THE EFFECTS OF CONVENTIONAL AND UNCONVENTIONAL MONETARY POLICIES ON THE EURO AREA HOUSING MARKET

Jyväskylä University
School of Business and Economics

Master's Thesis

2024

Author: Patric Zhang
Subject: Banking and International Finance
Supervisor: Heikki Lehkonen

JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

ABSTRACT

Author Patric Zhang	
Title The effects of conventional and unconventional monetary policies on the Euro area housing markets	
Subject Banking and International Finance (BIF)	Type of work Master's thesis
Date 19.6.2024	Number of pages 74

Abstract

This master's thesis focuses on the effects of conventional and unconventional monetary policies on Euro area housing markets. The financial crisis of 2008 originated from overheated U.S housing markets, where the initial problems in the housing markets had tremendous spill-over effects on the whole global economy. Housing accounts for over half of the Euro area household net worth (ECB, 2020b), and is usually acquired through bank debt financing, thus fluctuations in the Euro area housing prices can have contagious effects on the whole financial system.

After the crisis, the key interest rates were near or below zero, and the European Central Bank (ECB) started its Quantitative Easing (QE) programs. The Euro area sovereign debt crisis also expanded the ECB's balance sheet. Like Rosenberg (2020) and Elbourne et al. (2018), this expansionary monetary policy is defined as unconventional monetary policy in this paper, and conventional monetary policy is seen as changes in the short-term interest rate.

This master's thesis examines the impacts of traditional and unconventional monetary policy on European housing markets using a Vector Autoregression (VAR) model. This model has been applied to Euro area aggregate , Germany, and Italy. The findings of this study, which differ somewhat from previous research, suggest that the expansion of the ECB's balance sheet does not significantly impact residential property prices in the Euro area. However, policy rate shocks appear to have a more persistent effect. These results have significant implications, indicating that conventional monetary policy shocks may have a more enduring and potent effect on economic indicators than expansionary unconventional monetary policy measures.

Keywords
Expansionary monetary policy, conventional monetary policy, the European Central Bank, financial crisis, Euro area, housing markets, housing prices

Place of storage
Jyväskylä University Library

TIIVISTELMÄ

Tekijä Patric Zhang	
Työn nimi The effects of conventional and unconventional monetary policies on Euro area housing markets	
Oppiaine Banking and International Finance (BIF)	Työn laji Pro gradu -tutkielma
Päivämäärä 30.6.2024	Sivumäärä 74

Tiivistelmä

Tässä pro gradu -tutkielmassa käydään läpi tavanomaisten ja epätavanomaisten rahapoliittisten toimenpiteiden vaikutuksia Euroalueen asuntomarkkinoihin. Asuntovarallisuus on yli puolet Euroalueen kotitalouksien nettovarallisuudesta (ECB, 2020b), ja sen rahoittamisiseen käytetään lähtökohtaisesti asuntolainoja. Näin ollen Euroalueen asuntojen hintojen vaihtelu voi vaikuttaa koko Euroalueen rahoitusjärjestelmään.

Finanssikriisin jälkeen ohjauskorot olivat hyvin lähellä nollaa, jopa negatiivisia. Tässä korkoympäristössä pelkillä korkojen laskemisella ei välttämättä ole toivottuja taloudellisia vaikutuksia. Täten Euroopan keskuspankki (EKP) aloitti määrällisen elvytyksen ohjelmat. Finanssikriisin jälkeisten määrällisten elvytystoimien lisäksi myös Euroalueen velkakriisi kasvatti EKP:n taseen kokoa. Kuten Rosenberg (2020) ja Elbourne et al. (2018) osoittivat, myös tässä tutkielmassa epätavanomainen rahapolitiikka katsotaan olevan EKP:n ekspansiivinen rahapolitiikka. Sen sijaan tavanomaisen rahapolitiikan katsotaan olevan muutokset lyhyen aikavälin ohjauskoroissa.

