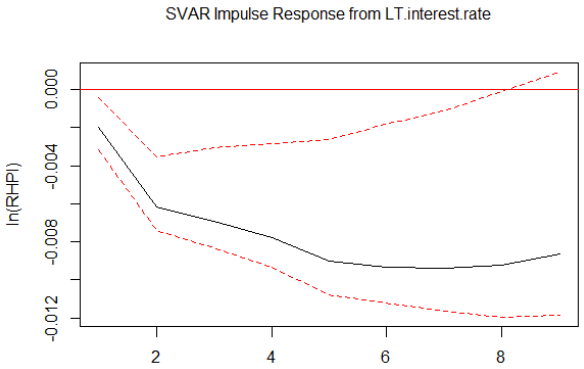


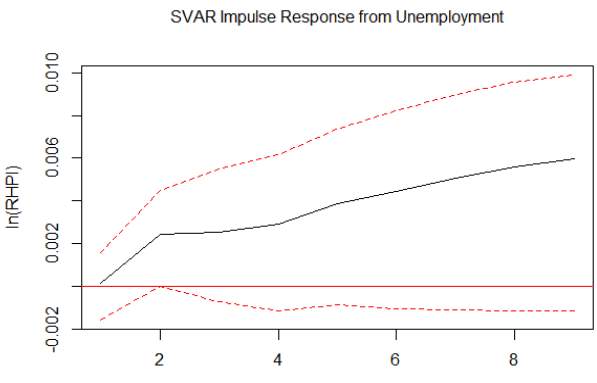


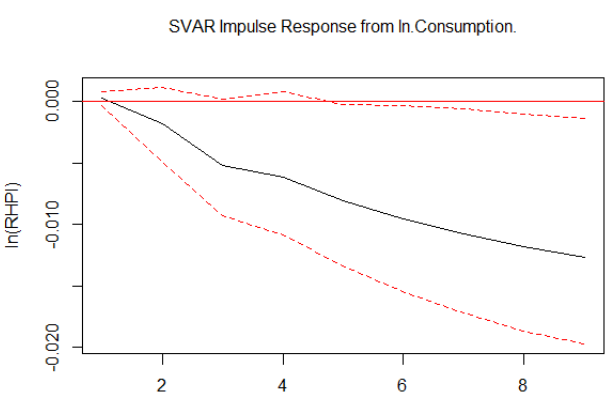


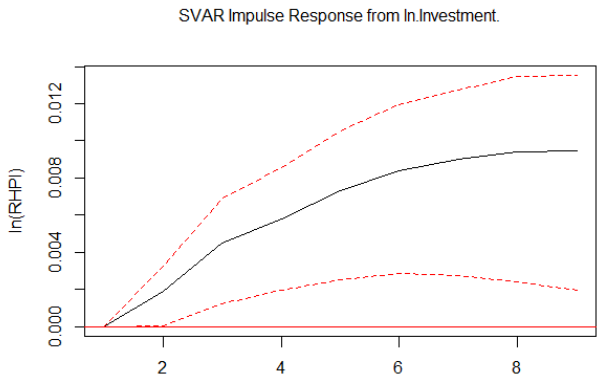
ORDER 2

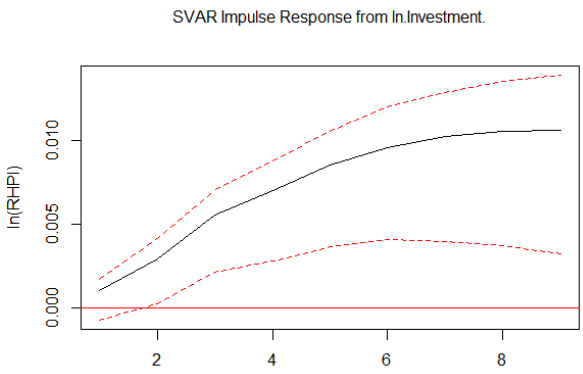






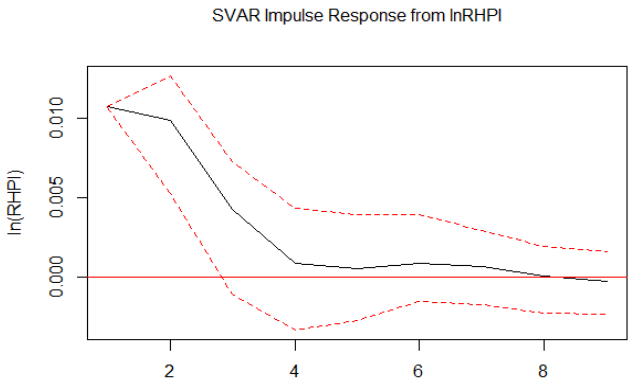


