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"Introducing housing costs in the HICP: challenges and policy implications for the European Central Bank"

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Abstract

I analyzed how the introduction of housing costs, through the net acquisition approach, would impact the Harmonized Index of Consumer Prices over the time frame 2005-2021 for the euro area context. Starting from a theoretical analysis, I calculated a new inflation index, called HICP_A, that includes the Owner-Occupied Price Index or the House price Index, both published by Eurostat. After an initial phase of trend assessment, I found that the inclusion of a pro-cyclical variable, with a relatively low weight, doesn't affect the inflation rate in a significant way. Finally, with the help of VAR models which include inflation, interest rate and real Gross Domestic Product, I explained how ECB policies would change (or not) in response to a new macroeconomic framework. Useful tools for dealing with risks arising from housing market will then be introduced.

Contents

Introduction

A meeting of the Governing Council of the European Central Bank was held in the summer of 2021, where the new strategies and medium-long-term goals were defined. One of the most relevant issues concerns the introduction of a housing cost component within the European harmonized inflation rate. The debate and doubts are heated, as the methodology chosen for implementing this process, is that of "net acquisition". The approach involves treating the housing asset as a normal consumer good without assessing its shades as an investment item; in fact, it focuses almost entirely on the home purchase stage alone. The sample of examined households will therefore be a small number compared to other methodologies, such as the "rental equivalence approach". We will see the substantial differences between these two possible methods of estimating housing costs, relating the euro area context to the U.S. context, the relationship of these two economies with housing sector, and the spillover behaviors of housing market to other economic areas.

The analysis based on Eurostat data covers the time frame 2005-2021, with reference to the Eurozone, where it is possible to use indexes for housing costs to be included within the harmonized inflation rate. Unfortunately, I had to use two different estimates of these costs, in particular until 2009 I used the House Price Index, while from 2010 until the end of the period I used the Owner-Occupied Price Index, the value chosen by the European Central Bank, which, however, was calculated only for the last 11 years.

By cross-referencing the data from the HICP items, with the proxies for housing costs, and simultaneously reformulating the index weights, I calculated a new index called HICP_A. The core of the central part of the thesis involves a comparison and evaluation of the peculiarities of the two rates over time. They are not exempt from the housing market trend, which will be pitted, highlighting its movements during the period under review, against the key variables that make it up, such as real house prices and mortgage debt.

Lastly, the time series of inflation rates will be used in a VAR model along with two other important macroeconomic variables in the euro area, real Gross Domestic Product and the interest rate. The dual regression put in place, evaluates the different interactions between measures of HICP and the other items involved. Will or will not the ECB respond monetarily to a

new inflationary setting? Will monetary policies and strategies change? Conclusions will be drawn at the end of the thesis on whether indeed the analysis carried out has indeed an impact on the behaviors of the top monetary policy institution. The time frame covers two crisis periods, financial and pandemic, which were affected by housing market trends; therefore, preventive tools will be useful to avoid booms of this spilling over into the business cycle.

The thesis is structured as follows. Chapter 1 provides a literature review of housing market, its trends and its relationship with the economic environment. The continuation focuses on the introduction of major inflation indexes, housing costing methodologies, and the first hints of the Owner-Occupied Housing Price Index. Chapter 2 outlines the benchmark dataset, trends and sub-indexes of the OOHPI, then, after some assumptions, introduces the housing component within the HICP. A quarterly comparative analysis is made between the increased index and the euro area and U.S. inflation indexes. At the end, a summary of the highlights of the pre-post-financial crisis housing market is provided, especially credit and house price items. Chapter 3, through a VAR model, seeks to understand the macroeconomic implications of the new increased inflation rate; the other variables are real GDP and interest rate while the referenced time frame lasts from the first quarter of 2005 to the last quarter of 2019, thus excluding pandemic-related years. Granger causality test and impulse response functions are compared with an equal model that uses the inflation rate without adjustments. Finally, the importance of appropriate housing risk and prevention tools by institutions is emphasized in order to avoid further crisis periods.

1. Literature review: Behavior and cost treatment of Housing Market

The first strategy, and in general the first guidelines of ECB, were settled in 1988, then reviewed in 2003. It consisted in three main elements, first the double key formulation of the price stability objective that include a quantitative definition of it as a year-on-year increase in the Harmonized Index of Consumer Prices of below two per cent, and the aim to maintaining inflation rates below, but close to, this percentage. Second, the orientation of medium-long term in view of the time lags in the effects of monetary policy on inflation. Third, the risks of price stability were analyzed from an economic and a monetary point of view, with the information being cross-checked to form a unified overall judgement (European Central Bank, 2021).

Since 2003 the world has seen a lot of changes which imply new challenges for the ECB and all central banks, and one of them is the treatment of housing cost. In the European context we have a lot of differences between the housing market across the countries, thus is very difficult to estimate and insert in the Harmonized Consumer Price Index a correct component of housing. It is necessarily having a clear idea of the peculiarity of this type of market and for this reason I'm starting with a comparison between the European and American housing market and their relationship with the macroeconomic context. Then I'll give a brief description to the indexes which involved the housing costs component and to two methods that could be used to calculate them. The end of the chapter explains the problem related to the Net Acquisition approach, which is chosen by ECB to obtain the costs of housing and to form the Owner-Occupied Housing index.

1.1 Characteristics of US and Euro Area housing market

The paper "Housing, consumption and monetary policy. How different are the US and the Euro area?" (Musso, Neri and Stracca, 2010) puts the focus on three structural shocks and after the standardization of the size of them, they compared the impulse response pattern of the two economies, US and euro area. The findings reveal **three main results**: a lot of similarities in descriptive analysis as regards key housing market and macroeconomic variables, while with a

SVAR analysis there is more evidence of a role for the housing market in the transmission of monetary policy in the US than in the euro area, a negative mortgage credit supply shock has a negative impact in house prices and residential investment in both economies.

We can underline **notable differences**: the land availability is higher in US (thus American people has less supply constraints), the mortgage market is more developed in US, mortgage lending rates are mainly tied to long-term rates in the US. After the recognition of the main characteristics of the two market, the authors carried out an empirical analysis of the role of the housing market in the macroeconomy. Then they moved to a structural analysis using Structural Vector Autoregression approach, conditional of a restricted number of structural shocks.

The data, that are related to variables of housing market of US, of euro area and the five largest euro area countries (Germany, Spain, Italy, France and Netherlands), are: private consumption, residential investment, the CPI, the real house price, a representative mortgage lending rate, the 3-month interbank interest rate, and mortgage debt.

In contrast with the common perception, the housing wealth, as a share of GDP, is bigger in Europe, in fact in this economy the people are less inclined to invest in financial markets and they see the house like a safe asset, while American tend to hold more stock. Also, the value of the land is higher in Europe, this is due by population concentration and the size of the entire continent.

From an unconstrained point of view and with a sample spanning from 1986 to the last quarter of 2008, a number of considerations about key housing market variables in the United States and the euro area emerged. First, residential investment is strongly procyclical and tends to drive the business cycle. Real house prices are also procyclical, but less than residential investment, while the correlation between these two variables is positive in both economies. Average annual house price growth is higher in the United States, but it is important to note that house prices are not harmonized between the two economies and, to some extent, between some euro area countries. The average annual growth of real mortgage debt is similar in all economic areas (around 6 percent), and mortgage debt itself is procyclical everywhere. The mortgage lending rate (expressed as a spread over the 3-month interbank rate) is higher in the United States, perhaps because of the longer maturity of mortgage debt, and rate spreads are strongly countercyclical. Therefore, we find more similarities than differences in the unconstrained analysis.

1.1.1 The Var evidence

The Var model gives a more structural interpretation to the stylized facts introduced in the unconditional model (empirical analysis). It includes shocks which impact on the key variables and the SVAR is specify for the euro area and the United States separately, identified using short run restrictions. The model is defined as:

$$Ay_t = c + B(L)y_{t-1} + \Sigma\varepsilon_t$$

The vector y includes seven variables, in this order: the log CPI "p", log private consumption "c", log residential investment "ri", the log real house price "hpr", the 3-month interbank interest rate "R", the representative mortgage lending rate "Rl" and log nominal mortgage debt "b". Then each Var model includes a constant term.

There are **two important caveats to keep in mind** in the phase of interpretation of the analysis. First, the euro area and US are considered separated in each VAR, and there isn't the consideration of any international spill-over effect. Second, the model has a linear structure, while some phenomena that are treated by the model involved non-linear dynamics, especially in periods of crisis.

The housing market could be a conduit for the transmission of shocks as well as an independent source of shocks for the broader economy for two reasons. First, housing is a form of wealth and a variation on house prices impact on it. Second, housing is a form of collateral for loans to household, some of which could be used for consumption purpose.

The paper notes institutional differences between mortgage markets across euro area countries, and these lead to the question if these differences matter in the transmission of key structural shocks. The authors describe the results for US, the Euro area and the Euro area excluding Germany (the European country with the most differences in housing market). They evaluate the response of the variables included in the SVAR model to selected unit shocks:

- *Monetary policy shock:* the monetary policy shock is intended like an **increase in the short-term interest rate**. In US the housing variables are very influenced by this type of shock, especially residential investment and real house price, while in the euro area the impact of the shock on these two variables is smaller. In both economies there is a contraction of mortgage debt, while the private consumption reacts sluggish and muted.

Then there is the evidence that the increase of nominal interest rates leads to a rise in mortgage lending rates. In general, the monetary policy shock has a greater impact on housing market in US than in the euro area.

- *Credit supply shock:* a negative credit supply shock is intended like an i**ncrease of mortgage lending rate** but not an increase of short-term interest rate which is accompanied over time by a contraction of mortgage debt. The effect of the shock is first a reduction of residential construction (larger in US) and the effect on house prices is negative (more in Eu). The consumption declines only in the US although the difference isn't statistically significant. This shock has also a significant effect on mortgage loans.
- *Housing demand shock* is intended like an **increase of real house price that over time leads to an increase of residential investment**, and is not associated with a fall short-term interest rate (in US the residential investment shock characterizes more the housing demand shock). An important difference is that the positive effect on consumption is much shorter lived in the euro area than in the US.

In general, Musso, Neri and Stracca have found more similarities than differences as far as the housing market is concerned, with both types of analysis. In the US and in the euro area the real house price, mortgage debt and residential investment are procyclical while the spread between the representative mortgage lending rate and the short-term interest rate is countercyclical. Mortgage credit supply shocks have significant effects on residential investment and mortgage loans, while the effects on real consumption seem to be more limited. All the variables are affected by housing demand shocks in a positive manner, but the effect on consumption appears stronger and more persistent in the United States. Overall, the paper has found some evidence that housing markets could play a bigger role as conduits of monetary policy shocks in the US than in the euro area while the evidence for housing demand and credit supply shocks is less clearcut.

1.1.2 Housing market spillovers

The concept of spillover, a lack of the previous VAR model, is treated in the paper "Housing market spillovers: evidence from an estimated dsge model" (Iacoviello and Neri, 2008). The wealth effects in US from housing on consumption are significant and positive and have become more important over time. In the 21st century US economy is characterized by strong residential investment and growth in housing prices. To assess whether housing market imbalances cause spillover effects both in the housing market itself and in other economic sectors, it is essential to answer two questions: "What is the nature of the shock that hit the housing market?"; "How big are the spillovers from the housing market to the rest of the economics?".

The authors estimate a dynamic stochastic equilibrium model of US economy, based on quarterly data over the period 1965-2006, which studies the price and the quantity side of the housing market, in order to reach **2 main objectives**: understand the extent to which a model with nominal and real rigidities and credit frictions can explain the dynamics of residential investment and house prices observed in the data and measure the spillovers of housing markets on the broader economy.

To the classical framework of dynamics equilibrium models, they added two important features. On the supply side the model is characterized by heterogeneity between sectors: the non-housing sector produces consumption and business investment using capital and labor; the housing sector produces residential investment using capital, labor and land. On the demand side both housing and consumption enter in the household's utility, and housing could be use like collateral for the loans.

Since consumption and housing goods are products that use different technologies, the model generates heterogeneous dynamics both in the residential investments and in the house prices. At the same time the fluctuations in the house prices influence the capacity to borrow of a fraction of households and the profitability to produce new houses.

The dynamics of the model are driven by nine orthogonal shocks: productivity shocks (non-housing technology, housing technology and investment specific shocks), two monetary shocks (transitory "monetary policy" shock and a persistent inflation objective shock), a price markup shock, and discount factor shock, a labor supply shock and a housing preference shocks.

The model reports that housing prices and housing investments are strongly pro-cyclical, volatile and high-sensitive to the monetary shocks. Then in the last four decades before 2006 the rise of housing prices is due to low technological progress and by the presence of the lands in the production of new homes.

The results highlights that in US the housing demand and housing technology shocks are about one quarter each of the cyclical volatility of housing investments and housing prices while monetary shocks are about 15-20% and they have played a bigger role in housing market cycle at the beginning of the century. The fluctuations in the housing investments impact directly on GDP, and the spillovers are defined considering the nominal, real and financial frictions and their contribution to the mechanism. The model is divided in two subsamples: before the liberalization of mortgage market (1965-1982) and after the liberalization (1982-2006). The fluctuations in the housing markets accounted around the 2% of the total variance of the consumption growth in the first period, while around 15% in the second period. The spillovers are non-negligible, and they are more important in the last two decades of the sample.

In general, the analysis of Iacoviello and Neri is composed by four principal elements:

1. A multisector structure with housing and non-housing goods
2. Nominal rigidities
3. Financing frictions in the household sector
4. A rich set of shocks

After the estimation of the parameters, we can discuss the main workings of the model. **A positive preference shock** rises the house prices and the returns of investments in the construction sector, thus causes an increase of residential investments; then the value of the collateral constrained of the agents rises, giving the possibility to them to increase borrowing and consumption. After an **adverse monetary policy shock** the real house prices drop and remain under the baseline for about six quarters, then all the components of the aggregate demand drop with the highest negative effect for the residential investments. A **productivity shock** in the goods sector implies an increase of house prices and consumption, while a **positive technology shock** in the housing sector brings to a decline of real house prices.

The four shocks previously cited account for roughly 75 percent of the fluctuations in residential investment, and 60 percent of the fluctuations in house prices at business cycle frequency. The

first answer to Iacoviello and Neri's questions is that housing demand and housing technology shocks are responsible for about a quarter each of the cyclical volatility of housing investment and housing prices, while monetary shocks are responsible for between 15 and 20 percent, but played a key role in the housing market cycle at the turn of the century. The authors then deduct that the spillover to the broader economy is non-negligible, especially on consumption rather than business investment.

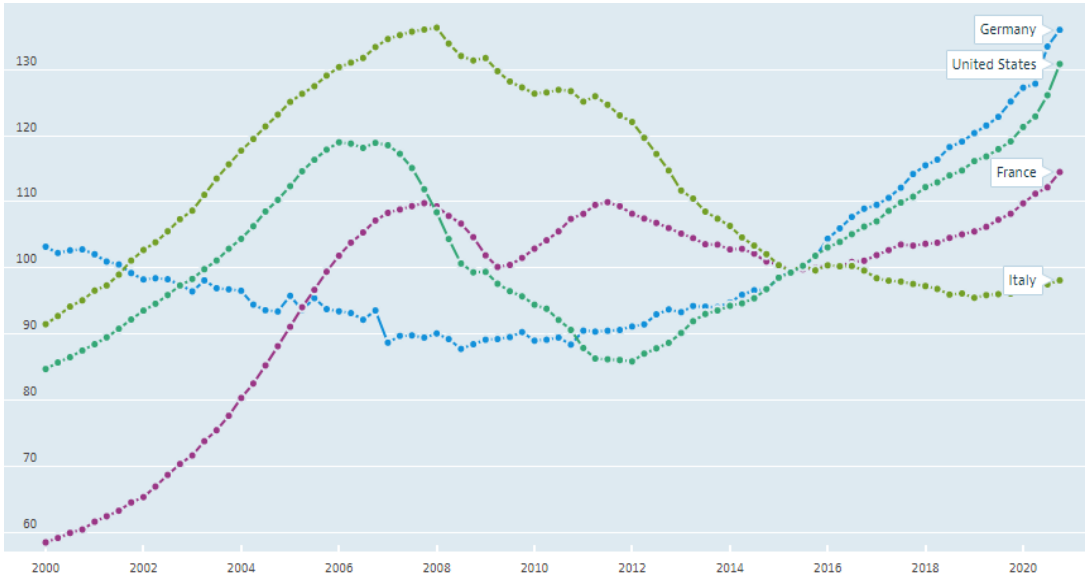
1.2 House prices and Rents: their trends and how they are treated

So far, we have given an overview of the relationship between housing market and the rest of the macroeconomic features. Now, with the help of figure 1.1 and figure 1.2 we can take some insights about the trends in Europe and in Us. I have decided to put in comparison France, Germany, Italy and United States with respect to the real house prices and the prices of rent, with base year 2015=100[1].

The time interval for the two graph starts in the first quarter of 2000 and it ends at the last quarter of 2020. For the house prices we notice the increase in European economies until 2008 and then a substantial decrease while in US there is a stable trend until 2015, then a strong increase above one hundred bases. Italy has the highest prices until the 2015 and the lowest prices after this date. For the figure 1.2, the rent prices, trends are quite similar, but after the 2015 the US overcomes other economies presented the highest values. In general, like Iacovello and Neri remind us, United States in the third millennium present an important growth in house prices and residential investments. Summarizing the two figures, we state that the variables related to the housing market presented similar trends, **thus it is important to ask ourselves why the housing market in US is much more correlated with the monetary shocks/macroeconomics features.**

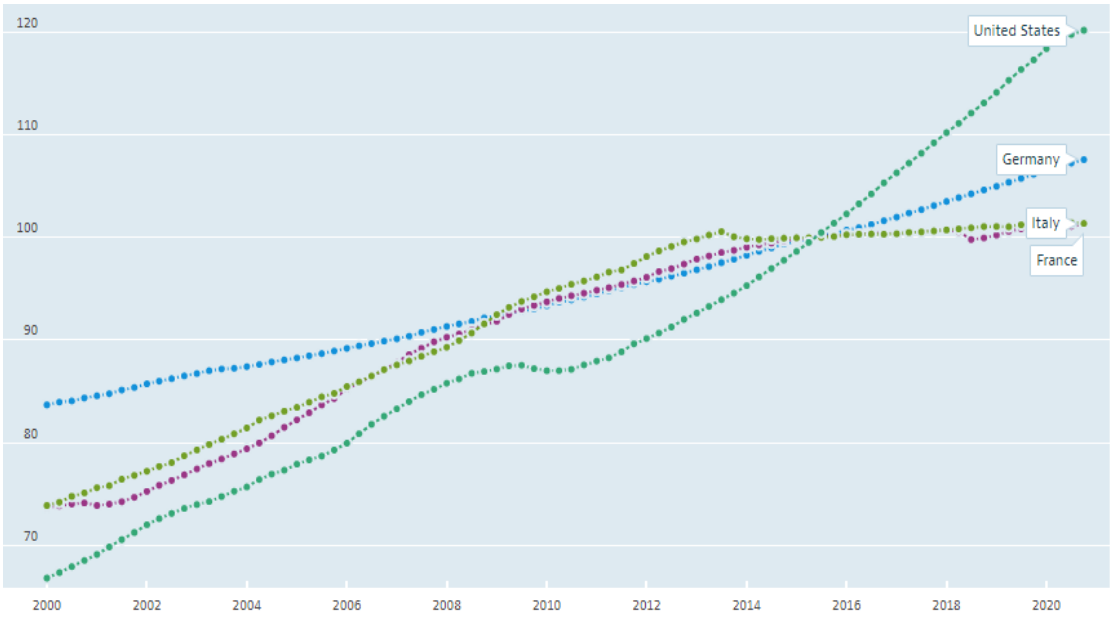
[1] The data are retrieved from the OECD's web site: https://www.oecd.org/.