Tässä työssä ekspansiivisen rahapolitiikan ja lyhyen aikavälin korkojen vaikutuksia euroalueen asuntomarkkinoihin on analysoitu Vektoriautoregressiivisen (VAR) mallin avulla. Mallia on sovellettu Euroalueen aggregaatin, Saksan ja Italian asuntomarkkinoiden osalta. Tämän tutkimuksen tulokset eroavat jonkin verran aiemmasta kirjallisuudesta, ja tulokset viittaavat siihen, että EKP:n taseen laajentumisella ei ole tilastollisesti merkitsevää vaikutusta euroalueen asuntojen hintoihin. Sen sijaan ohjauskoron muutokset näyttävät vaikuttavan asuntojen hintoihin pysyvämmin. Nämä tulokset viittaavat siihen, että tavanomaisten rahapoliittisten toimien vaikutukset ovat pysyvämpiä ja voimakkaampia taloudellisten indikaattorien suhteen, kuin epätavanomaisten rahapoliittisten toimenpiteiden vaikutukset. Jälkimmäinen tulos on yhteneväinen aikaisemman kirjallisuuden kanssa.

Asiasanat
Ekspansiivinen rahapolitiikka, määrällinen elvyttäminen, tavanomainen rahapolitiikka, Europaan keskuspankki, finanssikriisi, Euroalue, asuntomarkkinat, asuntojen hinnat

Säilytyspaikka

CONTENTS

1 INTRODUCTION

This master's thesis focuses on conventional and unconventional monetary policy and its effects on the Euro area housing markets. The unconventional monetary policies were implemented after the Great Financial Crisis (GFC) of 2008. The collapse of the real estate markets led to a severe deleveraging process, as household debt suddenly exceeded property prices (Huber & Punzi, 2020). The declining house prices, the sudden drop in household wealth, and the recession following the crisis forced central banks to swiftly lower the interest rates as an emergency procedure. The recession was still ongoing in late 2008, and interest rates were nearly zero, so conventional monetary policy (MP) tools were ineffective (Ngo, 2015). This led several central banks to adopt unconventional monetary (UMP) tools to reinforce the economy and end the recession. Instead of steering the interest rate, UMP tools are focused on expanding the central banks' balance sheet and forward guidance. As the policy rates have been near or below zero, unconventional monetary policies are not noted in the short-term interest rate. Thus, during the lower zero bound (ZLB), the effect of UMP can be hard to identify.

This paper starts by exploring how conventional monetary policy has affected housing prices in the Euro area and what policies have had the most impact. After establishing the effects of MP, I will start to analyse the Euro area housing development after the GFC, when UMP was introduced. Analysing the impact of ZLB and UMP is vital, as the Euro area's recovery from the GFC can be seen as sluggish compared to the USA's recovery. This research aims to find possible reasons for the subpar economic development of the Euro area and how the housing market has developed since the GFC.

1.1 Structure of the thesis

The structure of this thesis is as follows: The first chapter establishes the research questions, the motivation, and the research methods of this thesis. The second chapter focuses on the Monetary Policy Transmission Mechanism (MTM), which describes how the central bank's monetary policy actions, including the housing markets, influence the economy. The third chapter includes the previous literature on the topic. This Chapter illustrates how housing markets started the financial crisis of 2008, and what policy measures were implemented post-crisis. This chapter also delves into the differences between the U.S. and Euro area housing markets. The fourth chapter describes how the Vector Autoregression (VAR) analysis on the Euro area housing markets is constructed and the data used in the analysis. The fifth chapter contains the conclusions of this study.