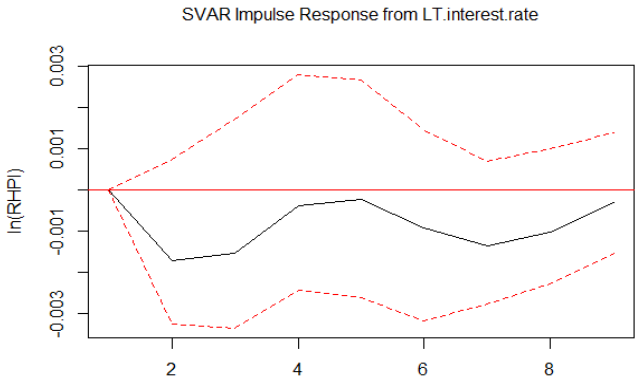


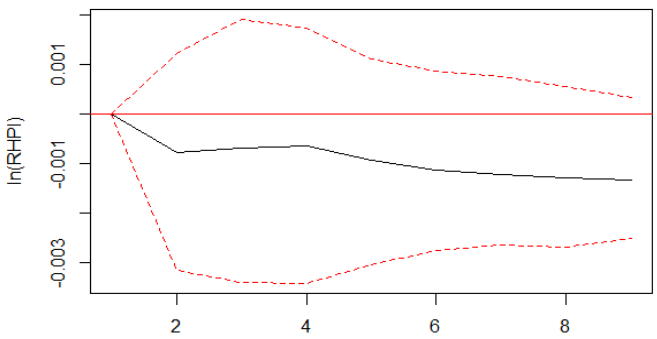


US Impulse response function 5 (level SVAR 5): post crisis

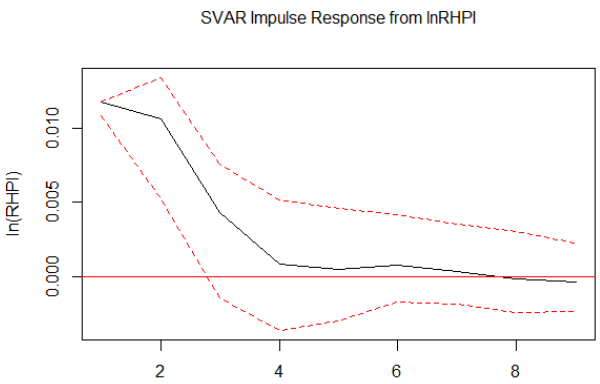
ORDER 1

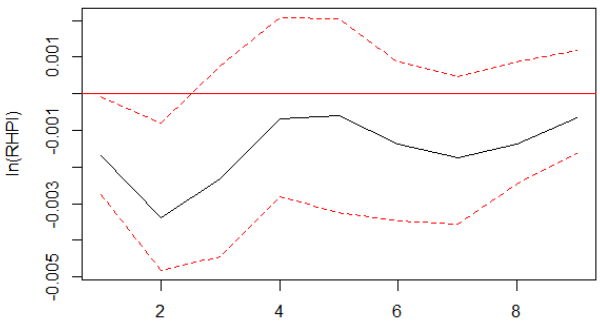


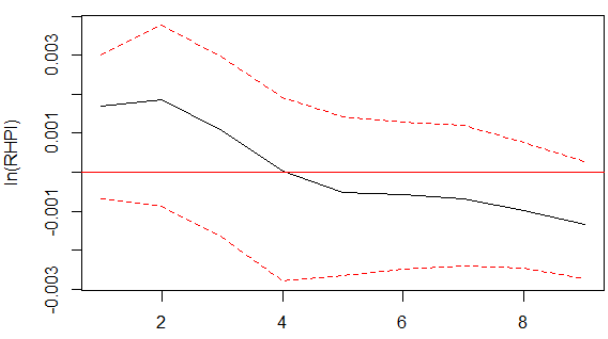