Figure 1.1: Real House Prices



Source: OECD

Figure 1.2: Rent Prices



Source: OECD

Every country has his system to calculate the inflation, and the characteristics related to this parameter show difference and similarities between the nations. The component of housing is present everywhere but with different consideration and treated with heterogeneous method of

calculous. US behavior towards this type of costs is similar with some European countries, but the American housing market is much more homogeneous with respect to the old continent. The last presents high differences in this market across the countries, and the challenge to treat the housing cost in aggregate and harmoniously way pose a big challenge to European Central Bank. Given a clear measure of inflation which involve the costs that impact on household is necessary to understand the best solution and strategy to apply to maintain the price stability. The next sections will describe the inflationary indexes of the two economies and how housing costs are represented within them.

1.2.1 Consumer Price Index and the component of housing

The work "Consumer Price Index" (U.S. Bureau Of Labor Statistics, 2020, 1-15), says that the CPI is a measure of the average change over time in the prices paid by urban consumers for a representative basket of goods and services. It measures inflation as experienced by consumers in their day-to-day living expenses. Indexes are available for the United States and various geographic areas; **thus, the CPI directly affects hundreds of millions of Americans.**

The eight major groups of CPI are: food and beverages, housing, apparel, transportation, medical care, recreation, education and communication, other goods and service. In particular, the most relevant group for us is the group of housing that is composed by rent of primary residence, owners' equivalent rent, utilities, bedroom furniture.

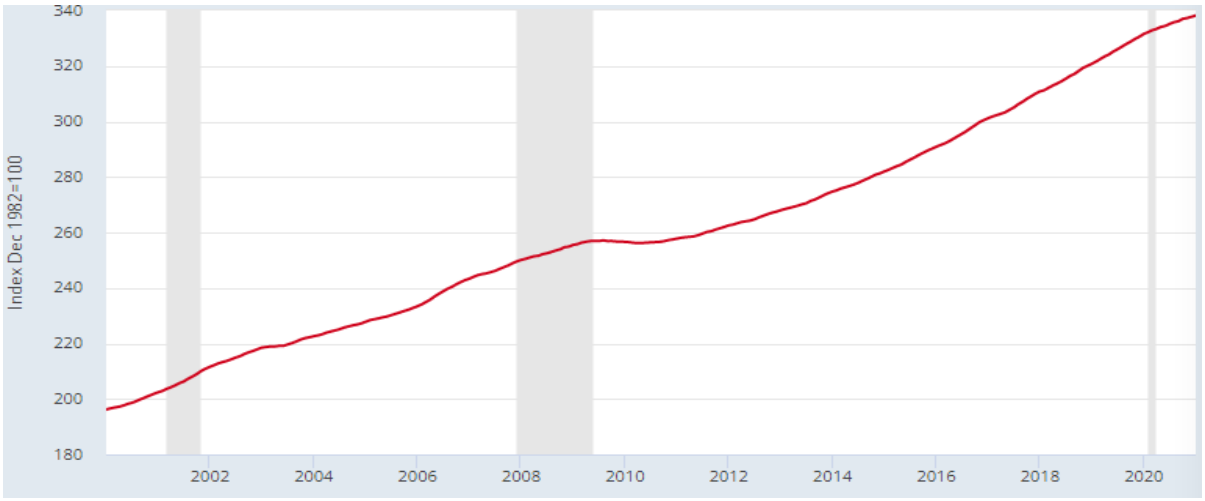
The most utilized category of CPI is for all urban consumers (CPI-U) and is also the broader category. It is based on the pattern expense of urban consumer sample who represent the 93% of the population. This pattern could change strongly during the year, so CPI is published seasonally and not seasonally adjusted. The base period, when the time series index values is normalized to 100, for most categories is 1982-1984=100. Like we said before CPI involves only consumer goods and services, thus some items are excluded: stocks, bonds, real estate and business expenses.

The fundamental data in the CPI are the prices, which are collected through two surveys: one collects the prices of commodities and services and the other collects rent prices. The last involves about 8000 rental housing unit quotes each month to compute the indexes for the housing component. The survey uses quotes of rent prices and homeowners' equivalent rent to

compute the estimates of price change. Because the rents don't change frequently, the CPI's program collects rent data from each sample unit every six months, and it allows to use a much larger sample.

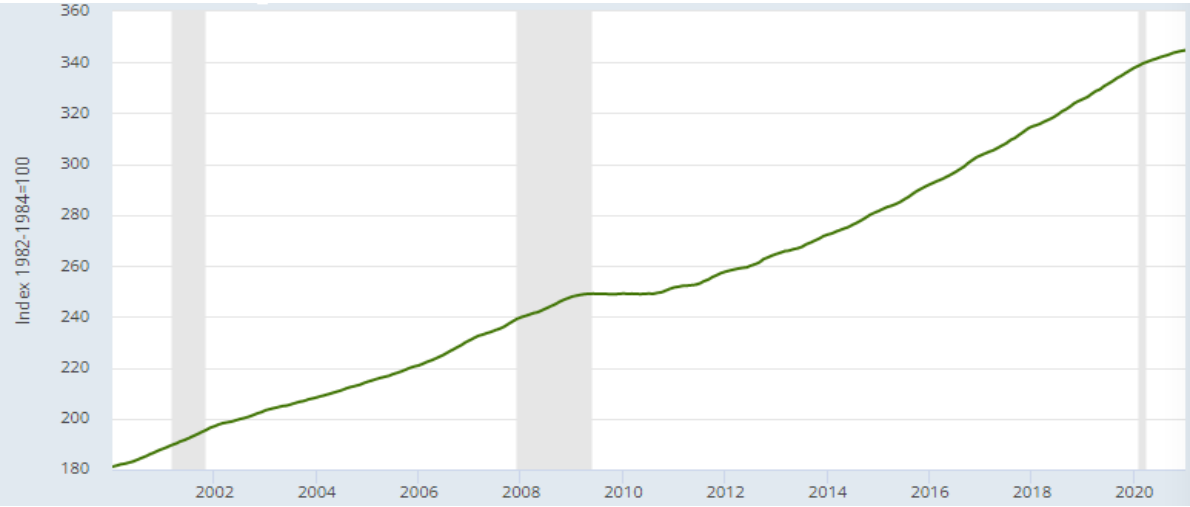
In US, **the shelter**, is the service that is furnished by the residential unit to their owners, and it is an important part of the basket goods of the CPI. Two CPI' indexes, owners' equivalent rent (OER) e rent of primary residence, measure the variation of the cost of shelter service that the consumers receive from the residence. In particular, the imputed rent for the own residence is the biggest category in US CPI, with a weight of about one quarter in the last years. The CPI considers the housing units **like capital goods** (or investment goods) and not like consumer goods. Figures 1.3 and 1.4 show how the "OER" and "Rent" evolved from 2000 to 2020, underlying a constant increasing of the indexes with respect to the year base.

Figure 1.3: OER trend in US



Source: Bureau of Labor Statistics

Figure 1.4: Rent trend in US



Source: Bureau of Labor Statistics

The weight of the expenditure in the basket goods of CPI for the owner equivalent rent is based on the following question that the survey on the consumer expenditure asks to the consumers that own their principal residence: "If someone were to rent your home today, how much do you think it would rent for monthly, unfurnished and without utilities?". While the question to the consumers that rent their principal residence is: "What is the rental charge to your [household] for this unit including any extra charges for garage and parking facilities? Do not include direct payments by local, state or federal agencies. What period does this cover?" (U.S. Bureau Of Labor Statistics, 2009). These indexes have the largest weight of the 211 item categories in the CPI, for example in 2008 OER and Rent shares of the total weights (the relative importance) in the CPI for All Urban Consumers (CPI-U) were 24.43 and 5.96 respectively.

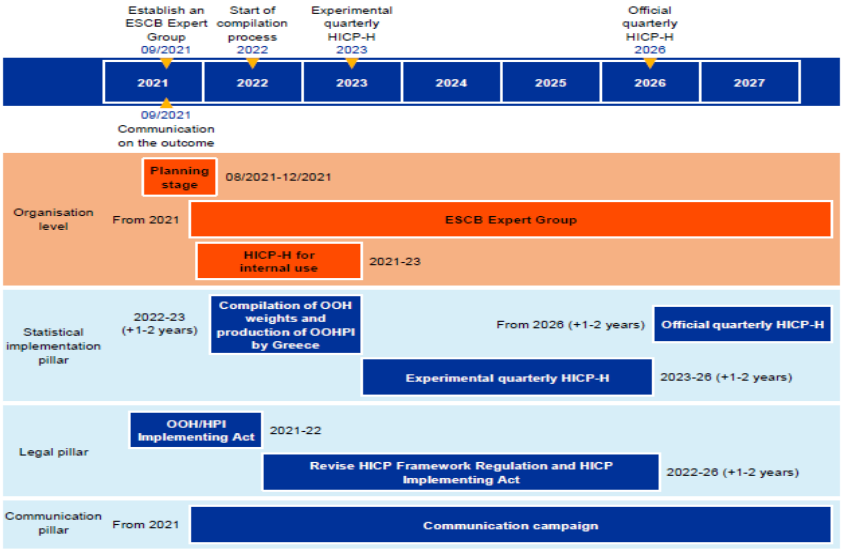
1.2.2 The Harmonized Index of Consumer Prices and the component of housing

The Harmonized Index of Consumer Prices (HICP) measures the changes over time in the prices of consumer goods and services acquired by households. They give a comparable measure of inflation as they are calculated according to harmonized definitions. Data is available on a monthly and annual basis, and the **principal indexes** for HICP are food and non-alcoholic beverages, alcoholic beverages tobacco narcotics, clothing and footwear, housing water

electricity, gas and other fuels, furnishing household equipment and routine household maintenance, health, transport, communications, recreation and culture, education, restaurant and hotels, miscellaneous goods and services.

There isn't a harmoniously voice in HICP that reflect the Owner-Occupied Cost (OOH), due to the heterogeneity of European housing markets, so there is the doubt that the level of inflation is underestimate, especially in the last years with the increasing house prices. **The Ecb's strategy review contained a decision to "recommend a road map to include owner-occupied housing (OOH) in the HICP" (Figure 1.5) prior this date will give a lot of importance to the index of OOH estimate by the Eurostat.**

Figure 1.5: Possible roadmap



Source: ECB

1.3 The method to calculate housing cost

More methods are or can be used to calculate the cost related to housing, but I want treated two of them: rental equivalence approach and net acquisition approach. Each present pros and cons, and while the first method is already used in US and in some national CPI in the euro area, the second is related to the strategy of inclusion of OOH costs in the HICP. The "Technical manual

on Owner-Occupied Housing and House Price Indices" (Eurostat, 2017, 10 and 13-15) provides an overview of them in the following paragraphs.

1.3.1 Rental Equivalence approach

In the Rental Equivalence approach, the rent for the rented dwellings is taken as a measure of the cost of use. **In this approach is imputed a price for dwelling OOH equal to the rental price of location of an equivalent dwelling for the same time.**

The RE is the only approach that doesn't request the compilation of an index of maintenance and major repairs, since these costs are normally pay from the owner and are reflected in the rents pay by the tenants. Nonetheless his attractiveness, the RE presents some **serious problems**:

- It is a notional concept that uses imputed prices rather than actual transaction prices. Thus, is not coherent with HICP requirements.
- It is not necessarily representative in the countries where the rental market is thin or structurally different.

Despite the problems, this type of approach presents **a lot of advantages** (Whelan, 2021). **First**, it furnishes a clear and intuitive measure of the relevant price for the consumption element of the own dwelling as opposed to the investment element. For example, if there is a boom in the house prices not accompanied with an increase of rents, with rent equivalent approach the implicit cost of consumption of owner-occupied housing doesn't increase. The option to rent is real but it isn't become more expensive, it is only augmented the house price like investment good. **Second**, the RE gives a measure of the opportunity cost associated to the home ownership. In a nutshell, it considers whether a person lives in a bigger house with an evident higher value, and this value could be measure by the rent that others are willing to pay to live there. **Third**, this approach means the total amount of the real consumption of dwelling services (both for rental property and owner-occupied property) depends only by the dimensions and from the quality of the stock of residential housing. Since the total stock tends not to change year to year, this approach produces a quite stable series for the consumption of housing services. It is important to underline that this series doesn't depend by the mix of tenure status in the economy (owners vs renters), the mix of debt used to purchase the dwelling (debt vs own capital) or the actual level of activities in the

housing market (the numbers of selling in a given year). These factors will have low correlation with the amount of housing services effectively consumed.

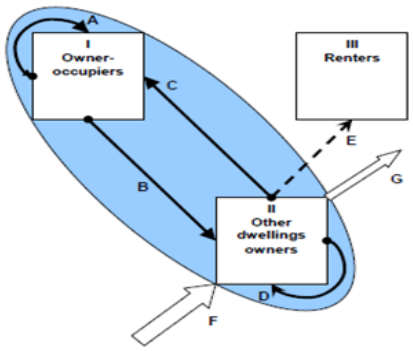
1.3.2 Net Acquisition Approach and OOHPI index

The Net Acquisition approach, selected by ECB to include OOH costs, is the method more in line with the HICP standard, which is designed to measure the variations of consumer prices where:

- The imputed transactions are defined as non-monetary
- Asset transactions are defined as non-consumption
- The transactions inside the household sector are excluded (as they net to zero), apart from the associated transaction costs such as estate agent and legal fees

In this case the OOH price index is calculated using the households' expenses directly observable for the purchase of dwellings, major repairs and services related to dwelling ownership and their legal transfer (so all the transaction expenditure related to living in an owner-occupied housing). In NA approach only the transactions by household destined for owner occupancy are taken into consideration (purchase, construction, renovation and other services related to dwellings). More difficult is the separation of non-tangible element from owner-occupied dwellings. The solution for OOH index is to exclude the land component from the index weights and prices. In the approach of net acquisition, sales and purchases of dwellings by households are treated symmetrically, the first have a negative weight while the second a positive weight. Thus, a system of OOH price index should capture the movements of the prices of all the domestic purchases destined for owner-occupied net of sales of al the dwellings occupied by the owner to the non-domestic sector. Figure 1.6 presents the situation, where the boxes show the relevant player and the arrows all the relevant flows for the dwelling while the blue area highlights the transactions that are relevant for the OOH. The owner-occupiers (I) and the renters (III) form the entire household sector, while the whole dwelling stock is owned by owner-occupiers (I) and by other dwellings owners (III). The last group is formed by the institutional sectors and households when acting as landlords or developers.

Figure 1.6: Flows of NA



Source: OOH manual

The flows A and D represent all the dwelling transactions that are carried out during the period take in exam. The flow E involves the services from the owner of the dwellings to the renters, while flow F represents the new stock of dwelling and G the sales of dwelling by non-household. To summarize the market transactions:

- **A**: household purchases of dwellings for own use, which were occupied by the sellers
- **B**: non-household purchases of dwellings for renting or for other scope that were owner-occupied by the sellers
- **C**: household purchases of dwellings for own use from the non-household sector. These transactions include the existing dwelling that were previously rented out and the new stock of dwellings (flow F) that were constructed during the period
- **D**: non-household purchases of dwellings from other members of non-household sector. Also, this flow includes both new and existing dwellings

When defining the coverage of the weights of the purchases of the dwellings in the field of net concept, all the sales must be detracted from the purchases to arrive at the net purchase. From the figure 1.6 we can see that the nets for the owners-occupied are given by:

$$\mathbf{(A+C) - (A+B) = C - B}$$

In this presentation the new dwellings always enter in the housing markets, to be used by their owners o to be rented, trough the sector “other dwellings owners”. A particular case emerges

when a household builds by itself a new dwelling for own use. The self-building dwellings going to the HICP, but weights and prices, are necessarily based on construction costs.

The fact that the house is new or old is conceptually irrelevant in this approach, while is extremely important to consider whether the dwelling is purchased from the household sector for own use and from what sector the dwelling is bought. Moreover, the NA is based on purchases from other sectors and on the self-building dwellings by the household sector. Then rented-out dwellings are by definition investment goods, whose purpose is to raise revenue for their owners and therefore whose purchase is out-of-scope.

The Owner-Occupied-Housing index published by Eurostat, based on NA approach, is composed in this way:

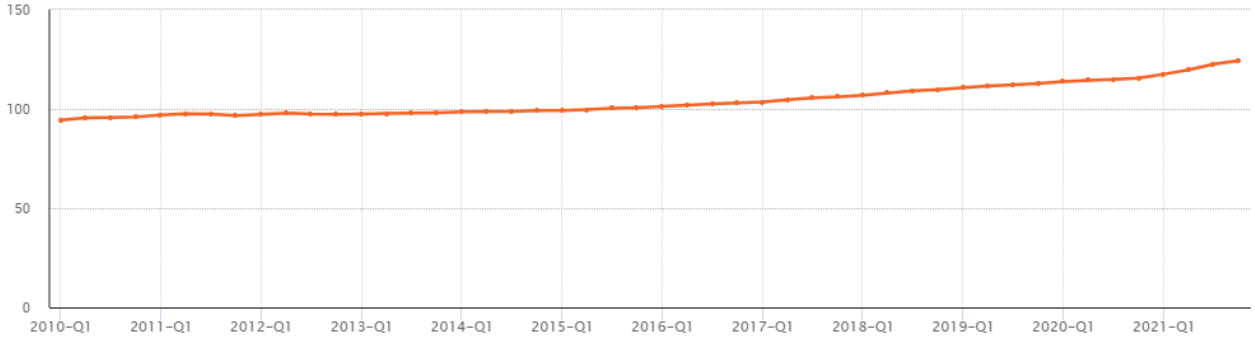
- **O.1.1 Acquisitions of dwellings**
- **O.1.1.1 New dwellings**
- **O.1.1.1.1 Purchases of new dwellings**
- **O.1.1.1.2 Self-build dwellings and major renovations**
- **O.1.1.2 Existing dwellings new to the households**
- **O.1.1.3 Other services related to the acquisitions of dwellings**
- **O.1.2 Ownership of dwellings**
- **O.1.2.1 Major repairs and maintenance**
- **O.1.2.2 Insurance connected with the dwellings**
- **O.1.2.3 Other expenditure**

The acquisition component accounting for around 80% and the ownership component accounting around 20% for the euro area. The first contains the acquisition of dwellings from the non-household sector and self-building of dwellings, plus related costs, while the second includes expenditures related to owning and maintaining the dwelling. As we will see in the next chapter, the OOH index is similar to the "house price index" and to the "dwellings price index", due to the dominant (80%) role of house prices in this index.

Figure 1.7 represents the quarterly trend of OOH index in the 19 countries of euro area in aggregate. The graph starts from first quarter of 2010 to the last quarter of 2021 with base year 2015=100. The coverage time at national level is variable while from 2010 the data are available

for all the countries. Evident is the high rise of the index especially in recent years coinciding with the covid pandemic.

Figure 1.7: The OOH trend in EU19



Source: Eurostat Database

OOHPIs are chain-linked Laspeyres-type price indexes published using a common index reference period; the reference year of the OOHPI series has been changed from 2010=100 to 2015=100.

Laspereys indexes are used to measure the variation of the general level of the prices. The variation of the prices is measured with respect to the year base and the weights are made up of the quantities of the base year as we can see from the formula:

$$L_P = \frac{\sum_i p_{it}\ q_{i0}}{\sum_i p_{i0}\ q_{i0}} \times 100$$

Thus, with a standard Laspereys the modify of the year base is not necessary but this index tends to overestimate the results because the basket good of reference is implicitly consider constant. For this reason, the trend is going to **chained-linked Laspereys indexes** which imply the change of reference year and thus a greater amount of work for the national statistic institutions which have to update in every period the weighting system.