1.2 Motivation

The housing market is a crucial sector in the Euro area, reflecting both the economic health of its member states and the overall stability of the European Union. Historically, conventional monetary policies, such as adjusting the key interest rates, have been the primary tool for central banks to influence and adjust economic conditions, including housing markets. When looking at the Euro area economy, housing wealth has been a significant component of household wealth. Housing wealth is more than half of the net worth of households in the Euro area (ECB, 2020b). Housing is the largest asset class of household portfolios, and analysing the factors that influence housing markets and the level of housing wealth and housing debt is crucial for understanding how the housing market can affect the economic development of the Euro area. As housing can be acquired with debt, which is the majority of household net worth, it also means that housing debt in aggregate is the most significant household liability. The housing market is deeply connected to the banking and lending sector, and housing pricing changes can have spill-over effects on the whole economy. This being the case, understanding the housing market's responsiveness to the transmission mechanisms of monetary policy and monetary policy shocks is vital.

Exploring how conventional monetary policy and monetary policy shocks affect the housing market is essential; however, the European Central Bank (ECB) and other central banks have increasingly employed unconventional monetary policies, such as quantitative easing and forward guidance, since the Global Financial Crisis (GFC) of 2007-2008. The GFC highlighted the limitations of conventional monetary policies and the need for new innovative approaches to address economic challenges. The global economy remained stagnant after the GFC governments and central banks enrolled in massive fiscal and monetary stimulus in hopes of a quick recovery from the financial crisis. Unconventional monetary policies have, therefore, become a significant aspect of monetary policy discussions. While the effects of unconventional monetary policy (UMP) on different macroeconomic variables have been studied, fewer studies have been made on the impact on housing markets.

1.3 Research question

1. How unconventional monetary policy has influenced the Euro area housing markets?

Unconventional monetary policies, such as quantitative easing (QE), negative interest rate policies, and targeted long-term refinancing operations (TLTROs), should increase bank liquidity and significantly affect asset prices, including housing prices. These policies were primarily adopted by the European Central Bank (ECB) in response to the financial crisis of 2008 and the subsequent Eurozone debt crisis to stimulate the economy by improving credit conditions, and lowering borrowing costs. This reduction in mortgage rates has made borrowing cheaper for households, leading to increased demand for housing and upward pressure on housing prices. According to Fratzscher et al. (2016) the announcement and implementation of Quantitative Easing programs (QE) in the Euro area, were associated with significant increases in housing prices due to the decrease in interest rates and increased liquidity in the housing market. Researching the effects of UMP could explain the recent positive development in Euro area housing prices, as investors have shifted their focus from the low-yielding bond markets to the housing market.

In this master's thesis, the focus is on the ECB's expansionary monetary policy and its effects on Euro area housing markets. The hypothesis is that Quantitative easing (QE) and other expansionary monetary policies would increase asset prices in the Euro area. This thesis defines the UMP as an abnormal extension of the ECB balance sheet. These abnormalities can be seen as ECB's policy measures post-GFC that increased the ECB's total balance sheet. These actions include the Securities Markets Programme, that allowed the ECB to purchase Euro area government bonds directly from the secondary markets. When looking at Graph 1, where the ECB's total balance sheet and Euro area residential price index (2015 = 100) post-GFC have been plotted, we can see that the Euro area residential price index and the ECB's total balance sheet seem to correlate significantly.