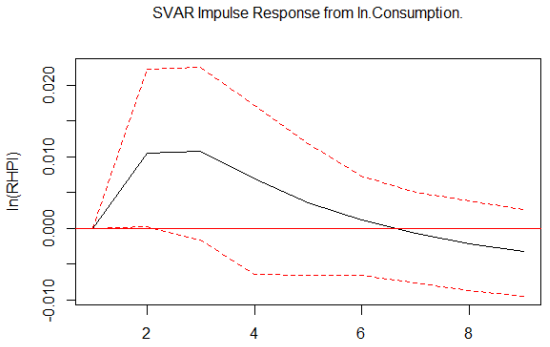


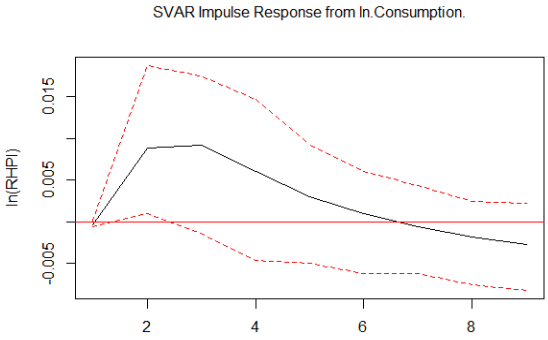
ORDER 2

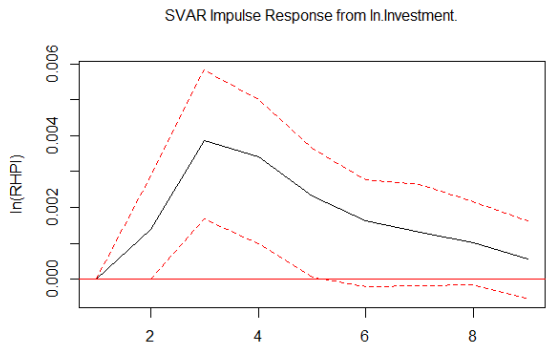


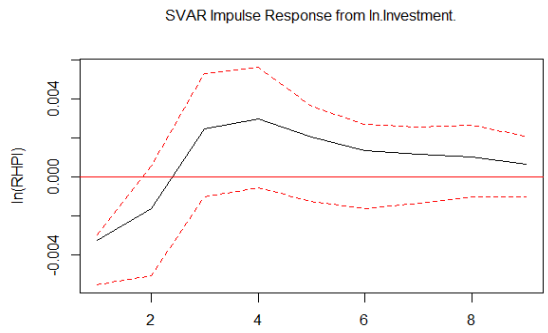




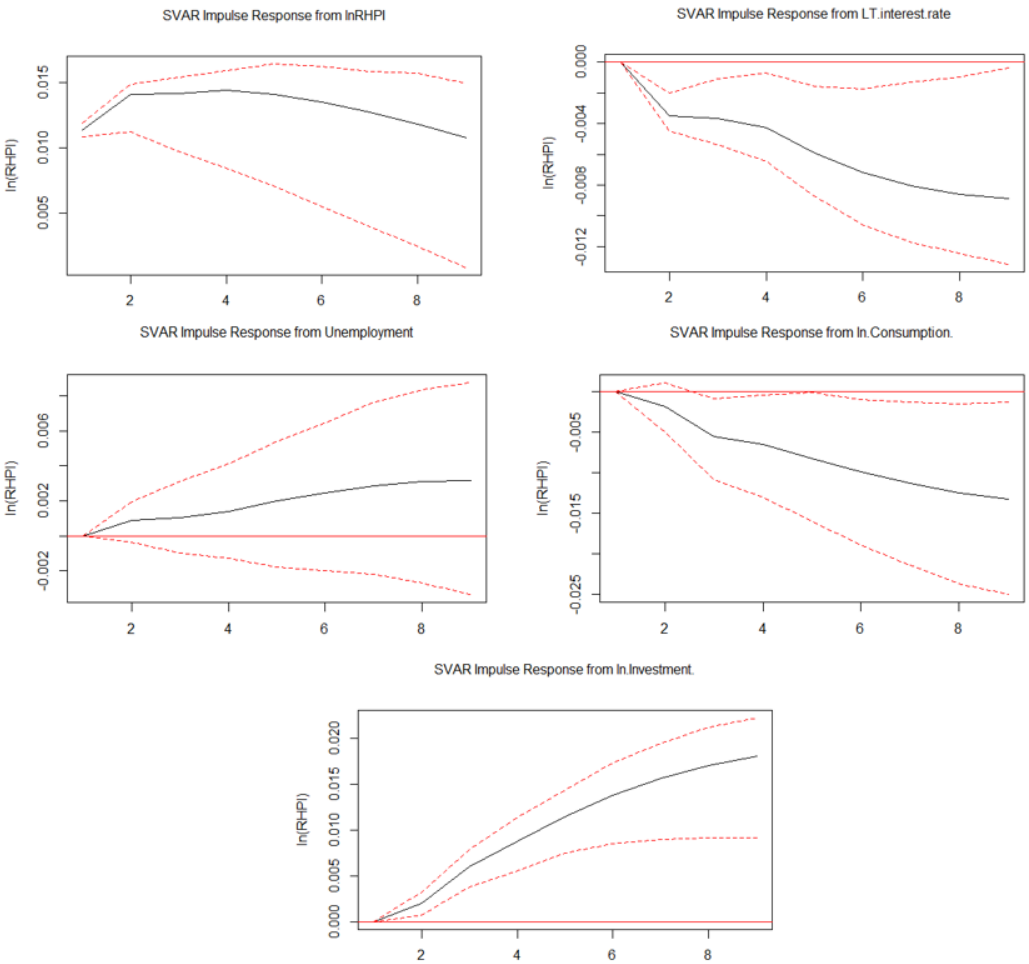