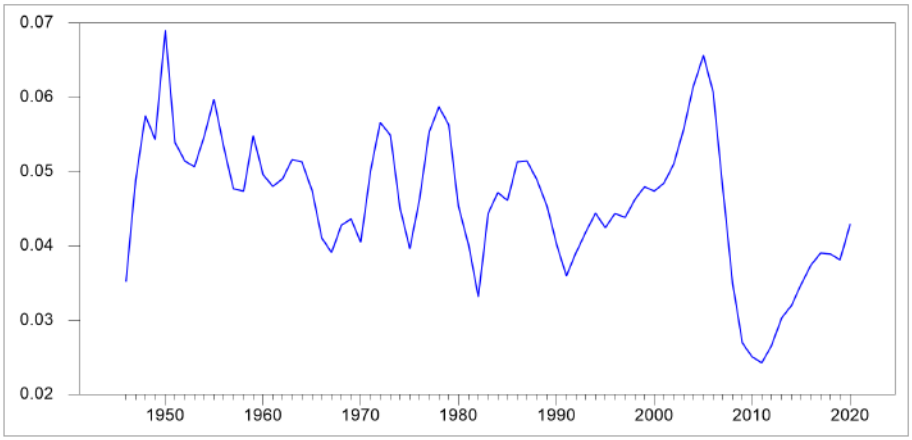
During a specific year, quarter or in general, the values OOH could be seen as the amount that a household should spend in average in that period to purchase the same goods and services which have a total value of one hundred in the base period.

1.4 The disadvantages of NA and the doubts of ECB

The NA approach has a main advantage, it is based on observable price shares for every category covered, thus the house sales. For this reason, it is simpler than RE. Nonetheless there are important disadvantages, this approach doesn't produce price indexes and the most amount of the accounted expenses are considered gross fixed investments by national accounts. Then, it treated only the actual transaction of houses excluding the flow of dwelling services obtained by the owner occupied.

Another problem is the possibility that this approach introduces volatility on consumption price index, as said by the paper "How should be treated housing costs?" (Whelan, 2021). The weight assigned to OOH would depend by the quantity of net-housing acquisitions, but the sector of constructions is highly cyclical, so the role of net-acquisition of housing on the overall price index, changes a lot over time. The historical series for the euro area are limited, but to give an example, figure 1.8 shows the shares of US GDP accounted for residential investment. The value moved a lot, from 6.6% of 2005 to 2.7% of 2009.

Figure 1.8: Share of US GDP by residential investment



Source: Paper "How should be treated housing costs?"

The HICP updates the weights annually based on the expense levels of each item of the previous year. The cyclicity of residential housing construction would imply big year-to-year changes on the OOH weights using NA. Then it could generate an upward bias on the average inflation, due

to the trends of housing markets, where sometimes the house prices increase and encourage additional constructions until the cycle reverse and both house prices and constructions fall. The NA apply to in the HICP context with an annual updating of the weights could give a lot of weight to OOH during housing booms periods when the house prices rising and low weight when the prices decrease (Whelan, 2021).

As we said before the service given by the ownership of a house is excluded in the HICP. **How should be included?** With the NA approach there is the addition of an asset price component in the consumer price indicator which is unwarranted. The HICP should measure the cost of living and not the cost of investment in an asset (for example are excluded share in funds, bonds…).

The purchase of a dwelling is seen as consumption at the time of transaction, like other durable goods, without the consideration that the consumption of this type of good is over time. The market price tends to increase, and the property could be a store of value for a lot of years. The inclusion of an index, which captures the housing price fluctuations, in HICP means including the price of a major investment.

The president of ECB Christine Lagarde said that only the consumption element should be included in the inflation indicator: "*What was decided by the Governing Council was to account for the consumer cost of the owner-occupied house. So, it has nothing to do with the investment cost that an owner incurs; it has to do with the consumer cost that the owner of a house actually incurs."*[2]

However, the separation between the investment and consumption components of the house purchase is a problem without a solution. In some countries the cost of the land is considered like an investment and the cost of the building like consumption. But also the latter is a store of value and the price of the secondary market could increase for years, so could be seen like an investment and not like a durable good.

[2] Christine Lagarde, press conference, Frankfurt, 8 July 2021, (https://www.bruegel.org/2021/11/including-home-ownership-costs-in-the-inflation-indicator-is-not-just-a-technical-issue/).

2. Owner Occupied Housing Price index, HICP_A and Housing Market trends

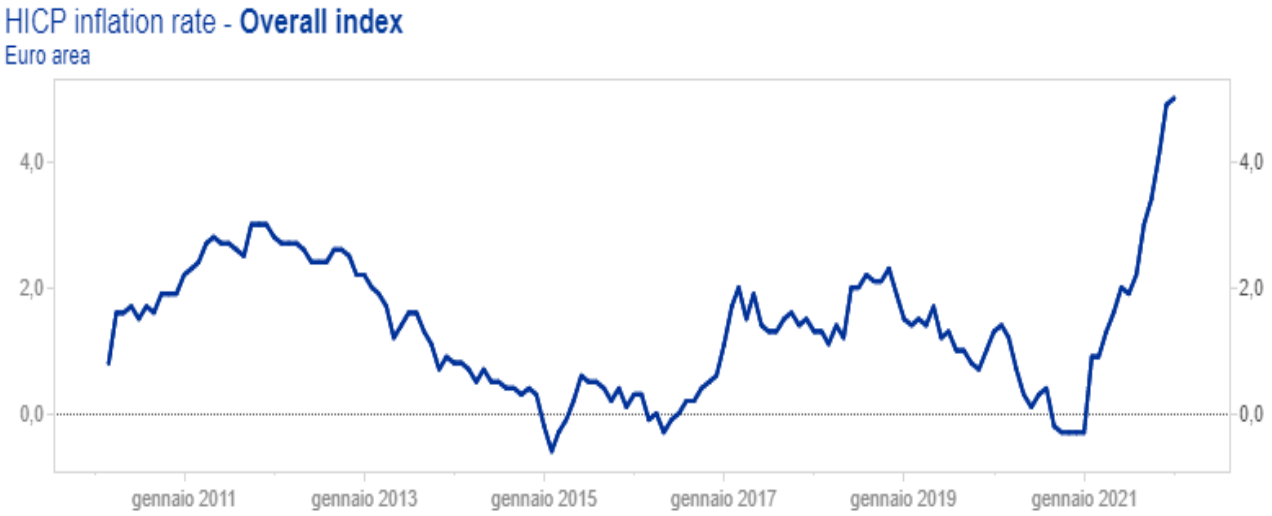
The first chapter underlines how the housing costs inclusion problem, within the HICP, derives from the housing markets heterogeneity across Euro Area and the difficulty of gathering robust data to create a reliable index. This process through the net acquisition approach is only just at the beginning, but despite an inclusion planning around 2026, attempts can already be made using the Owner-Occupied Housing Price Index, which is published by Eurostat. Chapter two gives an overview of the main statistics and data essential to encounter the contents of the thesis, starting from the composition of the HICP, with respect to the main items that compose it, then moves to a briefly explanation of the OOHPI's trend and the characteristics of the Euro Area housing market. The sub-components, which build the index, will be explained from a theoretical point of view, from the acquisition part to the ownership part. Subsequently I will tackle the problem of inserting a cost component of the house with the NA, and after some assumptions I will form a new index called HICP_A, which cover a temporal window from 2005 to 2021. For the first years of the analysis, I used the House Price Index as a proxy of the OOHPI, due to lack of available data. We will then see a comparison between our results with the original HICP and the US CPI and finally conclude with a theoretical review of the economic trends of the key variables of the housing sector in the Euro Area. This last part will be related to the results obtained and will act as a bridge with chapter 3.

2.1 The main dataset

I have decided to select the databases relative to the inflation of Euro Area (EU19 on Eurostat site) which excludes Iceland, Norway, United Kingdom and all the countries which don't have euro as currency. Regarding the Owner-Occupied Price index for the Eurozone, this does not include Greek costs, and the available data start from 2010 till 2020 for the annual OOHPI chained-linked Laspereys index with base 2015=100, and till the third quarter of 2021 for the quarterly data. Before to speak in detail of it, I must show the HICP, its trend and the sub-index weights, a necessary passage for the next analysis in the chapter. As a reminder, the HICP values

are also Laspereys indexes, and in Figure 2.1 we can see their annual percentage changes from a monthly perspective. They are compared on the basis of the HICP value of the month at year "t" and the month of year "t-1" (i.e. July 2012 and July 2013).

Figure 2.1: Annual monthly variations

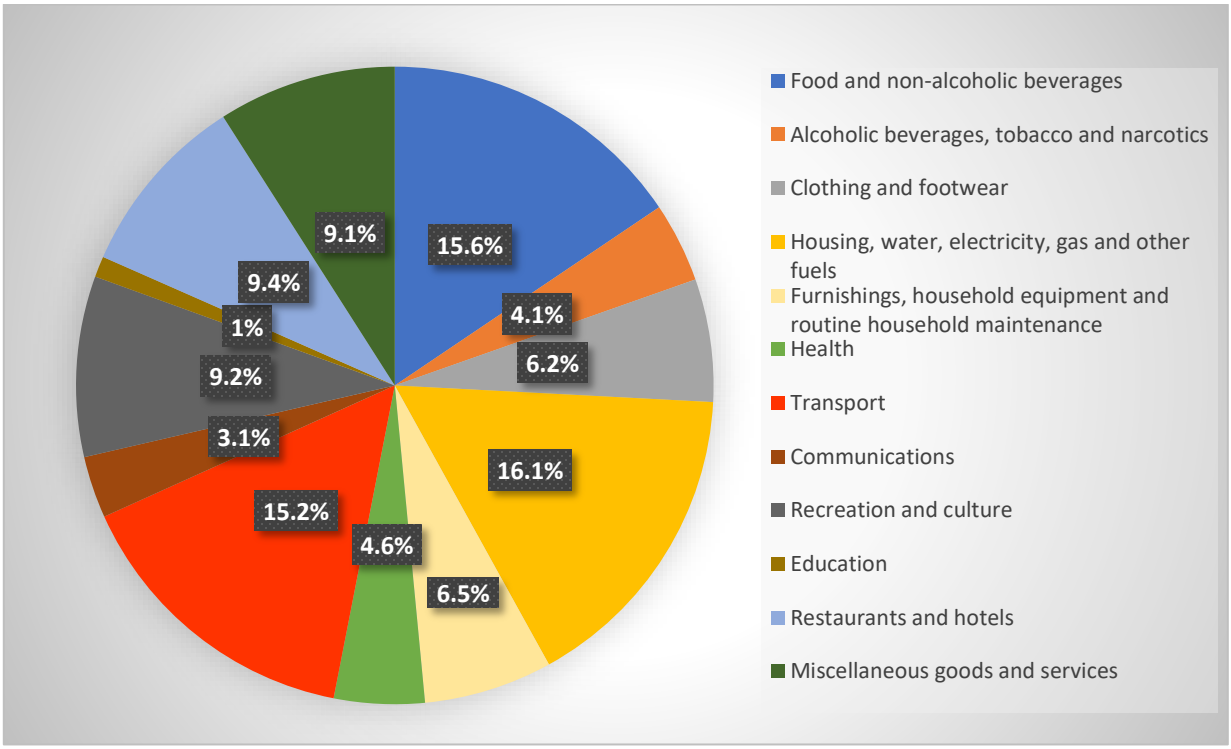


Source: Eurostat

Between January 2010 and September-October 2011, we can see a percentage increase of HICP which touches a peak of +3%. Since 2012, the HICP has been gradually decreasing till a negative peak of -0,6% in January 2015. In 2016 we see a trend that is around zero and then resumes growth in August of the same year. Between 2017 and 2019, the growth average was around 1-2% and then drops to -0.3% in December 2020. In the last period, coinciding with the Covid pandemic, prices have risen, and we see a rapid rise throughout 2021, up to + 5% in December of the same year.

Within the HICP we find **twelve main indexes**, which in turn are an aggregation of sub-indexes. Not all of them have the same impact on inflation, and their weight varies according to the economic period under consideration, for example in recent years some product categories have experienced a sharp rise in prices. Then there are indexes where European households spend more, thus in the consumption basket, they necessarily have a greater importance.

Figure 2.2: Items weights of HICP



Source: My own elaboration

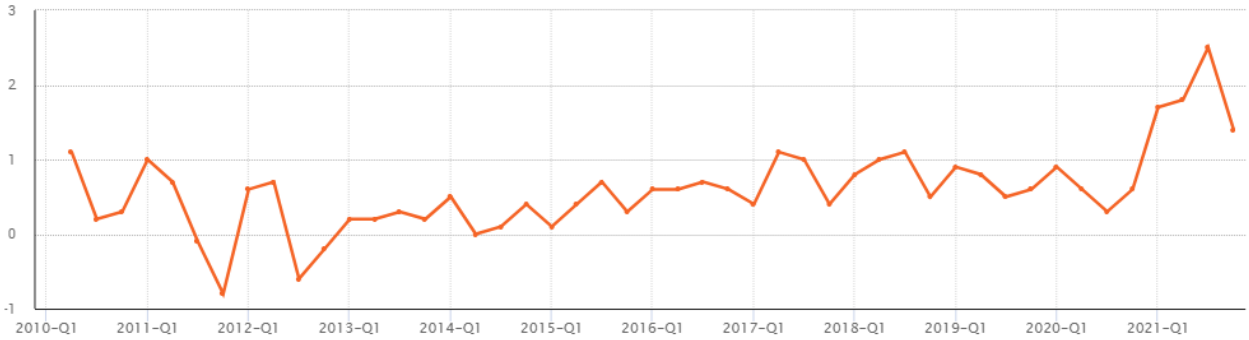
In the 2010–2021-time window, I calculated the averages of the weights[3], and therefore the average incidence in the total of the HICP of the various items. There are three most influential indexes, as Figure 2.2 shows, topping the list is "Housing, water, electricity, gas and other fuels" with an average weight of 16.1%; this figure is interesting because despite the absence of OOH costs, housing-related expenses already have a significant impact on the inflation rate. The items with a slightly lower average are "Food and non-alcoholic beverages" with 15.6% and "Transport" with 15.18%. The very low weights of "Communications" stand out with a total of 3.14% and that of "Education" with an average of 1.1%.

[3] In Eurostat the weights are multiplied by 1000. I converted them to a percentage.

2.1.1 The trend of OOHPI in the euro area

After a brief description of the HICP trends and its components, we can move towards the introduction of the largest index published by Eurostat and designated to cover the costs of acquiring and holding the house within the harmonized inflation at European level. **The base concept of net acquisition approach for OOHPI, refers to the dwelling purchase by the households of new dwellings or existing dwellings new to the household sector.**

Figure 2.3: OOHPI quarterly variations



Source: Eurostat

Figure 2.3 shows the trend of the Owner-Occupied Price Index, from a quarterly point of view. In particular, the trend refers to the quarterly rate of change of the chained-linked indexes. In Eurostat we can also find annual data but not monthly. I chose this period because before 2010 we have no data with respect to the OOHPI, if not the proxies that can replace it, as we can see in the next paragraphs. The trend is basically constant with fluctuations between 0% and 1% except for 2011Q4 (-0.8%) and 2012Q3 (-0.6%). Significant is the increase starting from the last quarter of 2020, so the price growth was meaningful with a percentage increase in the index of + 2.5% in 2021Q3 and then decreasing in the last quarter of 2021.

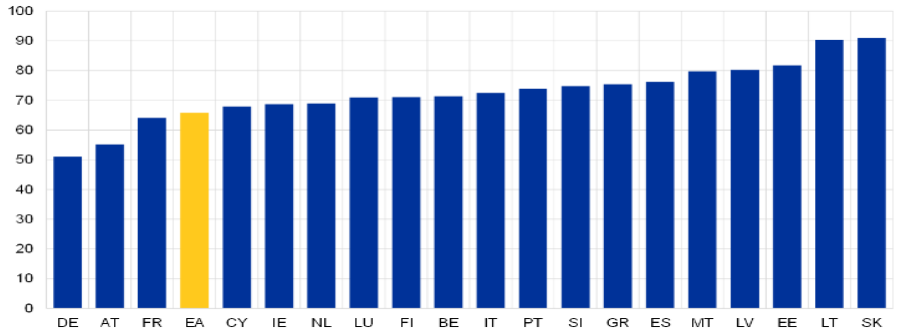
At the beginning of the 2000s, the ESS[4] (European Social Survey) decided to quantify the costs related to OOH according to the "net acquisition method". For the purposes of measuring OOH related costs in a CPI such as the HICP, buy-to-let purchases are ignored, since the buyers do not

[4] The European Social Survey (ESS) is an academically driven cross-national survey that has been conducted across Europe since its establishment in 2001.

intend to live in the property, the housing is not "owner occupied" and such purchases are investments rather than consumption. Net acquisition is determined by subtracting sales to sectors other than households (outflows) from purchases from other sectors (inflows), thus the method does not take into account house purchase by households from another household. ESS has also developed price indexes for OOHPI adding self-built homes, major maintenance and repairs, and expenses related to the purchase (transfer of ownership) and ownership of owner-occupied dwellings, like home insurance. In 2013, Member States started providing OOHPI and related breakdowns on the basis of a dedicated legal act, initially only within the ESS. Since then, further improvements have been made. Eurostat began publishing a series of stand-alone OOHPIs in 2016, while the euro area and European Union OOHPIs were published for the first time in October 2021.

The publication "Owner Occupied Housing and inflation measurement" (Arioli, Eiglsperger, Goldhammer, Goncalves, and Kouvavas, 2022), explains the importance of including these types of costs within inflation. Figure 2.4 may be misleading for our reasoning, as much of the index refers to the acquisition of new dwellings. Certainly, the share of owner-occupied houses is more related to the smaller part of the OOHPI that refers to ownership-related costs. The graph also is an indicator that explains how households in the euro area, despite differences, prefer to own a home rather than pay rent. The share of owner-occupants in total households in euro area countries ranges from 50 percent to 90 percent, with rates around or above 70 percent in 16 of the 19 countries. In light of the relatively high home ownership rates and large differences between countries, the inclusion of OOH costs in the HICP will improve the representativeness of the measure of inflation and the comparability between countries.

Figure 2.4: % share of owner-occupied



Source: Eurostat

2.2 The voices of OOHPI

Now I want to go into more detail on the composition of the OOHPI. The index is composed by two main parts: the first relates to the initial cost of acquisition of the dwelling which is based on market transactions, and it could be seen as a flow; the second component refers to expenditures incurred by households as owner-occupied housing. In a nutshell, the OOHPI is divides in two macro captions, Acquisition of Dwellings and Ownership of Dwellings, as we can see in the next paragraphs (Eurostat, 2017, 16-21).

2.2.1 Acquisition of Dwellings

This voice is divided in three indexes: new dwellings (in turn divide into "Purchase of New Dwellings" and "Self-built Dwellings and Major Renovations"), existing dwellings new to the households and other services related to the purchase of a dwelling.

The **purchase of new dwellings** corresponds to the acquisition of newly built dwellings of various types (block of flats, terraced houses…), and also specific cases as housing co-operatives and ready-built prefabricated houses are included in this category. The new houses can be categorized in this way:

a) owned apartments, cataloged as autonomous residential properties with independent entrances but which occupy a part of the condominium and share some common areas.
b) houses that are independent residential buildings on their own plot of land.

The **self-built dwellings** are built by the households for their occupancy. The land will be purchased separately or inherited. We have three categories of self-builders:

a) step-by-step self-builders: where the owners organize totally or partially (maybe is necessary the intervention of plumbers, electricians…) the construction of the dwelling.
b) Self-builders who rely on a construction company to undertake the work.
c) Self-builders with prefabricated houses ready to be assembled.

The **major renovations** cover new constructions or enlargement of existing dwellings, significant transformations and major renovations or refurbishments that go beyond the normal

routine maintenance due to preserve the internal and external fabric of the building (to avoid the depreciation of the dwelling). There is a shadow zone between the "repair projects" and the "major renovations", but these can be distinguished by two characteristics:

a) Major renovations are associated with permanent improvements which augmented the intrinsic value of the dwelling from its original standard, level of utility or substantially the expected life of the dwelling.
b) Major renovations will give benefit to the owner in the long-term period, and it is sometimes an investment decision to enhancement the dwelling's value, and it could be taken when the dwelling doesn't need repairs.

The **purchase of existing dwellings new to the households** refers to dwellings previously owned or rented by an individual or an organization (including government institutions), and to the first-time purchase of houses that have been converted to other uses and sold for the first time to the household sector. Examples of the latter can include warehouses and other commercial buildings that have been converted into urban apartments.