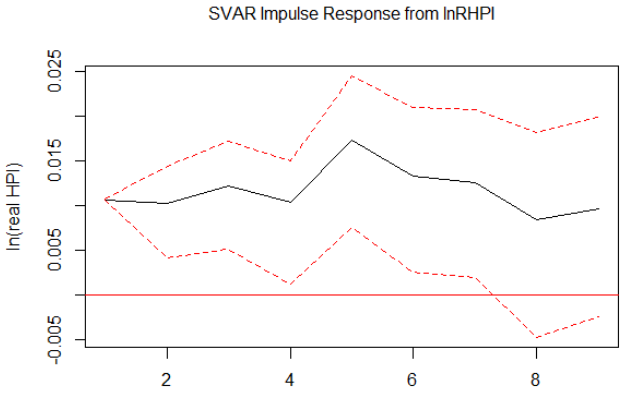


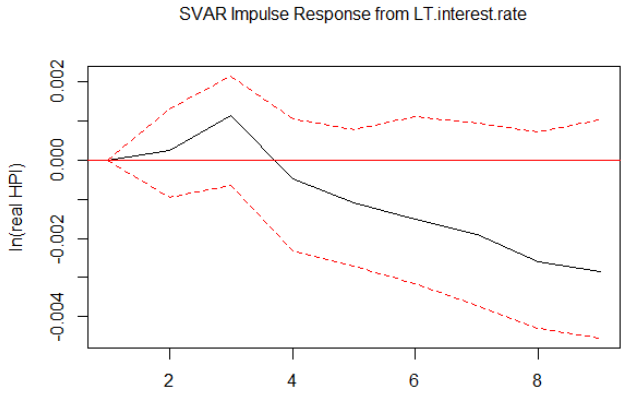
US Impulse response function 5 (level SVAR 5): full sample

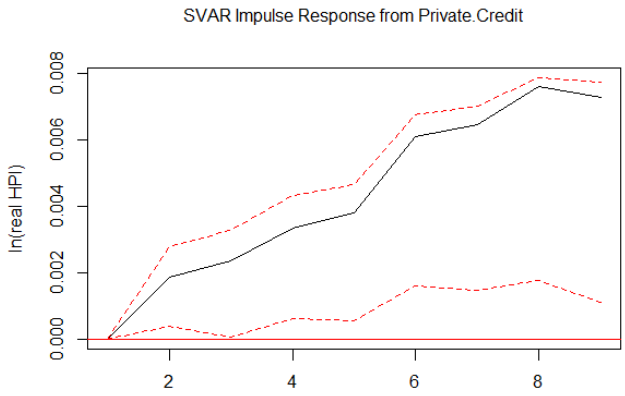


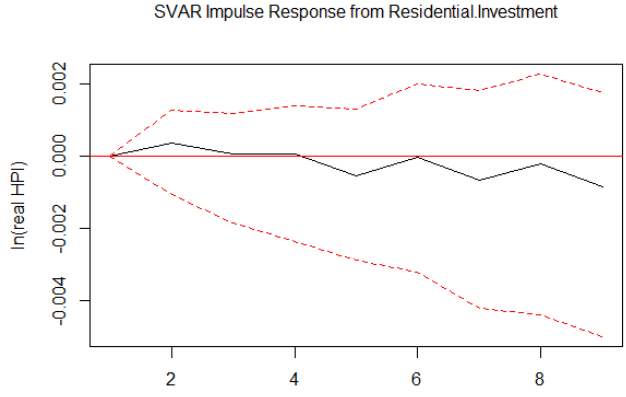
EA Impulse response function 2 (level SVAR 2): full sample