Other services related to the purchase of a dwelling cover all the transaction costs connected to the acquisition of the dwelling new or existing for own use. It includes for example payments for agent services and mortgage lenders or brokers (fee), expenses for arranging a mortgage; fees for legal services to ascertain that the seller is the legal owner of the property and that there are no pending claims or encumbrances against the property; government-imposed costs such as stamp duty, registration and transfer fees…

2.2.2 Ownership of Dwellings

The index is divided in three sub-indexes: major repairs and maintenance, insurance connected with the dwelling and other services relate to the ownership of dwelling.

Major repairs and maintenance must be distinct from "major renovations", because this last refers to extraordinary works to the improvement of the value of the dwelling. The expenses for these types of repairs and maintenance are necessary to maintain the dwelling in operation and usable, and to prevent its deterioration. The routine expenses given by the own property are considered based on:

a) expenses related to activities that must be undertaken regularly in order to keep the house in operation during the expected useful life. The user does not have the choice of whether or not to carry out maintenance to maintain the housing service at the same standard.
b) Following point a) the maintenance and the repairs made, do not result in an improvement in accommodation standards or expected service.

A further distinction must be made with the "minor repairs and maintenance", which refer to low volumes of work and linked to low prices, but they too can be considered ordinary works. These are already included in the HICP; therefore, they are not included in the OOHPI.

Insurance connected with the dwelling refers to premium paid by the occupier for the property insurance. This also includes service charges relating to mortgage protection insurance which covers the repayment of a loan in the event of the death, incapacity or loss of the job of the borrower.

Other expenditure is the index that reflects the other costs which are not cover by other indexes. Examples of them:

a) Costs related to the banking administration of the repayments of the loan.
b) Costs associated with the provision of legal certificates.
c) Any other costs associated with the commission of owner services that do not fall under insurance or major repairs work categories.
d) Municipal and/or local annual Property Tax.
e) Energy Efficiency Certificates and Gas Safety Certificates if necessary, only from the owner-occupiers independently whether the dwelling has been sold.

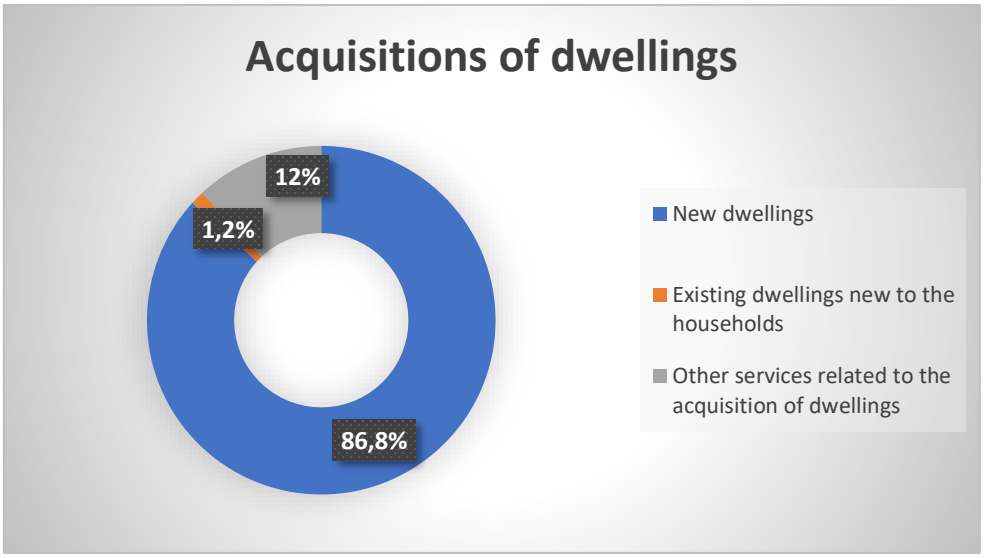
2.3 The weights of OOHPI and the importance of the sub-components

We have already said that the OOHPI is divided into two main components, one relating to the purchase phase and the other relating to the holding of the dwelling. The first represents the 80% of the total index, while the second approximately the 20%. Precisely for this reason the OOHPI is very similar to the other index released by Eurostat called "Housing Price Index"[5], which is

[5] Available in Eurostat database, (https://ec.europa.eu/eurostat/cache/metadata/en/prc_hpi_inx_esms.htm).

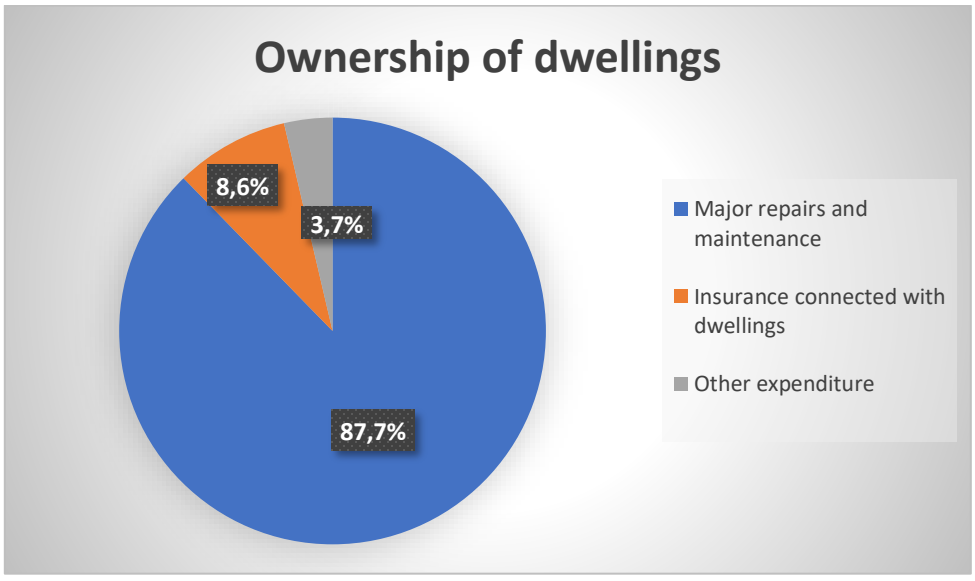
composed by two voices: purchases of new dwellings and purchases of existing dwellings (is excluded the ownership part). Figures 2.5 and 2.6 give an idea of the composition of the two main sub-indexes that make up our reference index.

Figure 2.5: Example of weights



Source: My own elaboration

Figure 2.6: Example of weights



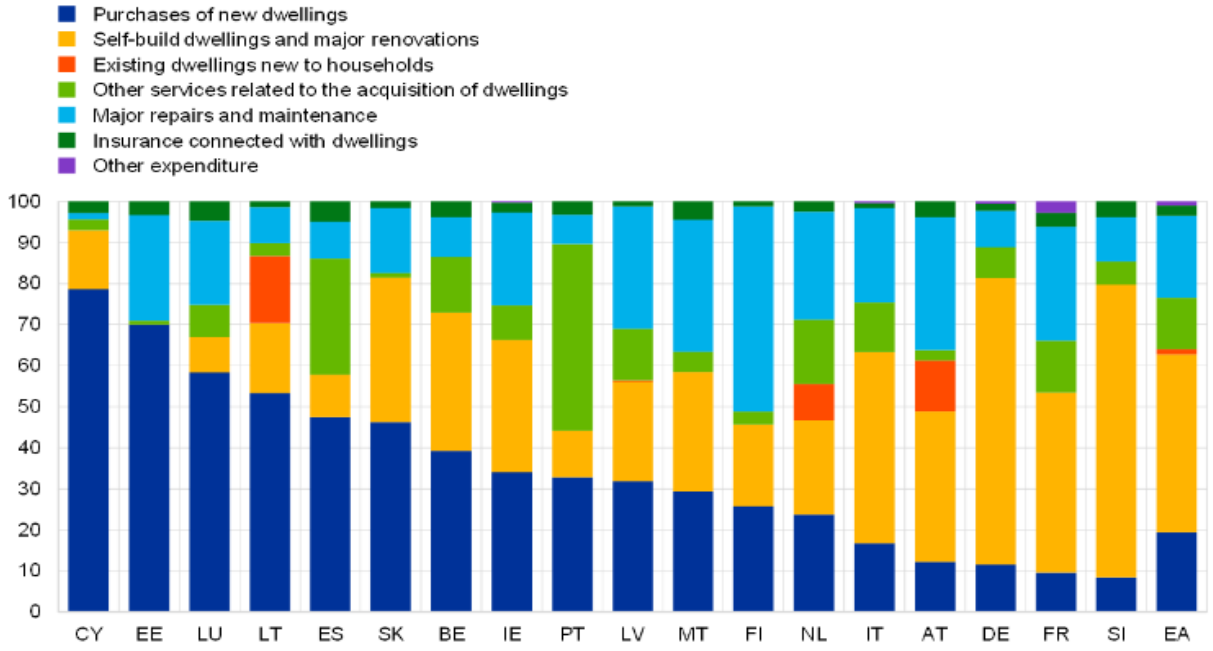
Source: My own elaboration

The graphs refer to the 2013 for the euro area. "Acquisitions of dwelling", the predominant value in the OOHPI, is made up of three sub-indexes. The "New dwellings" accounts for 86.8% for the index and is in turn divided into "Purchases of new dwellings" (30.7% of New dwellings) and "Self-build dwellings and major renovations" (69.3% of New dwellings). The remaining 13.2% is given by "Other services related to the acquisition of dwellings" and by "Existing dwellings new to the households" with only 1.2% of importance.

"Ownership of dwellings" is also divided into three components, but 87.7% of the index corresponds to "Major repairs and maintenance", then "Insurance connected with dwellings" and "Other expenditure" cover the remaining 12, 3%.

Moving on 2021 the acquisition element is still the main component and is around 78% at the euro area level. As we can see from figure 2.7, however, we must consider the importance of the sub-indexes among the different nations[6]. In Italy, France and Germany the "self-build dwellings and major renovations" is much more important than "purchases of new dwellings", while in other countries, such as Spain, the opposite is true.

Figure 2.7: Breakdown of the OOHPI euro area

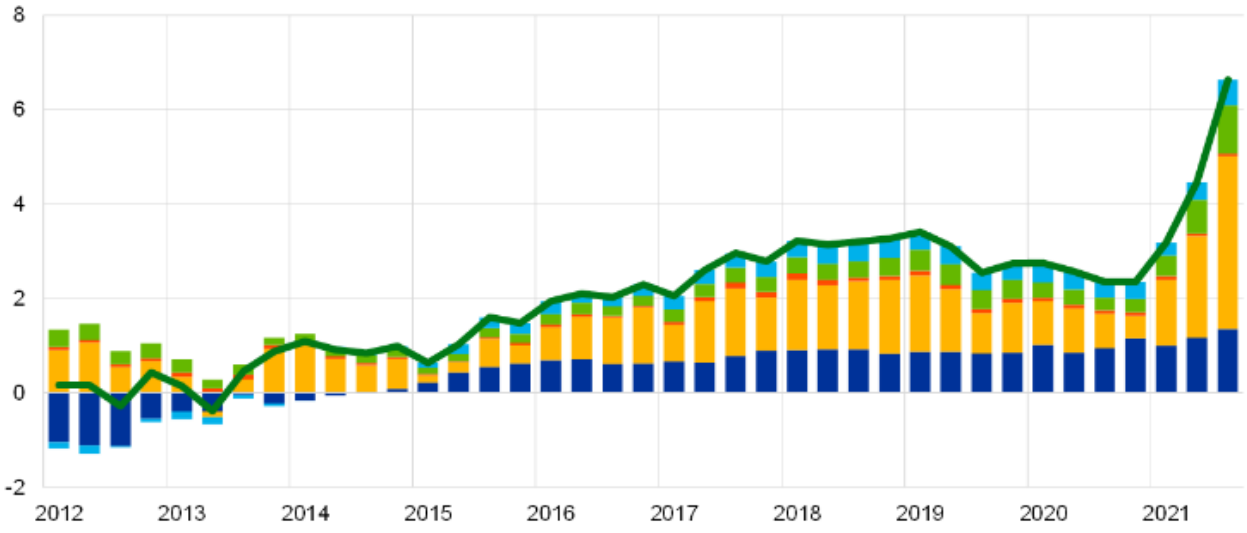


Source: Eurostat

[6] Data for Greece are not available.

At the aggregate level of the euro area, the price dynamics of the sub-components differ widely, for example "purchases of new dwellings" has seen the biggest annual growth in the last decade, but in terms of the overall contribution of the growth of the total index is second, in fact it follows "self-build dwellings and major renovations". These two components together are the most influencing for OOHPI growth, especially in recent years. To give an example, in figure 2.8, in the third quarter of 2021 (the last observation in the graph), they account for 5.0% for the total overall index growth. The other sub-components have a more moderate price evolution, and the contribution to the annual growth of OOHPI is lower, even if on an aggregate level their impact is not negligible.

Figure 2.8: Breakdown in annual growth in OOHPI

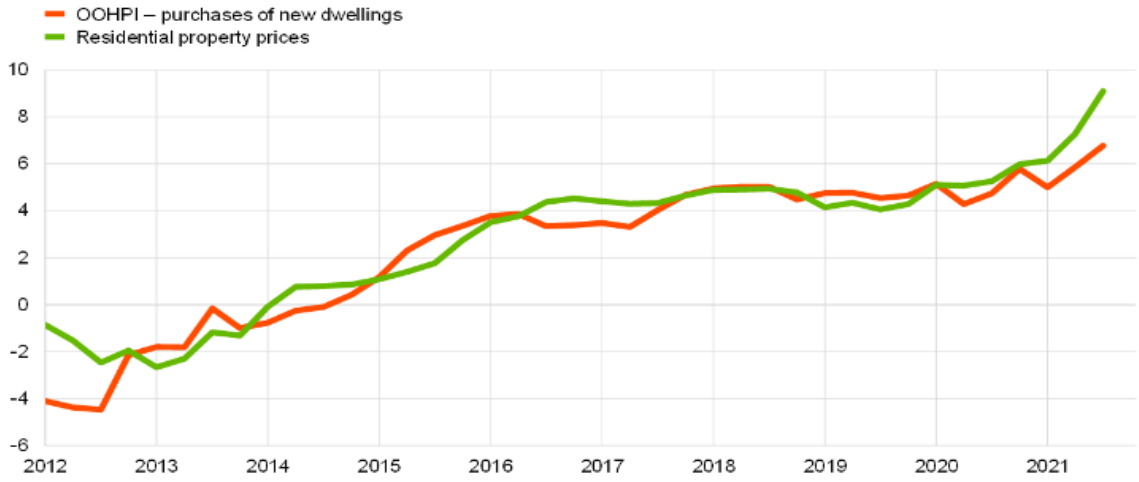


Source: Eurostat

Some sub-components show a strong correlation with construction costs and house prices. Following the publication "Which sub-components are driving owner-occupied housing costs?" (Arioli and Gonçalves, 2022), we can state that "self-build dwellings and major renovations" moves together with the construction costs available in short-term business statistics. Similarly, "major repairs and maintenance" shows strong co-movement with the HICP series "services for the maintenance and repair of the dwelling". While "purchases of new dwellings" is strongly correlated with residential property prices, as we can see from figure 2.9. These findings are useful to understand the continuation of the chapter. Obviously, further analyzes will be needed

to evaluate the behavior of the OOHPI and its components over time. A better understanding of the correlations is necessary to convey and predict a better OOHPI value.

Figure 2.9: Correlation between PoND and Residential property prices



Source: Eurostat

2.4 The Augmented Inflation indicator

The inclusion, and so the variation of the main indicator, could have a numerical impact on inflation target (es: the target of 2% based on the new indicator could change itself from the previous "close to but below 2%" inflation objective). Moreover, the new indicator could consider an asset price component, blurring the boundaries between the policy of financial stability and monetary policy.

The ECB Govern Council called for the inclusion of costs relatives to the owner-occupied housing, given that the 66% of the households of the euro area are owner-occupiers, excluding them is a great shortfall. Now, an OOH-augmented indicator is not available, only a roadmap is recommended by the Govern Council (already seen in Chapter 1) to define this measure, with the Eurostat's aim to release an official quarterly HICP which includes OOH costs from 2026 (a monthly index later). In the meantime, separated OOH indicators will be taken in consideration as complements to HICP.

2.4.1 Options for including owner-occupied housing costs in price indexes

The way OOH is included in the prime index also depends on how is conceptualized, whether the index is designed to capture the variations of the price in a basket of goods and services bought by the households (cost of good index, as HICP or CPI US), or is envisioned to measure the cost to households of achieving a certain level of utility, as US Personal Consumption Expenditure Price Index (Darvas and Martins, 2021).

US CPI can be comparable with the European HICP, and the gap between the two indicators implies that the US objective is slightly higher than the area euro objective of inflation. In the United States and in some European countries, as we said, is used the rental equivalence approach for the calculous of the consumption expenditures of the households and for their price index. The problem of RE approach is that it is difficult to implement when the rental markets are thin, while the lack of comparability between rental and OOH markets poses further challenges. Moreover, when the regulation about rental markets imposes controls on the volatility of the rental prices for the tenants, the rental price index couldn't reflect the market developments. An advantage of RE is that the implicit costs of the households who live in their property are taken in consideration.

For the euro area HICP, which is a cost-of-goods-index, the ECB claims an approach of net acquisition in line with the HICP principles (the "purchase of a dwelling" is recorded as consumption at the time the transaction takes place, as is done with other durable goods). Thus, the approach doesn't consider the fact that the good's consumption is over time. In a nutshell, the NA means purchases minus sales of the household sector from other sectors, while the transactions between the households are excluded (the net is zero). So, a disadvantage of this approach is the consideration of only a **little sub-sample** of households who buy a new dwelling from a non-domestic sector, or whether they build the dwelling from themselves.

Another critical point is the **separation between the investment and consumption purposes** of new dwellings, remarking that in HICP only the consumption element should be included. With the purchase and the owner-occupation of a dwelling, the household benefits from (1) having a place to live (it does not pay rent but will have maintenance and renovation costs), (2) possible capital gains from holding, in fact the house prices tend to increase over time.

To be clear, the NA called by ECB **implicitly assumes that the housing related consumer cost follows the house price fluctuations**, a not justify assumption. On the contrary, the variations on house price determine the earned or loss capital resulting from the investment in a dwelling and thus the HICP reflects the results of the investment for home ownership. The inclusion of an investment component, through house prices, would result in an asset-price component in the inflation measure, which on the other hand weakens the role of stability pricing and increases the role of financial stability[7] in monetary policy.

Focusing on the inflation measure of ECB and Fed of 2021, we notice that the share of housing cost in PCEPI is higher than the share in HICP, which doesn't include the OOH. If this share will be included the housing-related costs will be higher in the euro area than US area. In this last the OOH inflation differs from rental inflation. Interesting to see how in table 2.1, the average inflation from 2001 to 2020 of "other items" (all the non-housing items), was the same between US and euro area, so the component of housing makes the overall inflation higher in US. Indeed, in this economy the OOH costs grew faster than non-housing costs, so in the euro area the inclusion of them could imply an upward shift in the inflation.

As we said the Owner-Occupied House Price Index isn't already includable in HICP, partially because its composition is really different across the countries of euro area. According to the roadmap is not possible at this point forecast a date for a monthly release of an augmented HICP to be used as a main index for the objective of monetary policy.

Table2.1: Average inflations

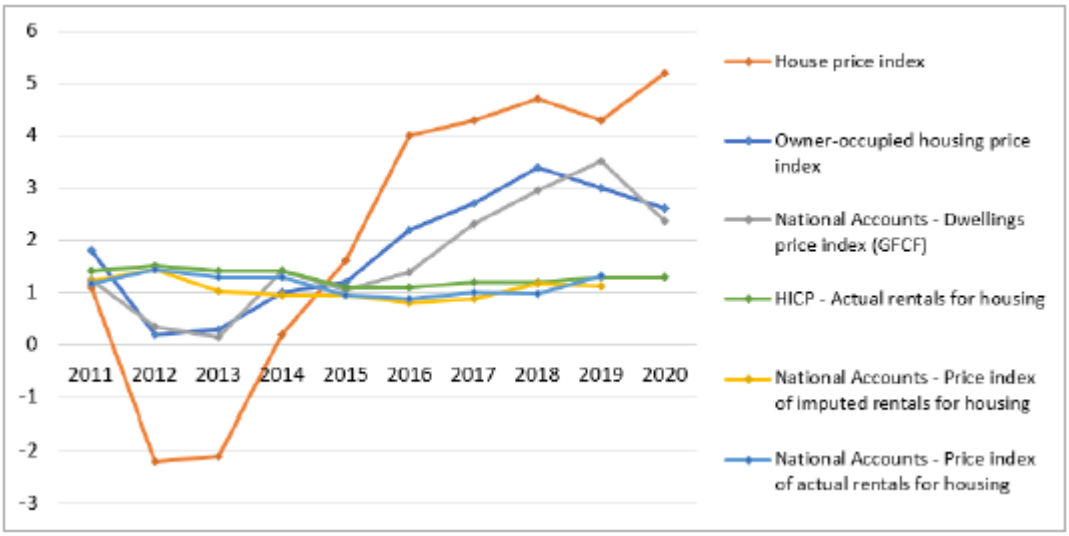
	Weights (2021)		Average inflation (2001 - 2020)		Standard deviation (2001 - 2020)	
	EA HICP	US PCEPI	EA HICP	US PCEPI	EA HICP	US PCEPI
Rentals (tenant-occupied housing)	7.5 %	4 %	1.6	3.1	0.3	0.9
Owner occupied housing costs	0 %	12 %	-	2.6	-	1.0
Water supply and others	3.1 %	1 %	2.3	4.4	0.9	1.1
Electricity, gas and others	5.9 %	2 %	3.0	2.4	5.0	4.8
Dwelling maintenance	1.3 %	0 %	2.3	-	0.9	-
Other items	82.3 %	80 %	1.3	1.3	0.7	0.8
All items	100 %	100 %	1.6	1.8	0.9	0.9

Source: Eurostat, FRED, US Bureau of Economic Analysis

[7] Condition in which the financial system is able to withstand shocks and the unwinding of financial imbalances.

Figure 2.10 helps us go into detail about trending behaviors of different indexes for euro area, the dwelling acquisition price indexes (the first in the legend) and the rental price indexes (last three in the legends). Rental price inflation tends to be more stable, while the elements that capture house prices fluctuate over time.

Figure 2.10: Trends behavior of different indexes



Source: Eurostat

2.4.2 A possible new indicator

After the OOHPI overview and the problems related to the housing of the previous paragraphs, I want to go in detail on the possible inclusion of this type of cost in the HICP. Starting from the work "Including home-ownership costs in the inflation indicator is not just a technical issue"[8](Darvas and Martins,2021), which have tried to give a possible solution, but not definitive. They have computed an augmented HICP, with respect to a temporal window that covers 2000 to 2021. They have simply computed a weighted average between the current HICP and the Owner-Occupied Housing costs for the Euro Area without any reformulation of the weights of the main sub-indexes of the overall index. The weight associated to OOH is the share of "Final consumption expenditure of households, by consumption purpose" called "Imputed Rental", a

[8] Publication on Bruegel site, 18 November 2021, (https://www.bruegel.org/2021/11/including-home-ownership-costs-in-the-inflation-indicator-is-not-just-a-technical-issue/).

voice clearly related to the world of rents. Imputed rent is the rental price an individual would pay for an asset he owns. The concept applies to any investment asset but is commonly used in real estate markets to measure the rent homeowners would pay for a unit equivalent to the one they own. Imputation of housing rent is necessary to measure economic activity in the national accounts, but since property owners do not pay rent, this cost must be measured indirectly. For me it is quite unclear decision because they impose a weight not in line with the net acquisition approach, which is only focus on the phase of purchase, and only to a small extent to ownership.

While for the last decade is used the index published by Eurostat, the OOHPI. From 2000 to 2010, they have used the Dwelling Price Indexes and the Housing Price Indexes as proxies for OOH costs, indexes that as we said are similar to OOHPI.

2.5 My personal augmented indicator: HICP_A

I began my analysis from the lack previously indicated. How it is possible use a rent weight for net-acquisition costs? The sample of people who pay or would pay rent is much larger than the sample of people who buy a home in a specific period. Is quite unreal that an OOH index, based on transactions, has the same impact on HICP as a Rent index (i.e., Owner Equivalent Rent or Rent of primary residence in the US case). In line with the paper "The New Euro Area Inflation Indicator and Target: The Right Reset?", I have decided to give a lower weight to this type of costs, not anymore 13 % but 9 % of total index. **A clarification is important for the continuation of the thesis.** The weight of the OOHPI index to be included in the HICP can be calculated from different sources but there is still no single idea on how it should be calculated. According to the "Technical manual on Owner-Occupied Housing and House Price Indices" (Eurostat, 2017), the expenditure weights could be retrieved from different sources, from national accounts data to official registers recording ownership. The manual also says that the weight of the index is formed starting from the weights of the previously mentioned sub-components, these will be calculated on the basis of Eurostat data in the "Gross Fixed Capital Formation" and "Household Final Consumption Expenditure & Gross Fixed Capital Formation". Despite a research phase in the Eurostat database, I did not find enough data to calculate a specific weight for the OOHPI. Thus, I went back to the notes in the paper by Darvas and Martins, which say: "According to ECB (2021a) an OOH component included in the HICP would have a lower

weight of around 9% or less." The same authors are aware that there is no official source for this weight, but according to the arguments made previously, a weight related to rents is not consistent with our index, which will have a lower impact in HICP, as transaction-based cost component.

I decided to cover the time window starting in 2005 and ending in 2021. While, for period 2010-2021, I used OOHPI as a component of housing costs in the HICP, in earlier years I used an index with similar (but not the same) characteristics, the House Price Index. The analysis highlights the quarterly data, and not the annual as the paper, in fact the main and first goal in the future of ECB is to augment the HICP in this way.

2.5.1 New weights and the remodulation of indexes

The addition of the housing cost component in the HICP implies the reshaping of all sub-index weights. I have decided to reduce them in a proportional way, considering the housing costs with NA weighting 90 on 1000 (9%). The proportion that I have used was:

New Weight : (1000-90) = Old Weight : (1000)

The weights that I found on Eurostat refer to a completely year, so the changes are in relation to seventeen periods, from 2005 to 2021. The table 2.2 shows how the weights have changed in 2013, it is evident that all have decreased to make room for the OOHPI that if in the old weights it was zero, in the new ones they occupy a space of 90 out of 1000. I have not removed any index as the OOHPI references to something that has never been entered and does not replace anything in the HICP.

Table 2.2: New Weights

Items	old weights	new weights
Food and non-alcoholic beverages	154,31	140,4221
Alcoholic beverages, tobacco and narcotics	40,23	36,6093
Clothing and footwear	66,1	60,151
Housing, water, electricity, gas and other fuels	158,94	144,6354
Furnishings, household equipment and routine household maintenance	67	60,97
Health	43,16	39,2756
Transport	157,22	143,0702

Communications	31,05	28,2555
Recreation and culture	93,63	85,2033
Education	10,35	9,4185
Restaurants and hotels	92,75	84,4025
Miscellaneous goods and services	85,24	77,5684
OOHPI	0	90

Source: My own elaboration

Other problem that I encountered was the asymmetry between the quarterly data of OOHPI and the monthly data of HICP, which I have selected for the first part of the analysis. What have I done? To maintain consistency between the indexes, I only selected the monthly values at the end of the quarters, so I only referred to the months of March, June, September and December. Now the year is composed in a quarterly way as the OOHPI. For me this passage was necessary, in order to create a new index.

Table 2.3: From monthly to quarterly

2010 M01	2010 M02	2010 M03	2010 M04	2010 M05	2010 M06	2010 M07	2010 M08	2010 M09	2010 M10	2010 M11	2010 M12
91,65	91,68	92,07	92,35	92,14	92,14	92,05	91,84	91,81	91,94	92,31	92,7

	2010Q1	2010Q2	2010Q3	2010Q4
Food and non-alcoholic beverages	92,07	92,14	91,81	92,7

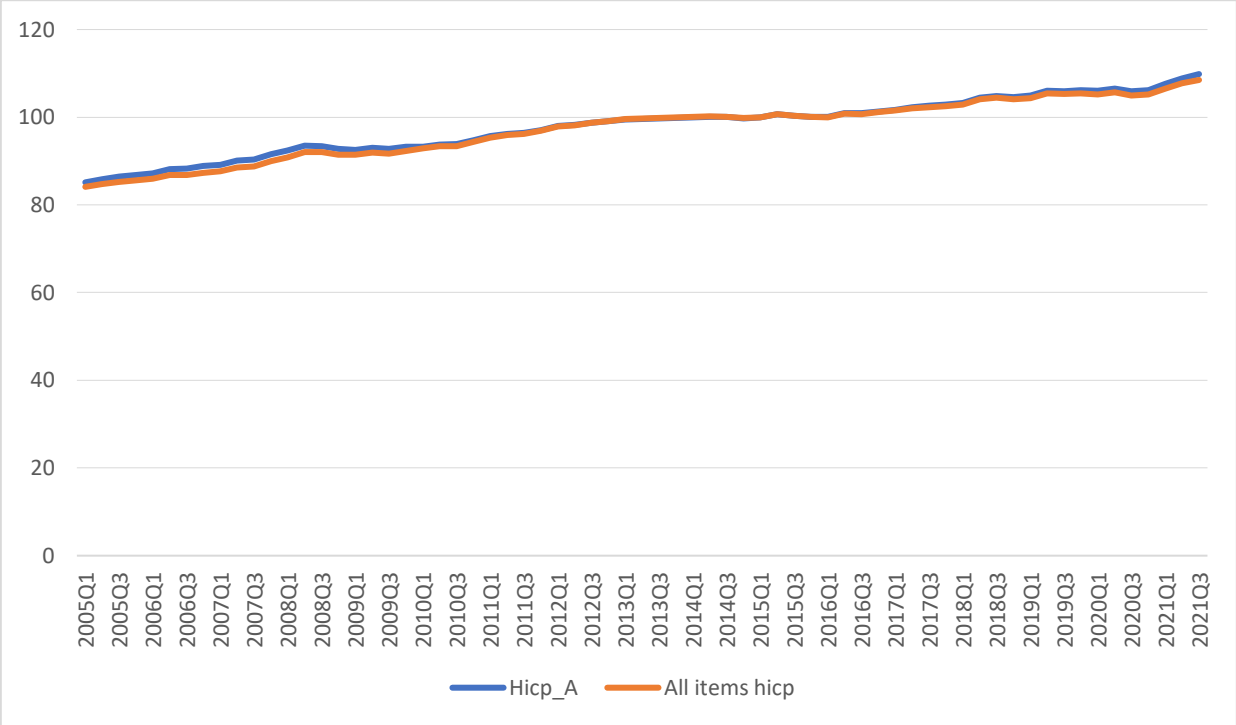
Source: My own elaboration

In the example of the table 2.3 of the "Food and non-alcoholic beverages" in 2010, I selected the months M03 M06 M09 and M12 and then include them as quarterly indexes, not considering the months not useful for my analysis.

The inclusion of the housing costs in my elaboration, consists in the weighted average between the twelve aggregate indexes of HICP plus the OOHPI or the HPI, each of them pounded with the new weights previously calculated. From a quarterly point of view, I obtained 67 observations which ended on the third quarter of 2021. HICP_A averaged 97.91 while HICP quarterly averaged 97.29. The average differential in each quarter between the two indexes is 0.62, in favor

of HICP_A. The standard deviation is greater in the base index and equal to 6.62 against the 6.36 of the augmented index.

Figure 2.11: HICP_A vs HICP



Source: My own elaboration

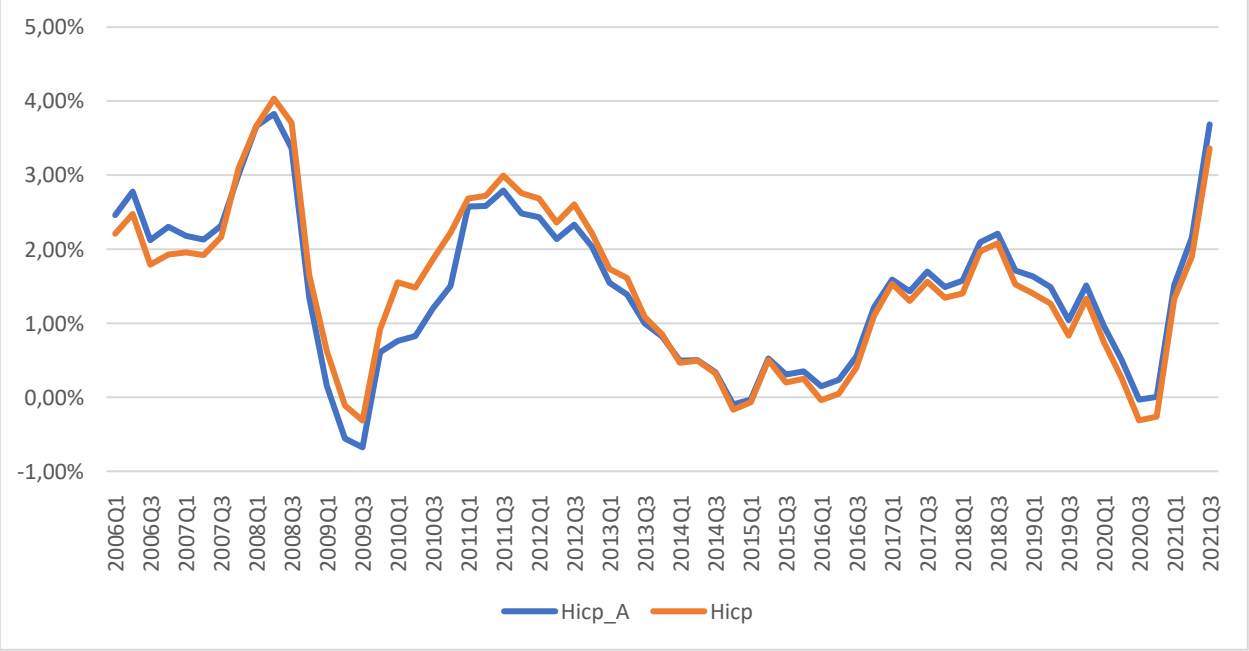
I can start my analysis finding the fundamental traits of the two trends of HICP_A (the augmented index) and HICP quarterly. We can immediately notice from figure 2.11 a similar behavior, in line with the results of other works, but inside the graph there are three macro-periods. The first consists in the first five years, from 2005Q1 to 2009Q4, where the HICP_A overcomes the HICP, with a differential mean of 1.3. This period coincided with the financial crisis, which we will discuss in the following paragraphs, where house prices in some euro area nations rose tremendously. Gradually the difference between the two indices is diminishing, until we go to identify the second macro-period which goes from 2010Q1 to 2016Q4. In this period, we find that there is a poor difference, or an overcome of HICP. Then, the HICP_A return gradually above HICP from 2017Q1 in a constantly way till the maximum differential peaks in the last years of my analysis, in 2021Q3 is 1,34 points higher.

The results are not surprising, we know from the previous chapter that the housing indexes grew faster than other HICP indexes, especially in the last period. Still relying on a quarterly reasoning, the OOHPI is the second index with the highest standard deviation, preceded only by

"Alcoholic beverages, tobacco and narcotics". This means that over the years, the housing index of Eurostat is increased a lot, with bigger values and bigger influence on HICP after 2016.

Figure 2.12 shows the annual percentage changes of the quarterly HICP_A and HICP indices, for the time window which starts from 2006Q1. We find consistency with the previous graph; in fact, the average of the percentage changes is very closed between the indexes, around 1.5%. In contrast to the previous graph, we notice different periods, of growth and decrease in the indices examined. Between 2006 and the end of 2007, the trends are around an annual growth rate of 2-3%, with HICP_A always greater than HICP. Thereafter, after an initial phase of joint growth until the second quarter of 2008, the two decline precipitously, with HICP_A reaching a minimum peak of -0.68 percent in the third quarter of 2009 (the period of the financial crisis). The indexes always follow a similar path but with HICP is always greater than the increased index, particularly in the first two quarters of 2010 the difference between them is 0.80%. Between 2014 and 2015, the differences are practically zero, only from 2016 we see that HICP_A will be consistently greater than HICP. After a rise in rates, the graph shows a fall in the growth changes of the indexes in 2020, and a surge instead at the end of 2021, where the maximum peaks reached are respectively 3.69% and 3.36%.

Figure 2.12: HICP_A vs HICP; annual quarterly changes



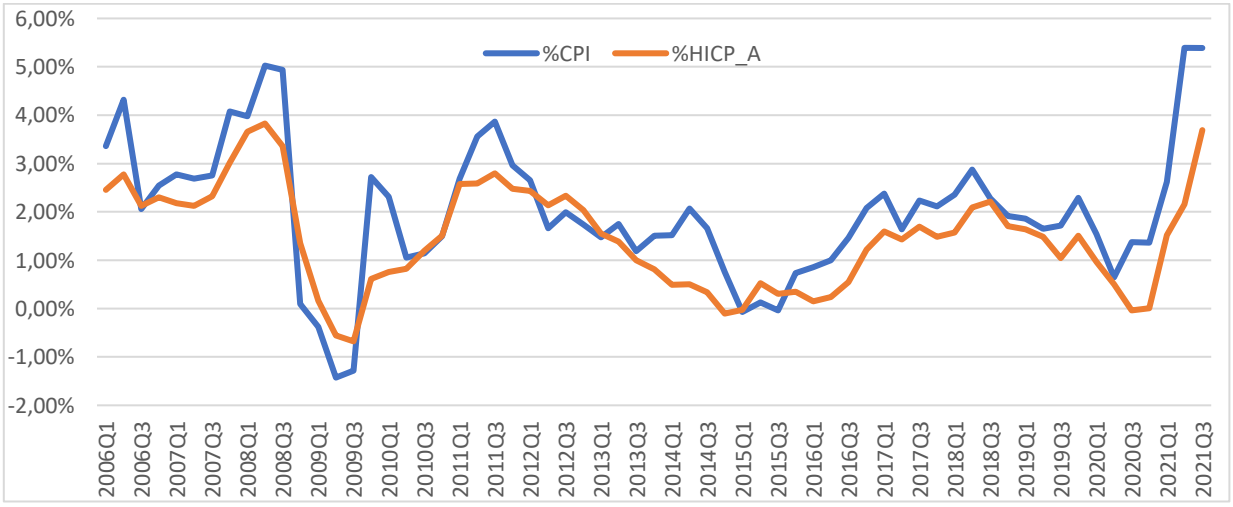
Source: My own elaboration

2.6 HICP_A vs CPI

I want to compare the increased rate with the US CPI but before doing so, I must make two important considerations, the first is that the reference base year in United States is not 2015 as in Europe, but 1982-1984 (I remember that also CPI is a Laspereys index), while the second consideration refers to the total impact of house costs within the overall indexes. With the introduction of OOHPI and considering all the other items relating to the home, the weight of housing within HICP_A is around 30%. In CPI, on the other hand, as we have already said in the first chapter, there are very heavy items relating to rent and considering housing costs in general, the percentage impact in the inflation rate of the latter is greater than the modified index of euro area inflation. Then the paragraph 2.4.1 reminds us that the gap between the two indexes is due by the **different inflation objectives** of the two economies.

To make a consistent comparison, I transformed the monthly values of the US CPI as in the case of the monthly values of the HICP, so I have converted the year into quarters from 2005 to 2021. Subsequently, to evaluate the two inflations jointly, due to the very different values of the indexes, I analyzed the trends of the annual quarterly rate of change. Therefore, the reference period starts from 2006. The quarterly CPI has an average of 1.92% in terms of annual quarterly changes, which is higher than the HICP_A average mentioned above, as well as the standard deviation is greater in the US index.