ORDER 1

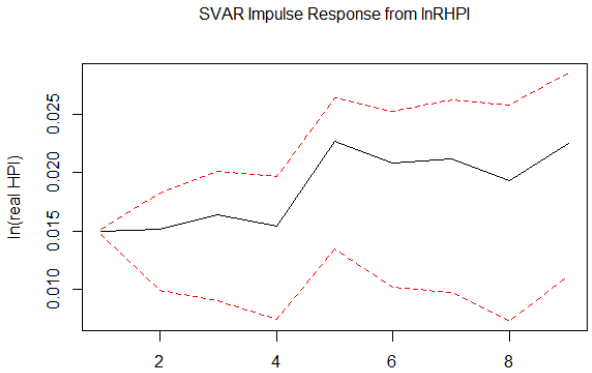


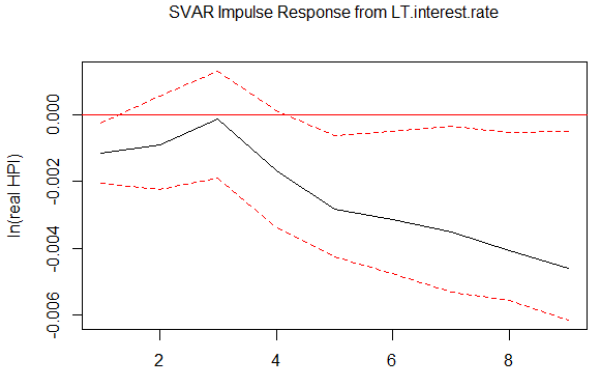


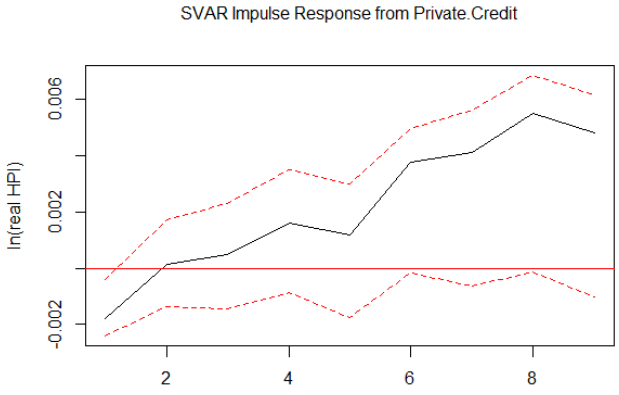


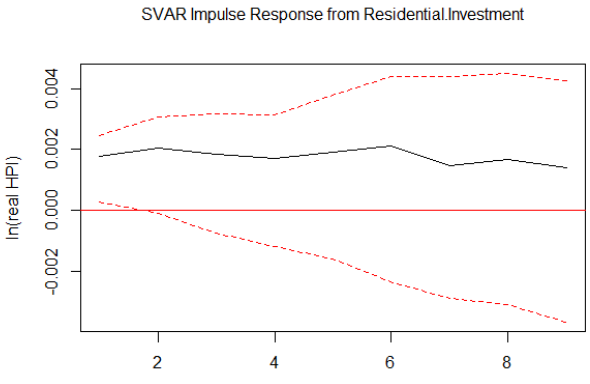


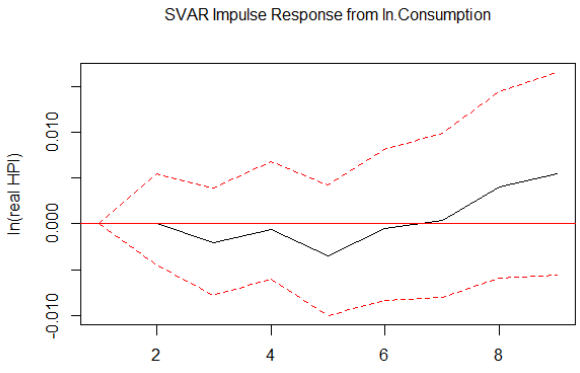
ORDER 2

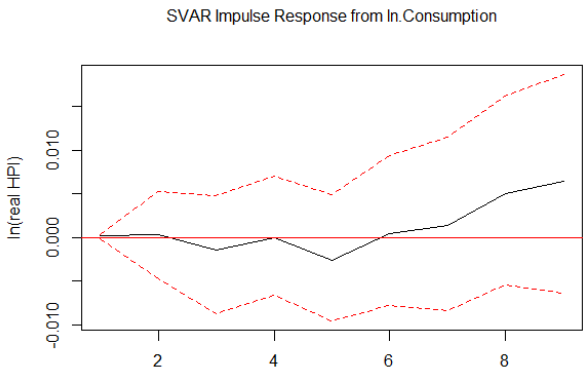