Figure 2.13: HICP_A vs CPI USA



Source: My own elaboration

In general, we can deduce two things from figure 2.13. The first is that the trends, albeit detached, are similar, but not as much as the previous case. The second is that the CPI on average sees greater variations in the indexes between the various periods. The average of the percentage differences between the two indexes is 0.55%, with a differential peak of 3.24% in the second quarter of 2021.

How do we explain these differences between the indexes? First of all, the treatment of housing costs is different between Europe and the United States, at the Eurozone level we are using the net acquisition approach to compute them while in the US the rental equivalence approach. Then we need to evaluate the peculiarities of the individual markets and how the variables have been influenced by macroeconomic trends.

In the CPI, the two main components of housing, "OER" and "Primary Housing Rent," are not affected by rising house prices. However, at the level of economic characteristics and response to shocks and market trends, the U.S. may have reacted differently than the Euro Area. For example, in Chapter 1 we saw how "Monetary policy shocks" influence US housing variables more than those of the euro area. Just as the impact in the US is greater in the presence of a "Negative credit supply shock", which will reduce residential constructions. These deviations between the two inflation measures of the previous graphs are also reflected in the annual monthly variations whether we evaluate CPI and HICP without modifications. The trends are very similar to the quarterly ones of HICP_A vs CPI, and in general the variations are always greater in the US. In particular, the average differential between them is equal to 0.63%, slightly higher than the average difference in the previous case of 0.60%. Also here, is evident the rise in rates during the pandemic period. Thus, we can conclude by saying that there are fewer similarities in this comparison, despite similar trends. The comparison between CPI and HICP is complex because inflationary dynamics do not only depend on the housing component, but also on other factors such as the business cycle or monetary policy decisions.

2.7 The economic developments of housing market in the Euro Area

To create a bridge between the second chapter and the third chapter it is useful to understand how the housing market has behaved in recent years in the euro area. The latter influenced the inflation trend and impacted on the GDP at an aggregate level. Following the paper “Euro Area

Housing Markets: Trends, Challenges & Policy Responses" (Martins, Turrini, Vasicek, and Zamfir, 2021), I retrieved some considerations.

The development of this type of market has a significant effect in the euro area. Among the nations to which we refer, the dynamics of the house price move in a very similar way, but the correlation between real house prices is slightly lower than for the business cycle, due to the idiosyncrasy of the real estate developments of some nations. The behavior of the housing sector affects the conduct of monetary policies, as it impacts inflation and the business cycle. Moreover, it matters for the assessment of bank collateral, for developments in mortgage finance and for an integrated financial system in the euro area.

We have said that housing market shows considerable differences in the euro area despite a strong correlation between housing cycles. There are very important differential aspects, for example the homeownership rate varies significantly and this may be one reason why housing cycles are less synchronized than business cycles between countries. The rental market also varies widely, both in terms of size and in regulatory terms. The household mortgage debt to GDP rate reflects a high dispersion as well as the rate of financial assets held by households. Then we see differences in loan agreements, both in the loan-to-value ratios (LTV)[9], ranging from 50% in Italy to 90% in the Netherlands, and in the nature of the contracts, with a predominance of fixed interest rates in some countries (i.e., France and Germany) and variable interest rates in others (i.e., Spain). The dispersion of characteristics between member states is substantial, and therefore significant structural differences between countries tend to persist over time.

2.7.1 Main developments in Euro-Area housing markets since the early 2000s

Before the financial crisis, real estate booms in the euro area occurred mainly in countries where credit conditions eased the most. In some nations, real house price growth was contained or even negative between 2000-2007, while in others the growth was strong and sustained (growth rate above 50%). The second group was characterized by strong credit dynamics related to financial

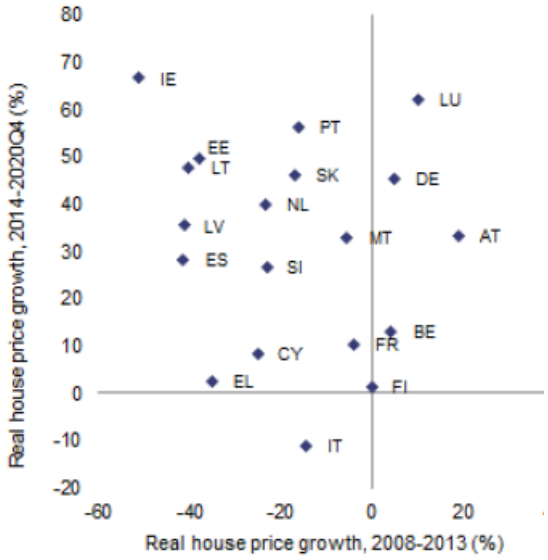
[9] The loan-to-value ratio is calculated by dividing the amount of the loan by the value of the lender's valuation of the property.

development (particularly Latvia and Lithuania) and lower interest rates on mortgages resulting from mortgage convergence associated with the monetary integration process[10].

After the global financial crisis, house price dynamics needed correction due to unsustainable trends in some member states. In the aftermath of the financial crisis, real house prices took a downward path, especially in pre-crisis boom countries, while growth continued in a few countries.

The recovery in house prices after the financial crisis started in 2013 and has gradually gained momentum. In recent years, many Member States have experienced very dynamic price growth (Ireland, Portugal, Lithuania ...), which in some cases even compensated for the post-crisis drops. Figure 2.14 compares two different period of real house price growth[11] for every country of EU19. The resumption of house price growth mirrored the economic recovery and continued very low interest rates. In some countries, on the other hand, prices have been stagnant, as in Finland and Greece, or even decreasing as in Italy in the period under consideration.

Figure 2.14: Comparison of real house price growth

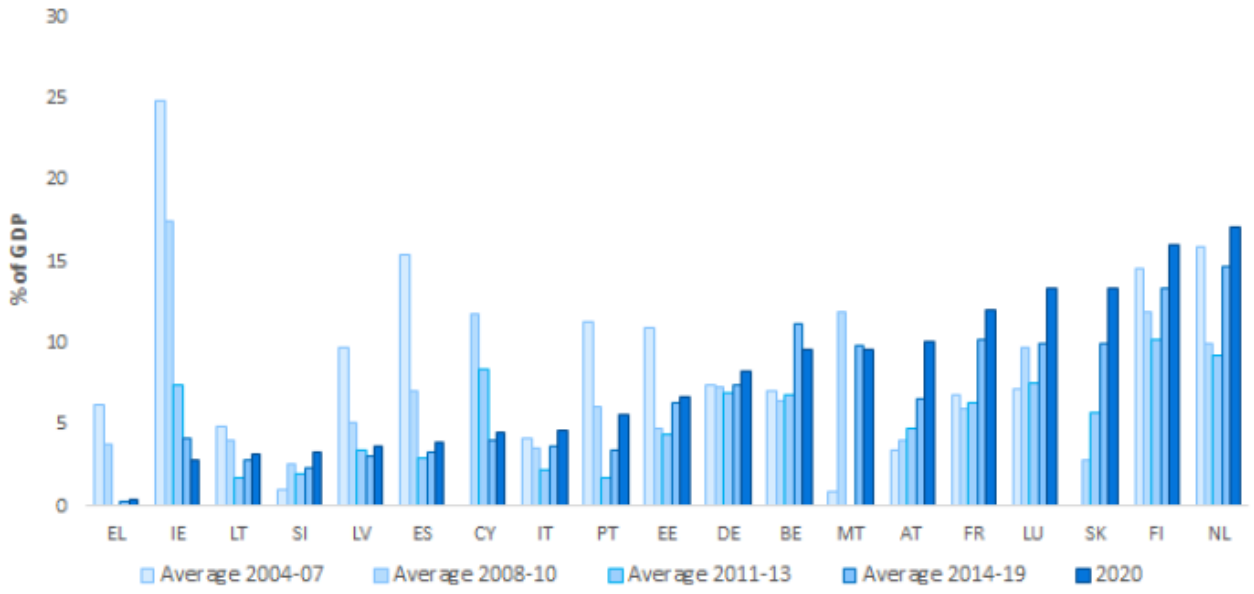


Source: Eurostat

[10] Before the crisis, some nations currently members, did not have the euro as their currency.
[11] Real house prices are nominal housing prices that are deflated by final consumption expenditure of households deflator.

The household sector has seen deleveraging in many of the euro area nations, but recently a spike in debt has occurred in a few member states, especially with regards to new mortgages. To be clear, the amount of mortgage credit in the euro area doubled between 2000 and 2007, but credit conditions tightened after the financial crisis. The latter together with the reduction in debt by households led to a sudden reduction in mortgage credit as a percentage of GDP, with only one recovery in 2010 which proved to be temporary. In 2013, banks tried to ease post-crisis tightening, but with poor results, and only in 2014 we see a small growth in mortgage credit. Figure 2.15 shows the data relating only to new mortgages[12] and compares the trends of recent years with those prevailing before and during the period of the global financial crisis for the euro area countries (for which data are available). It appears that the new dynamics of mortgage credit in the countries that experienced the boom in the period before the financial crisis are more contained (in particular in Ireland and Spain), while in the other countries the opposite is true.

Figure 2.15: New mortgage credit over the years for euro area countries



Source: ECB

[12] Data are unavailable in some years for some countries. EL (2011-2016); LU (2005 and 2008) and MT (2005-2006 and 2009-2013).

2.7.2 Recent developments and post-covid outlook for house prices and household credit in the euro area

House prices rose in euro area nations in 2020 despite the pandemic. Beyond the severe recession, the growth of house prices has not slowed down, in fact we see this acceleration in half of the euro area countries. How is this possible? First of all, house price data in 2020 may not reflect the impact of Covid as in many cases the transactions were agreed before the outbreak of the pandemic.

The price formation may have been influenced by lockdowns in both the housing markets and the construction sector. The hardest lockdowns occurred in the second quarter of 2020, but there is no common path in terms of quarterly home price growth rates that year. In some countries, such as Estonia and Cyprus, house price growth significantly slowed down in the second quarter compared to the previous quarter, while in other countries the prices were not affected. Aside from data collection delays, home prices may not have cooled as much as they did during previous recessions for additional reasons. Although the pandemic resulted in a contraction in market incomes, the shock was increasingly perceived by families as temporary. Thus, permanent incomes and consumption patterns, including the consumption of housing services, were not affected as much as current incomes. In addition, most countries have limited income support and layoffs schemes, which have helped to contain income losses. Moreover, standard fundamental variables affecting house prices, such as the real interest rate and housing supply, have not changed due to the Covid-19 shock.

In several countries, there has been sustained growth in house prices starting from values that were already overvalued. The strong sustained price growth in recent years in some countries, notably Latvia, Portugal and Slovakia, has gradually shifted them from negative to positive valuation gaps. Strong price growth was also recorded in Estonia, Lithuania and Greece, which show no signs of overvaluation.

House price was affected between conflicting forces, while GDP growth between 2021 and 2022 covered 2020 losses, wages and employment could recovered very slowly again due to poor household revenue growth. Weak growth in labor income explains most of the expected decelerations, but it is difficult to measure how income weakness is perceived and how this affects household demand, which can be supported by increased savings.

Mortgage lending remained resilient during the pandemic (as opposed to previous crises) as loans for house purchase in 2020, in line with relatively resilient labor market conditions. After some slowdown in the first half of 2020, mortgage credit increased in the second half of the year (notably in Cyprus, Germany and France) due to some easing of lending standards. In 2020, in turn, loan repayments slowed down compared to previous years, particularly in some Member States where payment moratoriums were also extended to residential mortgages (Austria, Belgium, Germany, Spain, Italy, Latvia, Malta and Portugal). Forecasts for mortgage lending are uncertain in the future, as the tightening of credit standards in 2020 follows a relaxation of the same towards the end of 2021.

2.8 Some statement at the end of chapter two

At the conclusion of chapter two we can draw conclusions about the analysis carried out. The OOHPI (and HPI), and in particular its sub-components, are influenced by the housing market trends. The strong growth in house prices in recent years has led to a sharp rise in the same index, I remember that for example the voice “purchase of new dwellings” (also present in HPI) is strongly correlated with the housing variable previously cited. This assumption finds consistency in the comparison between HICP_A and HICP, where the index with the net purchase component dominates the base index especially in recent years and in the financial crisis years. Instead, in the years prior to 2013, house prices were not growing in EU19 and in fact in figure 2.11 there is a lower preponderance of HICP_A, and in some periods the difference is almost nil. Therefore, it is clear that the introduction of a pro-cyclical component to the whole of inflation will lead to an increase or a decrease in the rate, based on the trends of the housing markets. The difficulty of inserting the cost of housing lies in the fact that the various nations that make up the EU19 have had different experiences before and after the financial crisis and during the pandemic. The dynamics of house prices as well as those of mortgage credit, that have influenced the national OOHPIs, have not been homogeneous.

3. Var Model and Macroeconomic Implications

The analysis carried out showed us that between 2005 and 2021, the modified inflation rate is not significantly different from the available HICP values. The question in Chapter three is, "Would HICP_A impact future macroeconomic trends differently than HICP?".

Using a Vectoral Autoregression model regressed with Stata software[13], the chapter will attempt to draw conclusions by making predictions about the trends in the variables involved. I decided to include three elements within the model, the harmonized inflation rate with or without the addition of housing costs, the interest rate and the real Gross Domestic Product. Initially, the variables considered, and the time window of reference will be described. Moving on, the Var model paragraph highlights the stationarity and stability of the analysis carried forward with an augmented HICP_A, and then delves into the specifics of the interaction between the variables through the Granger Causality Test and the Impulse Response Functions. The assessment will be repeated using the classic euro area HICP without the addition of housing costs, and then the results will be compared with the previous model in order to draw conclusions regarding the presence of a different inflation rate within the macroeconomic environment.

Starting from regressions' differences and similarities, the chapter concludes by identifying policy implications for the European Central Bank. The presence of housing costs does not significantly alter the interaction between the variables. Therefore, it is necessary to adopt congruent tools to assess and cope with the risks of the housing sector and the variables related to it. The prevention of housing booms in the euro area, which go to exacerbate the business cycle, can be done through macroprudential tools, as we see at the end of the chapter.

3.1 Real GDP and Interest Rate

The model presents three macroeconomic variables, inflation rate, interest rate and real Gross Domestic Product. All the series were downloaded from Eurostat, again with reference to the

[13] Stata codes I used are available on Appendix.

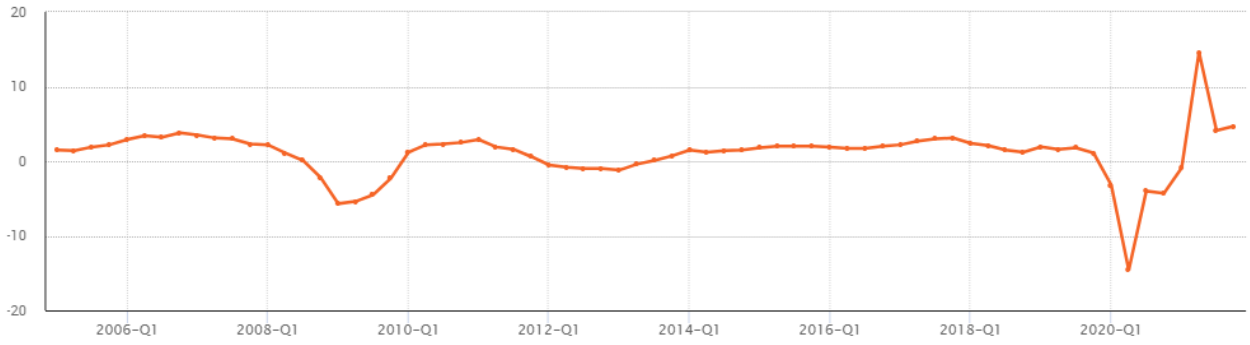
euro area (EU19). In the two Var models I used two different inflations, first HICP_A increased through housing costs with Net Acquisition method (computed in chapter two), and then HICP without changes, while GDP and interest rate series remained the same in each regression.

For the **real GDP**, I have chosen the "Gross Domestic Product at market prices" with unit of measure the chained-linked volumes index 2015=100[14], to maintain consistency with the inflation index. In a chain linked volumes GDP series, we calculate the value of goods and services produced in the current year using the prices of the year base. In contrast to Laspereys price index, the volume index holds price constant while quantities vary, as we can see from the formula:

$$L_q = \frac{\sum_i p_{i0}\ q_{it}}{\sum_i p_{i0}\ q_{i0}} \times 100$$

The data are already quarterly and are seasonally adjusted. To give a quick explanation of the GDP's trend, I use the percentage changes compared to same period in the previous year.

Figure 3.1: Variations of GDP



Source: Eurostat

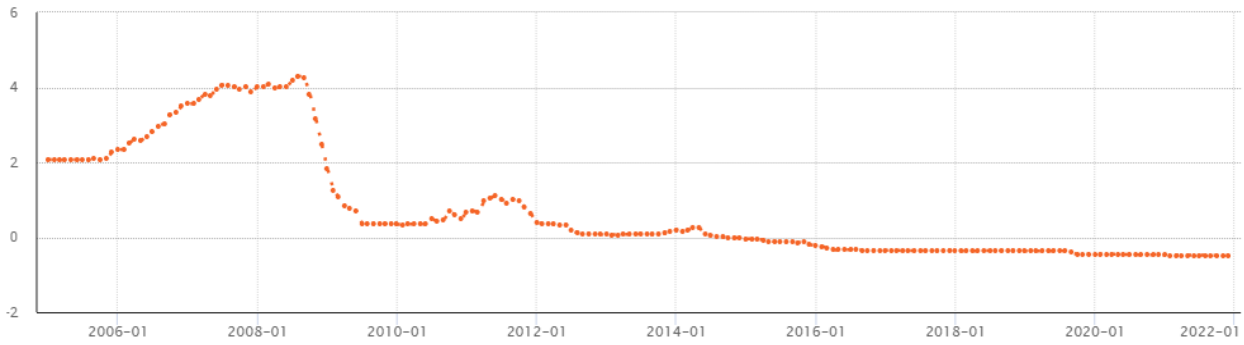
Figure 3.1 shows us how the period examined in chapter two, which considers two times when GDP experienced large fluctuations. In the stable situations in the graph, growth is between 0 and 4 percent. Two, on the other hand, are the unstable phases, the first between the end of 2008 and throughout 2009 that sees a strongly negative trend with a peak of -5.7 percent. The second,

[14] For more details on real GDP: https://ec.europa.eu/eurostat/cache/metadata/en/namq_10_esms.htm.

2020-2021 stand as even more fluctuating years, with decreases of up to -14.6 percent until the maximum positive peak of +14.6 percent in the second quarter of 2021.

For the **interest rate,** I have chosen the data on Eurostat database called "Day-to-day money market interest rate" which is included in the category of short-term interest rate[15]. Fundamentally, the rates are averages of EONIA (Euro Overnight Index Average), which are computed using a weighted average of the overnight lending operations unguaranteed in the interbank market[16]. The series are monthly, so in this case I made a weighted average of the first three months of the year, the average of the second three and so on, in order to have quarterly data.

Figure 3.2: IR growth rate



Source 1: Eurostat

Figure 3.2 shows us sustained rate growth until the last months of 2008, peaking at 4.29. Thereafter a rapid decline to zero is evident, and only a positive recovery in 2011. The trend then goes negative starting in late 2014, settling around -0.5 in the last months of 2021.

3.2 Temporal Window

My temporal window of reference is 2005-2019, which does not take into account the last two years of the analysis in chapter two, i.e., those coinciding with the Covid 19 pandemic. I made this decision because, within my VAR model, the presence of two crisis periods, financial and

[15] For more details on interest rate: https://ec.europa.eu/eurostat/cache/metadata/en/ei_mf_esms.htm.
[16] Panel of 18 banks contributing to the determination of EONIA: https://www.emmi-benchmarks.eu/benchmarks/euribor/panel-banks/.

pandemic, created too much noise within the regression (i.e., from the trends seen above, the volatility of real GDP in these years is too high). Since covid is an exceptional event that is leading to dynamics that are still evolving, I preferred to keep only the financial boom, which goes to influence the relationship between the variables involved.