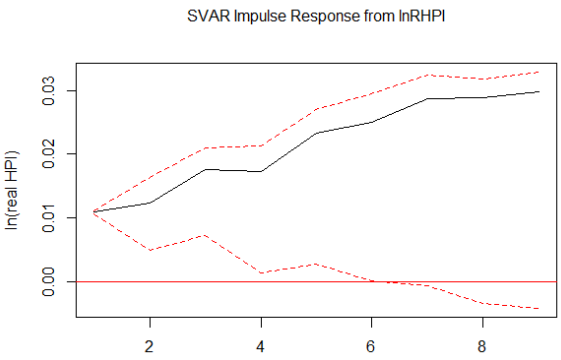


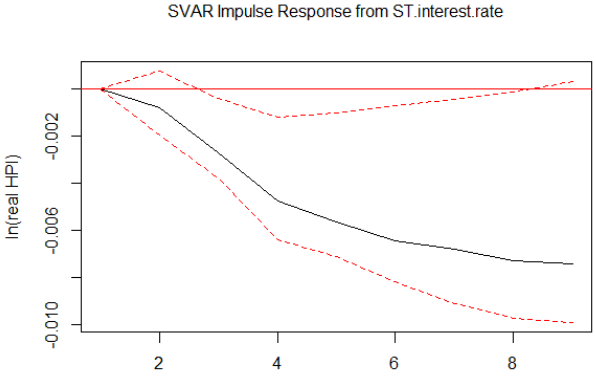


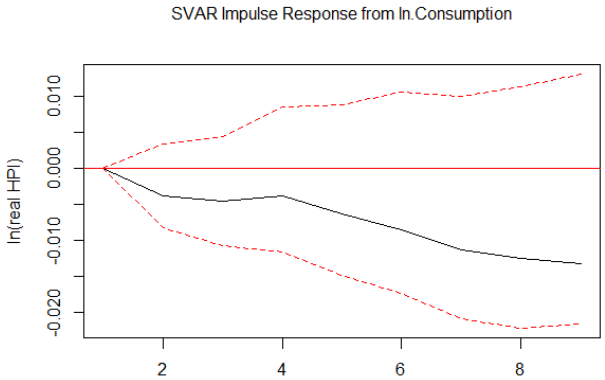


EA Impulse response function 4 (level SVAR 3): full sample

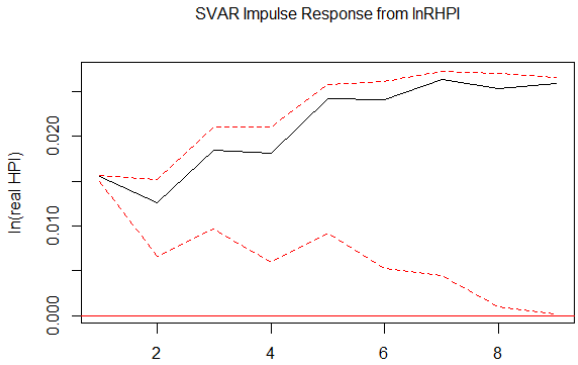
ORDER 1

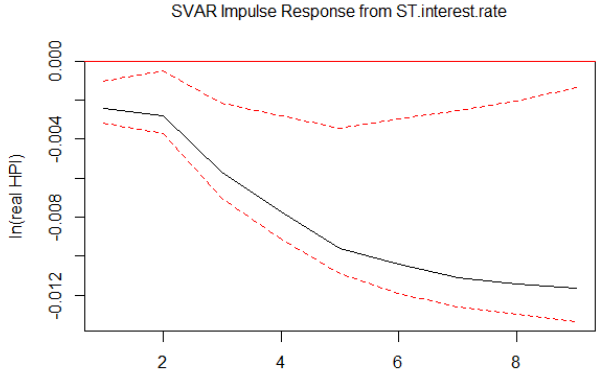


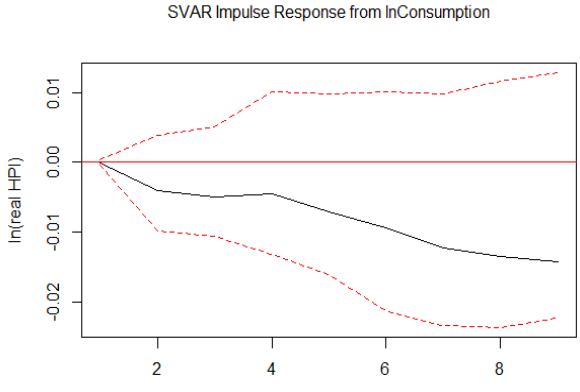