3.2.1 The financial crisis

The crisis that hit the world after 2007 is a two-stage crisis. The first half took place in 2008-2009 and is often referred to as the Great Recession, i.e., the simultaneous collapse of GDP, industrial production and turnover that followed the bankruptcy of the U.S. investment bank Lehman Brothers and the rise in oil prices in the summer of 2008. After the first half of the crisis, there was a recovery of varying duration and intensity depending on the country, but placeable between the second half of 2009 and the first half of 2011. But then came the second part of the crisis, which began in the summer of 2011, when the sovereign debt crisis which started in 2010 in Greece, Ireland and Portugal widened as the existing spread between the public debts of Spain and Italy and the public debt of Germany widened. Table 3.1 summarizes the most important numbers of the 2007-2013 crisis by referring to the main macroeconomic variables, GDP and inflation.

Table 3.1: GDP and inflation in the world economy

	Tassi di crescita (%)	
Anno	**PIL**	**Inflazione**
2000-2006	+3,4	+3,4
2007	+5,4	+4,0
2008	+2,7	+6,0
2009	–0,6	+2,5
2010	+5,3	+3,7
2011-2012	+3,5	+4,4
2013p*	+3,5	+4,3

Source: International Monetary Fund

The data refer to the world economy as a whole and come from the International Monetary Fund's April 2013 World Economic Outlook. In addition to data for 2007-2013, the table also includes average GDP and inflation data for the pre-crisis period, the years 2000-2006. The reference to these years serves to emphasize that 2007 was a year of economic overheating for the world economy, with GDP growth at 5.4 percent and inflation at 4 percent, values well above those recorded on average in previous years. In 2008, GDP growth halves from 5.4 percent to 2.7 percent and, in parallel, inflation accelerates from 4 percent to 6 percent. In 2009, GDP growth turns negative, for the first time since 1978 (i.e., since the International Monetary Fund has been recording world GDP trends). The world inflation rate also falls sharply, from 6 percent to 2.5 percent. In the second part of 2009 came the recovery for most economies, which translated into very positive world GDP growth for 2010 (5.3%) in parallel with a return of inflation above 3%. After the 2010 recovery, the scenario then changed again, with 2011-2012 data showing GDP growth of between 3 percent and 3.5 percent, a figure very similar to the average pre-crisis figure for 2000-2006. However, growth in 2011-2013 was supported by higher inflation by about one percentage point, not far from 4.5 percent. It can be inferred from this that sustainable GDP growth for the world economy is well below 5 percent. Although the paper assessment (Daveri, 2013, 1-4) is on a global scale, euro area GDP also exhibits these characteristics in the crisis years, which influence the Var model.

3.3 Var Model with augmented inflation

The variables, in order, are augmented Inflation index (HICP_A), Interest Rate (IR) and real Gross Domestic Product (GDP).

Here I have to make a point, after a series of attempts I noticed that the responses of the variables to each other did not change much in case I changed the order, however, I decided to put inflation as the first variable following the theory referring to the Var/Svar model, which tells me that if I want to evaluate the shock of one variable relative to the others, I must put it first. This step is particularly important for the analysis of Impulse Response Functions. I took the natural logarithm of HICP_A and GDP, following the suggestions of other papers, while I maintain the interest rate as a rate (average). The quarterly data available are from the first quarter of 2005

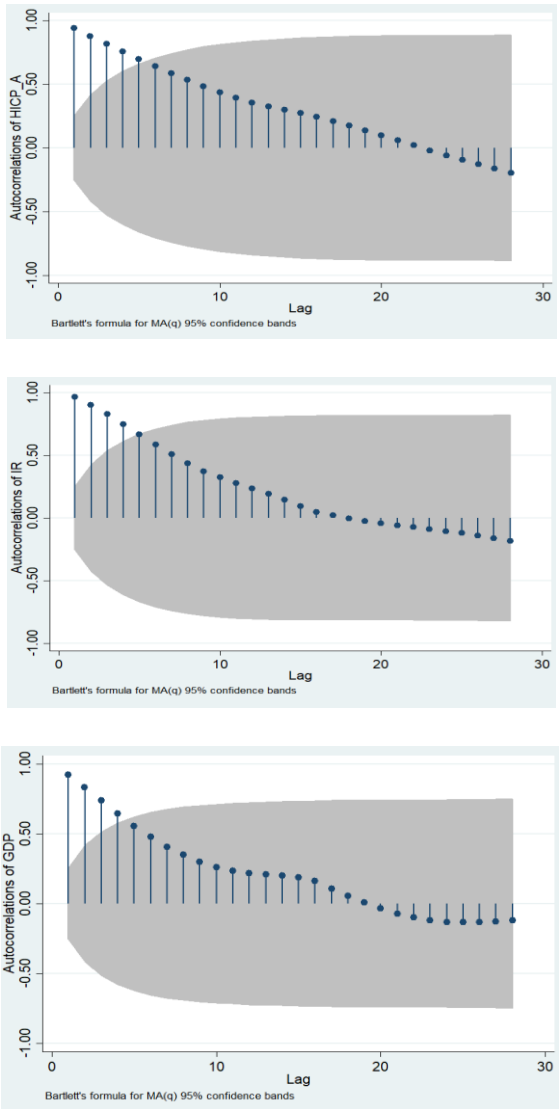
through the fourth quarter of 2019. The baseline VAR specification can be written in matrix form as: $\mathbf{y_t = c + A(L)y_{t-1} + \varepsilon}$

Where y_t is the vector of endogenous variables, c the vector of constants, ε_t is the vector of errors, A the coefficient matrix and L is the lag-operator. In my baseline specification the vector of endogenous variables y_t consists of three-euro area variables:

$$\mathbf{y' = (HICP\_A_t, IR_t, GDP_t)}$$

Starting with the following figure 3.3, I began my Var analysis by evaluating the stationarity of the series, and in particular their respective autocorrelations.

Figure 3.3: Autocorrelations



Source: My own elaboration

An autocorrelogram is a graph representing the autocorrelation of a time series as a function of the lag with which the autocorrelation is calculated. The value of the three variables slowly decrease to take on negative trends in the final lags, meaning that the values of the time series are strongly correlated with those of the one-period lagged series, then somewhat less for the two-period lagged series, and so on, meaning that the present is influenced by the recent past and in general that the series exhibits an underlying trend.

Before a VAR regression, I had to **test for stationarity of the variables**, I used a Dickfuller test. The resulting p-values greater than 0.05 (in order 0.2034; 0.8349; 0.9499) do not demonstrate stationarity of HICP_A, IR and GDP. Thus, in order to make the variables stationary, I had rendered them in First Difference. After a series of attempts, however, the analysis I had carried out with these new variables turned out not to be well specified, especially in the Impulse Response Functions. The results obtained were not economically correct, especially that an interest rate shock corresponded to an increase in GDP. Therefore, following the reference paper (Gerke, Weber and Worms, 2008), I decided to keep the nonstationary variables, maintaining only the change of GDP and HICP_A to logarithms. In addition, inflation and GDP time series are cointegrated[17], reasoning that analysis can be done in levels even if the variables are not stationary. In particular, the series of GDP and inflation indexes, follow a similar trend over time.

The test for optimal order (Table 3.2) tells me that following Hannan Quinn and SBIC, the best lag would be lag 2. The problem is that regressing my variables in this way will lead to an unstable model, and with three lags I had the same problem, so I decided to only use a lag that leads me to stability.

Table 3.2: Choice of optimal order

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	151.643				9.9e-07	-5.30868	-5.26662	-5.20018
1	460.375	617.46	9	0.000	2.2e-11	-16.0134	-15.8451	-15.5794
2	485.164	49.576	9	0.000	1.3e-11	-16.5773	-16.2828*	-15.8178*
3	496.125	21.923*	9	0.009	1.2e-11*	-16.6473*	-16.2267	-15.5623
4	504.32	16.39	9	0.059	1.2e-11	-16.6186	-16.0717	-15.2081

Source: My own elaboration

[17] Definition of cointegration in the Treccani website: https://www.treccani.it/enciclopedia/cointegrazione_%28Dizionario-di-Economia-e-Finanza%29/.

The estimation model meets the requirement of stability well as shown by the roots less than one in modulus. Which was not the case if I had reasoned with order 2. All the eigenvalues lie inside the unit circle; thus, VAR satisfies the stability condition. Table 3.3 shows the results of the test.

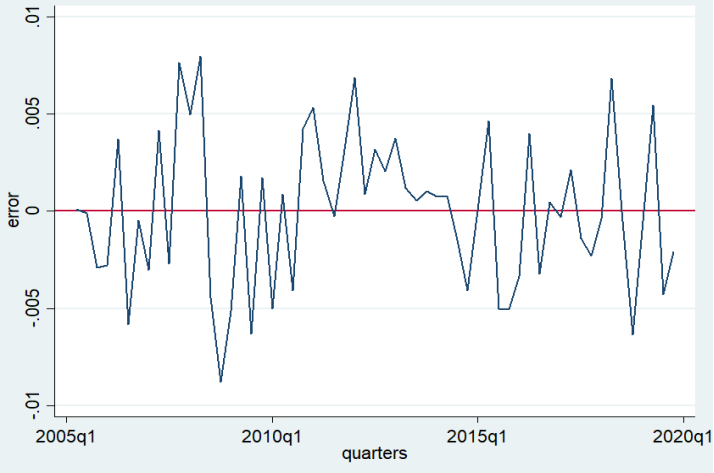
Table 3.3: Stability test for order 1

Eigenvalue	Modulus
.9953236	.995324
.936461 + .09964362i	.941747
.936461 - .09964362i	.941747

Source: My own elaboration

After the stability evaluation, I move to the **residual diagnostics**, where the residuals are the difference between the observed and estimated values in a regression analysis. Observed values that are above the regression curve have a positive residual value and observed values that fall below the regression curve have a negative residual value. Once I predicted the errors, I plotted the following graph (figure 3.4). The average of the residuals is around zero (1.63e-11) and shows an important imbalance at the height of the crisis quarters of 2009, where variables fluctuated strongly, especially GDP followed by HICP and IR.

Figure 3.4: Residuals



Source: My own elaboration

Moving forward, **Lagrange multiplier test** look for residual autocorrelations. The hypothesis test can be summarized as follows:

- **H_0**: no autocorrelation at lag order (serial uncorrelation)
- **H_1**: presence of autocorrelation at lag order

If p>0.05 I can accept the null hypothesis, otherwise I have to reject it. From table 3.4 I can say something about the autocorrelation.

Table 3.4: Lagrange multiplier test

lag	chi2	df	Prob > chi2
1	41.3445	9	0.00000
2	14.3179	9	0.11146

Source: My own elaboration

As I said before, my initial choice to maintain a Var of order 1, guarantees stability but var model has autocorrelation at lag 1.

3.4 Granger Causality Test and Impulse Response Functions

At this stage I go to analyze the relationship between the variables, through a Granger Causality test and Impulse Response Functions. From these two I draw conclusions and then go on to compare them by repeating the model with a different inflation rate.

With the **Granger causality test** we go to assess causality between variables. This type of test examines if lagged values of one variable helps to predict other variables in the model. The system of hypothesis is formed like that:

- **H_0**: X does not Granger Cause Y
- **H_1**: X Granger Causes Y

The rule of decision is:

- If p.value<0.05 = "X" Granger Causes "Y" at the 5% significance level
- If p.value>0.05 = "X" does not Granger cause "Y" at the 5% significance level

With the help of the table 3.5, we can give some statements about the relationship of our variables.

Table 3.5: Granger Causality Test

Equation	Excluded	chi2	df	Prob > chi2
HICP_A	IR	3.9732	1	0.046
HICP_A	GDP	9.4227	1	0.002
HICP_A	ALL	9.542	2	0.008
IR	HICP_A	11.191	1	0.001
IR	GDP	7.0853	1	0.008
IR	ALL	11.28	2	0.004
GDP	HICP_A	26.639	1	0.000
GDP	IR	33.532	1	0.000
GDP	ALL	34.045	2	0.000

Source: My own elaboration

All values in the last column are below 0.05. This shows us that the variables explain each other's trends and their future values, GDP in particular is very much explained by inflation and interest rate. The order of the variables is correct, in view of the Impulse Response Functions as well, in that it will be convenient to put the most exogenous variable first, then the second most exogenous, and so on.

With the **Impulse Response Function (IRF)** we can trace the time path (present and future) of the variables in our model to a one unit increase in the current value of one of the Var errors. In a nutshell, we answer the question, "What is the effect of a one-unit shock in "X" on "Y"?". In the Var model we cannot evaluate the effect of a variation in one shock on the variables. In order to assess the effect of a shock, it is necessary for shocks to be uncorrelated with each other. For this reason, in this paragraph I used the Structural VAR model.

In structural analysis, there is an evaluation of the dynamic relationship between the variables in our model. Structural analysis begins with the structural vector autoregression (SVAR), which applies restrictions that allow us to identify the impacts that exogenous shocks have on the variables in the system.

To estimate the orthogonalized impulse-response functions, I followed the exercise and theory notes from the "Advanced Econometrics" course, University of Padova, 2021/2022[18]. I proceeded in this way:

(a) I estimated the VAR;

(b) I choose the causal ordering (HICP_A IR GDP);

(c) I computed the Cholesky decomposition of the variance/covariance matrix of the VAR(1) model errors;

(d) I estimated the coefficient matrices in the structural moving average form (SMA);

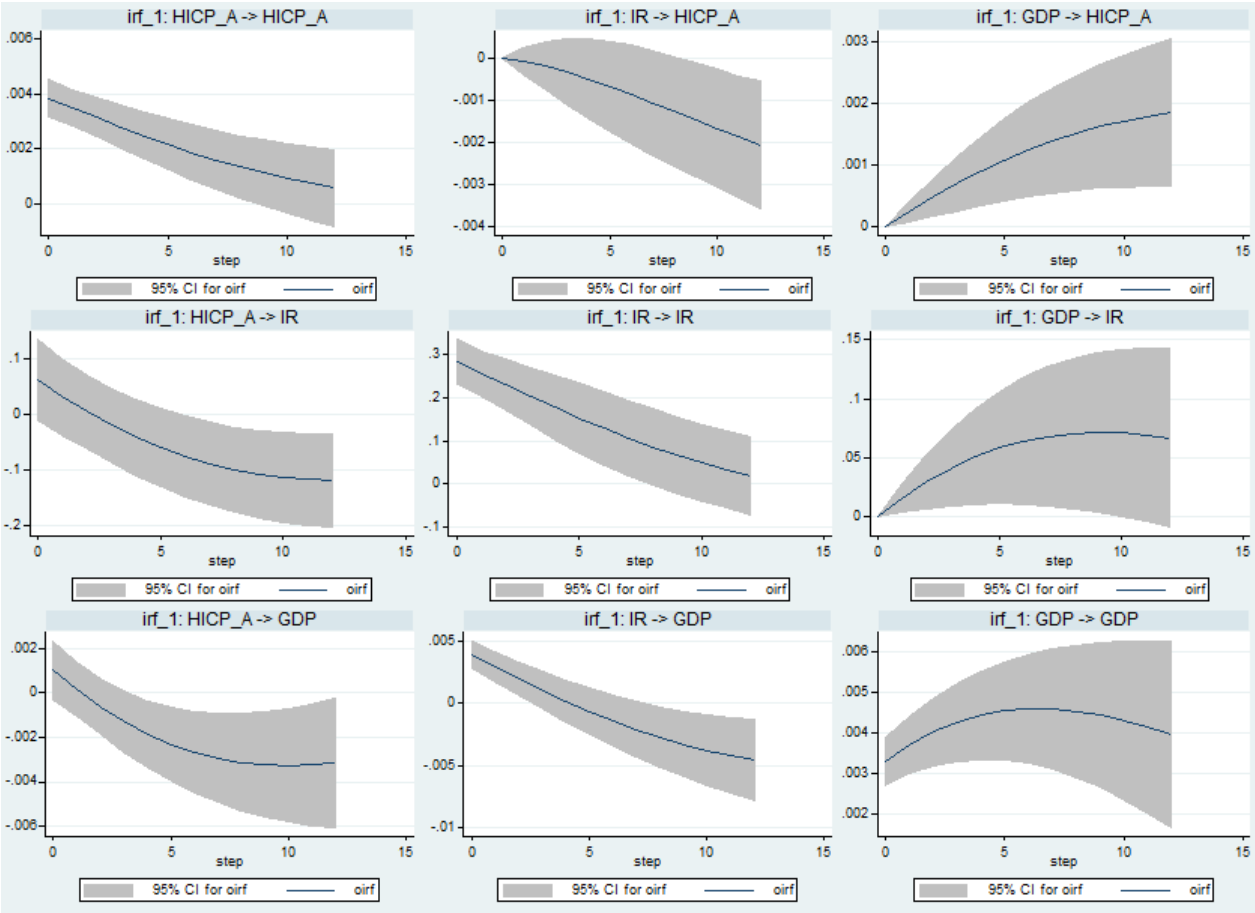
(e) I plotted the orthogonalized impulse-response functions

In order to identify impulse responses, a restriction in the main matrix (Cholesky Decomposition) is required. The order of the variables plays a key role because restrictions on the matrix imply that some shocks do not have simultaneous effects on some variables in the system. In general, the most exogenous variable in the model should be put first, then the second, and so on. The Granger Causality test can help decide which variables are more or less exogenous; following the test, the variables that are most explained by others are more endogenous than those that are not. I decided to keep inflation as the first variable because I wanted to assess its shock to the interest rate and GDP. With this setting, inflation will not be affected by the other components of the Svar

[18] In particular the two files that I used, "Exercises_6" and "VAR_SVAR_DalBianco", are available on moodle platform webiste: https://elearning.unipd.it/economia/course/view.php?id=1812.

model, the interest rate will not be affected by GDP, while GDP will be affected by the shocks of all the other variables.

Figure 3.5: IRF with HICP_A



Source: My own elaboration

How are organized the graphs:

- The structural shocks are the unexpected changes in the variables
- Grey Area is the standard error confidence bands
- X axis represents the periods ahead (12 quarters in our analysis)
- Y axis shows the variations

Figure 3.5 shows the 9 impulse-response functions along with the 5% confidence intervals (the grey area). The top row shows the responses of HICP_A to the structural shocks, the middle line

shows the responses of IR to the structural shocks and the bottom row shows the responses of GDP to the structural shocks.

Comments:

1) In the diagonal, the variables to a shock to themselves all respond positively.
2) A shock to HICP_A results in a slight increase in IR, which becomes negative over the quarters.
3) HICP_A slightly positive impact on GDP, which then goes negative over time.
4) The most controversial and macroeconomically incorrect result is GDP's initially positive reaction to an IR shock, if not by much.

From the Figure then we notice some counterintuitive results. After many attempts and using different settings of the variables, the Impulse Response Functions, are the most statistically and economically correct, compared to the other results obtained. The variables 'correlation matrix is:

	HICP_A	IR	GDP
HICP_A	1.0000		
IR	-0.7901	1.0000	
GDP	0.8236	-0.4568	1.0000

The interest rate has a negative correlation with inflation and GDP, while the latter two have a positive correlation with each other.

3.4.1 Temporal window 2010-2019

To show how the financial crisis affected the model, I decided to retrieve the Impulse Response Functions of the time window starting from the first quarter of 2010 until the end of 2019, thus excluding the initial years of the time series.

The Granger Causality Test (table 3.6) shows poor predictive ability of some variables. Values of p>0.05 tell me that the interest rate does not explain inflation, just as GDP does not Granger cause the interest rate.