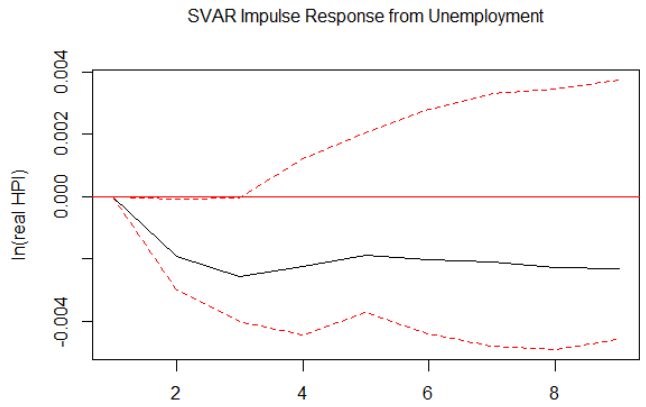


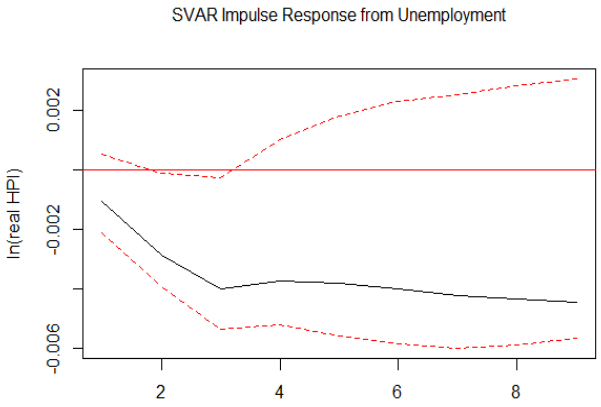
ORDER 2







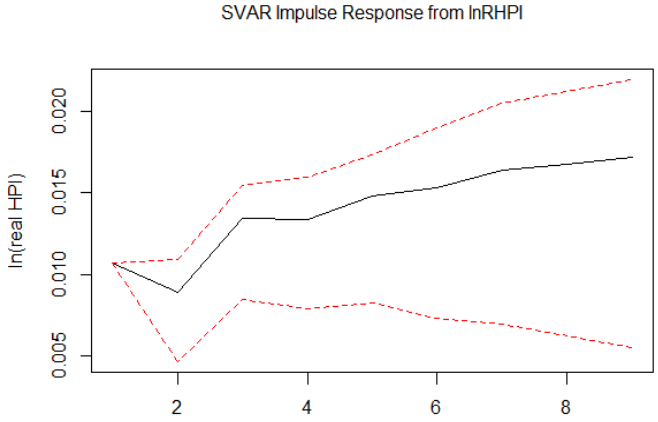


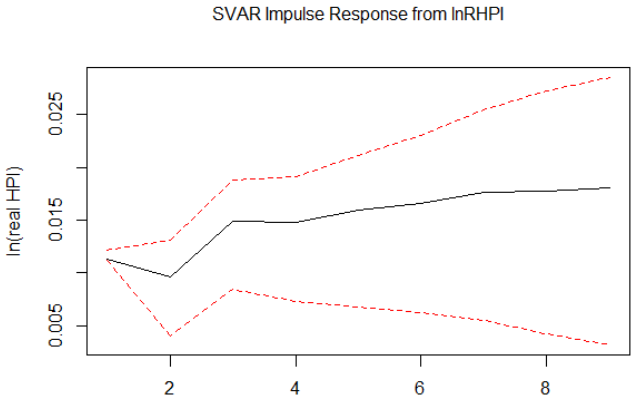


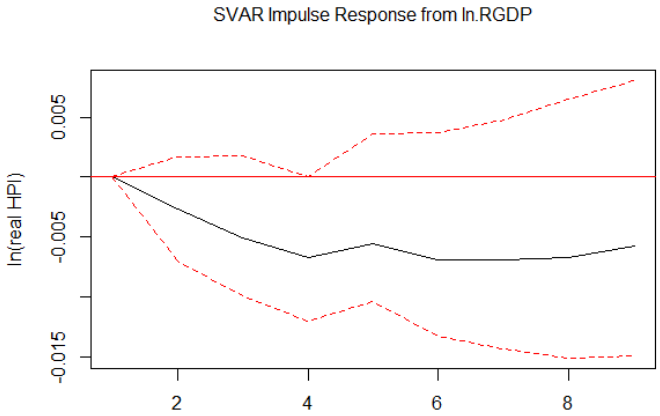
EA Impulse response function 5 (level SVAR 5): full sample order