Table 3.6: Granger Causality for 2010-2019

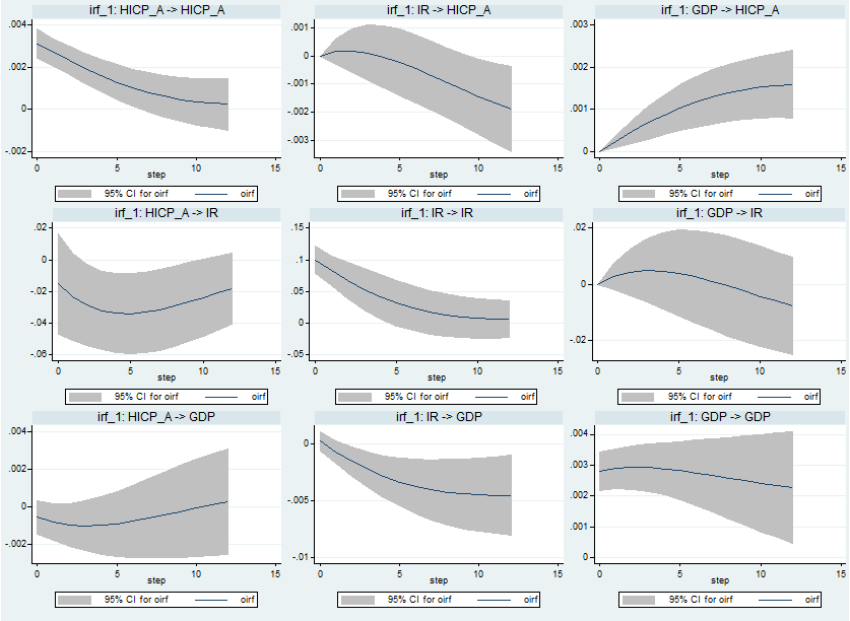
Equation	Excluded	chi2	df	Prob > chi2
HICP_A	IR	.34183	1	0.559
HICP_A	GDP	11.567	1	0.001
HICP_A	ALL	11.638	2	0.003
IR	HICP_A	6.9463	1	0.008
IR	GDP	1.3783	1	0.240
IR	ALL	7.692	2	0.021
GDP	HICP_A	13.3	1	0.000
GDP	IR	21.066	1	0.000
GDP	ALL	23.019	2	0.000

Source: My own elaboration

Figure 29 of the reduced-period IRFs, shows us some deviations from previous results:

1) the response of IR to a shock of HICP_A is more negative,
2) the response of GDP to HICP_A is more negative, and the trend at the end of the forecast returns to positive,
3) the negative impact of IR on GDP is greater

Figure 3.6: IRF for 2010-2019



Source: My own elaboration

3.4.2 Var Model with classic HICP

Now, in line with the comparisons made in Chapter 2, I am going to regress a model using the inflation rate without the housing cost component. Instead, the GDP and interest rate series remain unchanged. The variables are still in logarithmic apart for IR, and cover time frame 2005-2019. As in the previous case they are not stationary, but at lag 1 the model is stable, despite presence of autocorrelation, in line with Var with HICP_A.

First, I'm going to redo the Granger Causality Test and compare it with the one before. From the table 3.7 we can draw similarities and slight differences.

Table 3.7: Granger Causality Test

Equation	Excluded	chi2	df	Prob > chi2
HICP	IR	1.9978	1	0.158
HICP	GDP	4.3881	1	0.036
HICP	ALL	4.5135	2	0.105
IR	HICP	9.7176	1	0.002
IR	GDP	5.5099	1	0.019
IR	ALL	9.8041	2	0.007
GDP	HICP	24.78	1	0.000
GDP	IR	31.785	1	0.000
GDP	ALL	32.025	2	0.000

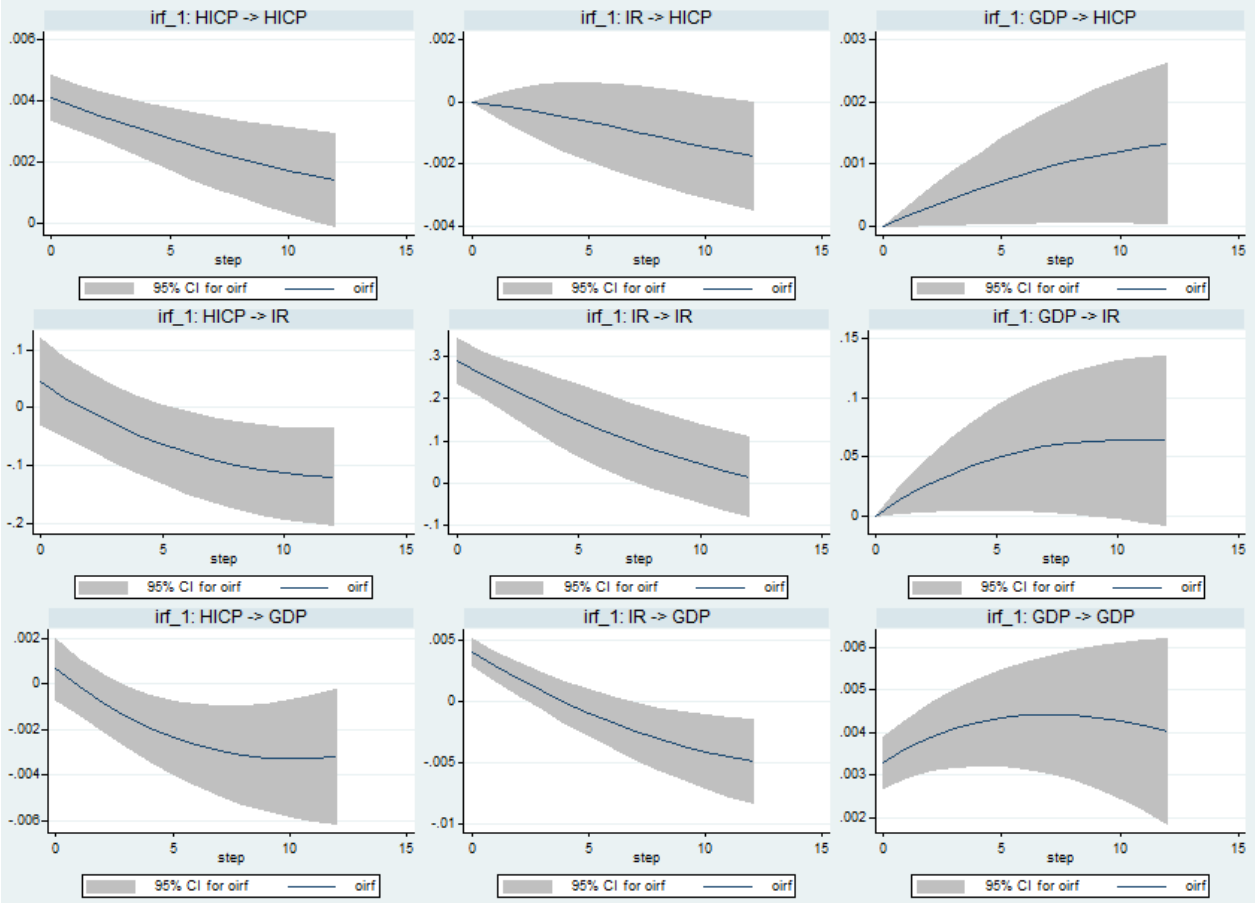
Source: My own elaboration

Again, GDP is well explained by the model, with p-values being zero. Things change, however, for inflation, which was previously well explained while now it is not, in fact at the interest rate and “all variables” we find no significance. IR on the other hand, despite slightly higher values than in the previous case, is well explained by the variables.

We now move to the Impulse Response Functions analysis. The resulting graph (figure 3.7) is practically the same as the previous one, we can see only a slightly greater variation in inflation at a shock of itself. These results are not surprising, in line with what we saw in Chapter 2. The differences between inflation with or without the presence of housing costs are minimal, counting

a weight of this component of 9 percent. I therefore come to say that the relationship between the three macroeconomic variables does not change whether I use HICP_A or HICP.

Figure 3.7: IRF with HICP



Source: My own elaboration

3.5 Policy Implications for ECB

From Granger causality and the Impulse Response Function we deduced that the differences at the macroeconomic level of using an inflation rate increased with housing costs compared to the classical HICP, are minimal if not zero. Thus, the real problem of ECB is to deal in the most proper way with the housing costs and risks that arise from real estate. The analysis brought forward tells us that the housing sector has influenced the macroeconomic environment, first

during the financial crisis of 2009 and then during the years coinciding with the covid pandemic, where the components and subcomponents of housing costs have undergone significant growth.

The financial crisis of 2008 originated from the U.S. housing market, stemming from a financial shock, while the shock caused by Covid 19, did not stem from economic fundamentals, at least in the early stages. The economy was affected mainly because of the restrictions put in place to deal with the spread of the virus. These led to economic characteristics similar to those of the financial crisis, particularly because of their different impact on real and nominal housing dynamics and different housing developments in different countries.

The debate about whether monetary policy should respond to asset prices to prevent and avoid bubbles is not new, but the use of rates by monetary authorities is no longer sufficient to address the risk problem associated with the housing sector. More specific instruments will therefore be needed in relation to the latter. This is because any changes by the ECB in interest rates, could have an impact on mortgages and aggregate demand in the housing market, thus going to impact housing dynamics. Tightening rates will most likely prevent real estate booms, but is costly in terms of short-term growth, and thus would not be recommended. The other problem is the heterogeneity of member states, rate change cannot respond to the specifics of all the nations, particularly with respect to real estate risks.

3.5.1 Macro-prudential policy and tools to cope the housing risk

Macroprudential policies are implemented to preserve the stability of the financial system as a whole by limiting systemic risk. Given the heterogeneity of nations, risk may occur in only some of them, so monetary policies are often delegated to national authorities, usually central banks. The importance of using these policies is gradually growing in developed economies, especially after the financial crisis, in order to bring together existing monetary and fiscal instruments with macroprudential ones.

These types of instruments can go to the root of assessing real estate-related risks (Martins, Turrini, Vasicek and Zamfir, 2021). They are aimed to identify the very sources of boom and bust, and a key distinction is between measures aimed at lenders from those aimed at borrowers. The former are mostly capital-based instruments while the latter refer to borrow-based

instruments that have a direct impact on the characteristics and nature of new mortgages. The macroprudential tools that go to affect lenders and increase their protection are:

- *Countercyclical capital buffer:* its purpose is to counteract the procyclicality of the financial system by building up a capital buffer during periods of excessive credit growth. Capital requirements adjusted over the course of the cycle can address procyclical credit risk by reducing the probability of mortgage booms and creating buffers that mitigate the impact of housing crises and support the recovery of lending once released. Currently, however, this type of reserve does not only apply exclusively to real estate exposures.

- *Sectoral capital requirements:* capital surcharge that depends on exposure to real estate. The main advantage is that they are more effective than aggregate capital requirements when the boom is contained to a particular sector. They could, however, bring risky developments to other parts of the financial system, for example by increasing lending by nonbank financial institutions.

- *Increased risk weights to target asset bubbles in residential real estate:* in relation to banks' real estate exposures, they aim to limit the impact of risks when they materialize, strengthening banks' loss-absorbing capacity.

The other tools that target borrowers are:

- *Limits on loan-to-value ratios (LTV):* the maximum loan value set for borrowers is defined on the basis of real estate collateral, thus reducing the impact of mortgage default on banks' balance sheets. LTV ceilings reduce the mortgage boom and decrease borrowers' indebtedness in the face of a downturn.

- *Debt-to-income ratio limits (DSTI):* reduce the amount that can be borrowed by limiting monthly mortgage repayments to a certain percentage of monthly income. In addition to curbing booms and busts in the real estate sector, DSTIs could help curb speculative demand, as they go to the exclusion of borrowers who might obtain mortgages in order to quickly resell their property.

- *Limits on loan-to-income (LTI):* limit credit in relation to the borrower's disposable income.

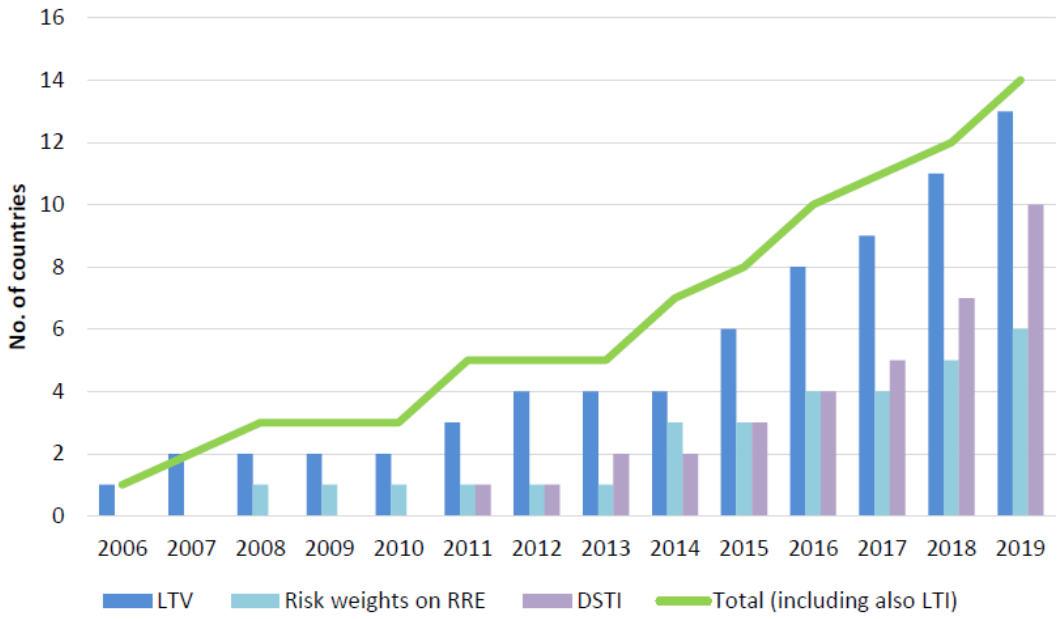
- *Maturity limits:* limiting the duration of mortgage loans to a certain number of years have an offsetting effect on the borrower's probability of default. They are likely to contain credit demand and household debt.

- *Amortization requirements:* contribute to easing credit growth and household indebtedness.

The main objectives of these instruments are to prevent excessive credit growth and leverage, excessive maturity mismatch and market illiquidity, direct and indirect exposure concentration and misaligned incentives. However, they are not without their challenges and drawbacks: (i) the need to have correct macroprudential measures over the cycle goes through difficult real-time estimation of possible deviations from house price and mortgage growth fundamentals; (ii) the key variables referred to in these policies are more specific, so the measures defined could be circumvented. For example, borrowers could circumvent LTV limits by combining multiple loans to buy a property; (iii) macroprudential instruments excessively target mortgage lending, thereby impacting homeownership availability, and thus particularly affecting younger borrowers who have little equity; (iv) it is not easy to predict their relationship to the mix of other policy instruments; (v) the tendency for inactivity on the part of national institutions may affect the effectiveness of the macroprudential instrument.

Despite the difficulties, many empirical studies point to the goodness of these instruments, particularly the LTV and DSTI ratio, which go to mitigate the effects of boom-bust housing cycles. The global financial crisis revealed that authorities responsible for supervising the financial system lacked a clear mandate and adequate analytical tools to address systemic risks. Now euro area nations are increasingly applying macroprudential policies, with differences in the number and type of tools used. Figure 3.8 shows us the trend in the use of them over time, starting in 2006 and ending in 2019. Fourteen out of nineteen nations use at least one tool, the most common tool being limits on LTV.

Figure 3.8: Trend of tools



Source: European Systemic Risk Board

To date, the procyclicality of housing costs predicts not so much a deviation from the original inflation rate but could adversely affect the business cycle. Therefore, in the short run and in the future, it will be necessary to govern housing price trends using the right mix of harmonic instruments. Price dynamics, especially in this pandemic period, are uncertain due to political and economic instability, thus the ECB and the institutions must act promptly to avoid the creation of new imbalances. The Var regressions showed that the relationship between inflation (HICP_A or HICP), interest rate and GDP, from a macroeconomic perspective, does not change. Therefore, the ECB need not worry about the introduction of a new inflation setting, but it will be necessary to use appropriate tools in order to estimate and manage housing cost and the housing market dynamics.

Conclusion

The objective of this thesis was to assess the impact of introducing housing costs within the European harmonized inflation rate and whether this new framework has relevant macroeconomic implications for European Central Bank policies.

The study pursued led to the creation of an augmented Harmonized Index of Consumer Prices with related reformulation of the weights of the major sub-indexes, making room for a new housing component, which hinges on the stage of housing acquisition and its holding, calculated by the method called “net acquisition approach”. The index used and included within the inflation rate is the one mentioned in the ECB's strategy review, namely the Owner-Occupied Housing Price Index. The analysis, which covers the period 2005-2021, also includes the use of a housing cost proxy for the first period up to the end of 2009, the House Price Index, due to the non-availability of data from the ECB-chosen index. The indexes, downloaded from Eurostat's database, show a steady growth and cause a deviation, albeit minimal, of the inflation rate with housing component compared to that without any change especially during periods of housing boom, coinciding with financial crisis and Covid pandemic.

With the help of some reference papers, it is evident that housing market variables are procyclical, and that they tend to be conductors of monetary policies, even though from the Eurozone perspective their influence on the business cycle is minor than in the U.S. context. The treatment of these costs is different and less impactful than in the new continent, where through the imputed rents method, housing costs occupy a large share of the Consumer Price Index. The sample of households that purchase a home is smaller than the total sample of households that "pay" an imputed rent; in particular, the most important components of Owner-Occupied Housing Price Index, which drive its growth, refer to acquisition phase, which obviously does not occur monthly as in the case of a rental.

The ECB, which forecasts a final quarterly rate increase in 2026, will be faced with an inflation rate not so different from the current one, in fact it will add a housing cost component as if it were a consumer good, not considering the latter’s investment component. Through two VAR model, which exclude Covid pandemic years, composed by Inflation (augmented or not), Interest Rate and real Gross Domestic Product, we saw the future economic implications do not vary if we choose to use an increased harmonized rate. The comparison of the Impulse Response

Functions of the two regressions are almost the same, so in line with other papers I have come to say that the implications for the ECB do not change. During the period examined between Chapters 2 and 3, it is evident how the economic troubles of the crisis periods affected the housing sector and its key variables, which in turn pushed the business cycle. Institutions will not change monetary strategies and policies; rather, it will be necessary to better manage and estimate the variables that bear on the housing market, taking into account the risks that come from this world. Throughout the analysis it is clear that periods of economic boom are positively related to real house prices, mortgage debt and residential investment. Protective tools against lenders, such as additional reserves, and against borrowers, such as limits on loan-to-value ratios, are necessary to prevent the exacerbation of crisis periods.

Appendix

Stata codes

The codes refer to the first regression with increased HICP_A. In the other Var models, I reduced the time window or replaced the inflation series with the classical HICP without the presence of housing costs.

```
***Creating a time variable****
generate quarters = tq(2005q1)+_n-1
format %tq quarters
tsset quarters

***Evaluation of the Autocorrelations***
ac HICP_A ac IR ac GDP

*****Stationarity Test with Augmented Dickey Fuller*****
dfuller HICP_A dfuller IR dfuller GDP

***Lag Length Criteria***
varsoc

///Estimating the VAR Model/////
var HICP_A IR GDP, lags(1/1)

***VAR Stability Condition***
varstable

***Generate residuals and graph residuals***
predict error, resid
summarize error
tsline error, yline(1.63e-11)

***Autocorrelation Test*****
varlmar

** Granger Causality Test **
vargranger



///Svar and Impulse Response Functions///
mat Omega=e(Sigma)
mat list Omega

mat B=(1, 0, 0 \ ., 1, 0 \ ., ., 1)
mat Sigma=(., 0, 0 \ 0, ., 0\ 0, 0, .)

svar HICP_A IR GDP, lags(1/1) aeq(B) beq(Sigma)
qui var HICP_A IR GDP, lags(1/1)

irf set "irf_1", replace
irf create irf_1, step(12)

irf cgraph (irf_1 HICP_A HICP_A oirf, ci) (irf_1 IR HICP_A oirf, ci)
(irf_1 GDP HICP_A oirf, ci) (irf_1 HICP_A IR oirf, ci) (irf_1 IR IR oirf, ci)
(irf_1 GDP IR oirf, ci) (irf_1 HICP_A GDP oirf, ci) (irf_1 IR GDP oirf, ci)
(irf_1 GDP GDP oirf, ci)
```

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