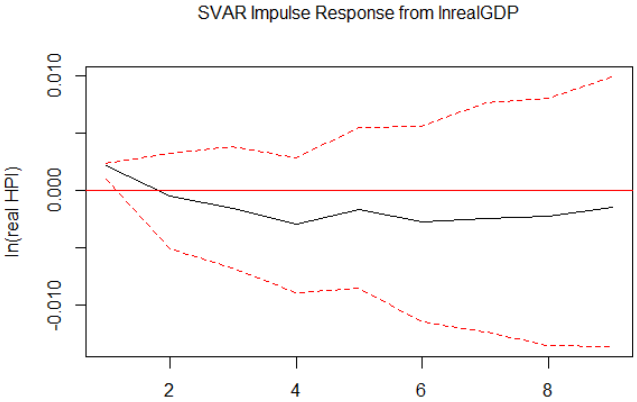
ORDER 1

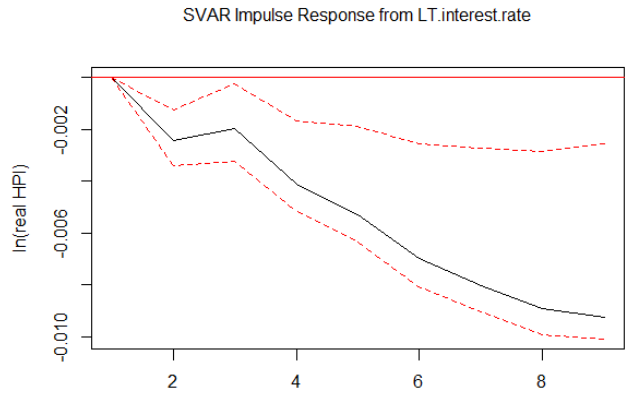
ORDER 2

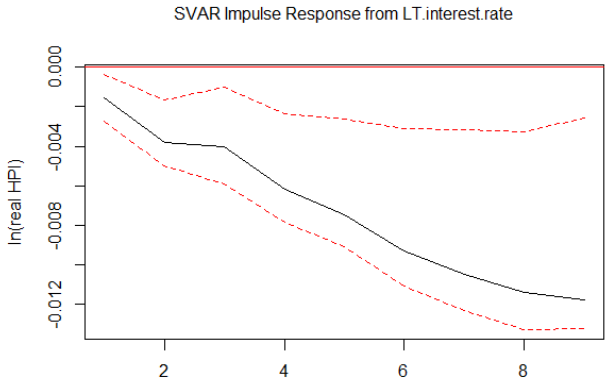


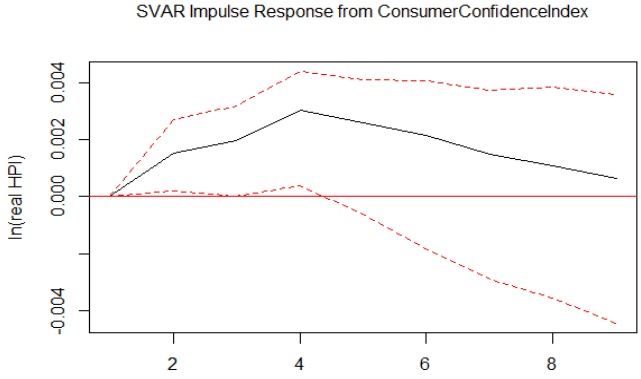


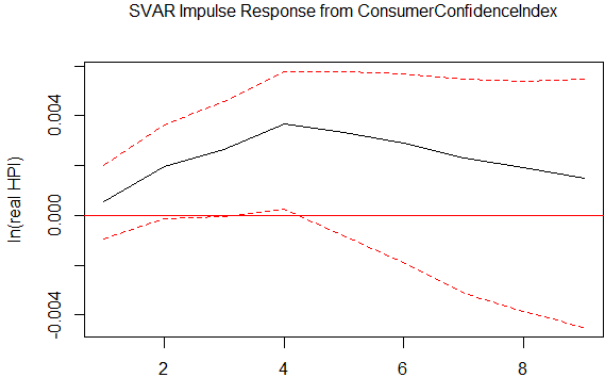


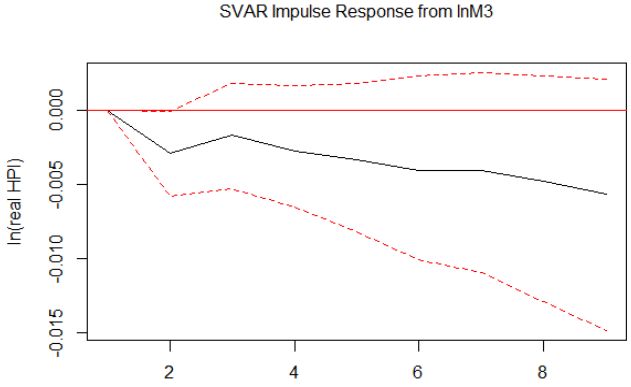


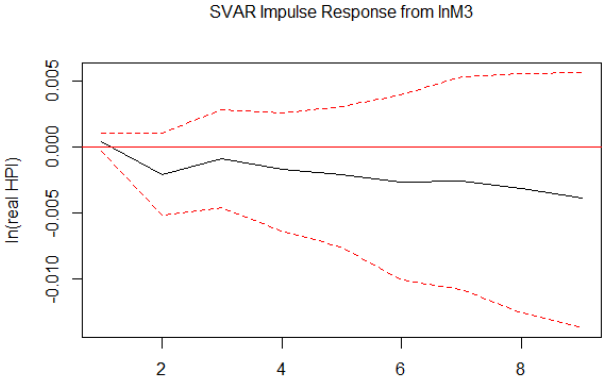

SVAR Impulse Response from LT.interest.rate
ln(real HPI)
-0.002
-0.006
-0.010
2
4
6
8


SVAR Impulse Response from LT.interest.rate
ln(real HPI)
0.000
-0.004
-0.008
-0.012
2
4
6
8


SVAR Impulse Response from ConsumerConfidenceIndex
ln(real HPI)
0.004
0.002
0.000
-0.004
2
4
6
8


SVAR Impulse Response from ConsumerConfidenceIndex
ln(real HPI)
0.004
0.000
-0.004
2
4
6
8


SVAR Impulse Response from lnM3
ln(real HPI)
0.000
-0.005
-0.010
-0.015
2
4
6
8


SVAR Impulse Response from lnM3
ln(real HPI)
0.005
0.000
-0.005
-0.010
2
4
6
8