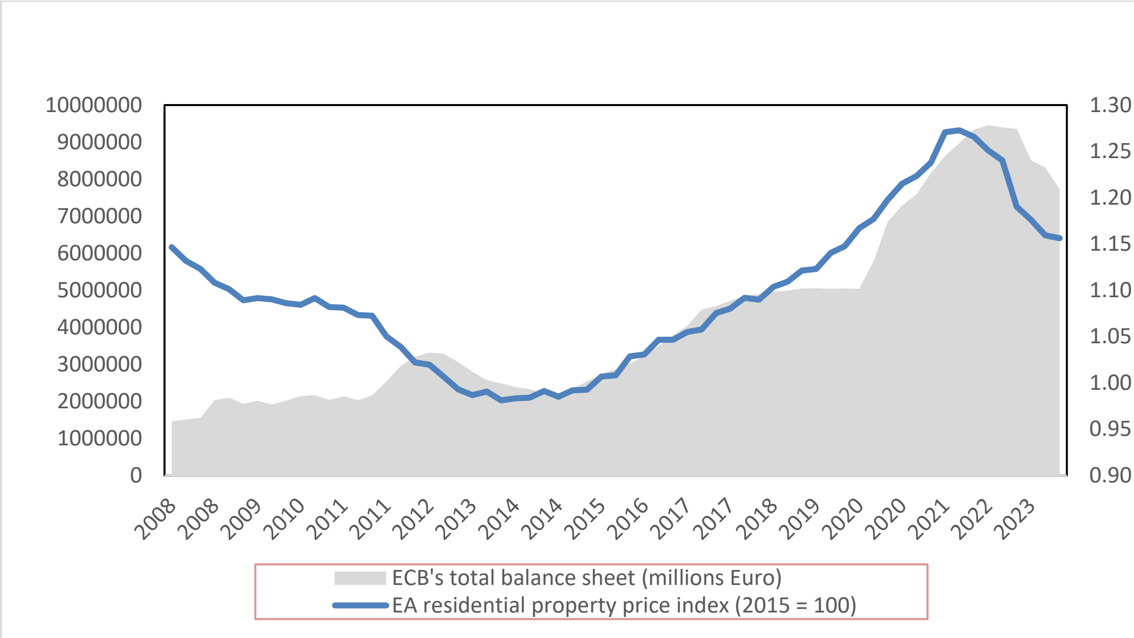


Figure 1. The left y-axis depicts the ECB's total balance sheet (in millions of Euros), and the right y-axis depicts the Euro area residential property price index post-GFC. (ECB database)

2 MONETARY TRANSMISSION MECHANISMS (MTM)

Before analysing the differences between traditional monetary policy and unconventional monetary policy, it is essential to understand how the housing market operates and what factors influence homeownership, investments in the housing market, and consumption. This chapter will further evaluate the housing market dynamics based on the theory of monetary transmission mechanisms (MTM). MTM describes how the central bank's policies and decisions affect the economy.

This chapter serves as a background for Chapter 3, where the Euro area housing market development is split between eras before and after the GFC. In this chapter, I will conceptualize the economic terminology and concepts that affect and influence the housing markets both in pre-and post-GFC, as chapter 3 delves into the economic theory of monetary policy (MP) and unconventional monetary policy (UMP). In this chapter, I further open the concepts of monetary transmission mechanisms, as MTM can be used to evaluate factors that influence the housing market and how developments in the housing market could spill over to the economy.

MTM can affect interest rates, exchange rates, equity, and real estate prices (Ireland, 2010). MTM shows how the changes flow through the economy, how individual sectors respond to these changes, and whether specific sectors amplify the effects of the monetary policy changes. Mishkin (1995) emphasizes the importance of monetary policy over fiscal policy in macroeconomic decision-making and sees monetary policy as being more at the centre of financial stability. Mishkin (1995) finds that the channels of MTM are fourfold. These are the interest rate channel, the exchange rate channel, the Credit channel, and the asset price effect. Changes in the short-term interest rate can impact all the channels mentioned above, and some of the channels directly impact housing markets.

2.1 Interest rate channel

In the classical Keynesian models, the interest rate channel is viewed as a tightening monetary policy, which leads to increasing interest rates, higher capital costs, and lower investment spending. This leads to a decline in aggregate demand and a fall in total output (Mishkin, 1997; Ireland, 2010). The interest rate channel is a fundamental part of the traditional Keynesian IS-LM model, which was first illustrated by Hicks (1937). In the original content, the shock in monetary policy was seen only as influencing businesses' investment decisions.

However, later research has recognized that the interest rate channel influences consumer spending on durable goods and housing. The current literature recognizes these two variables as part of investment decisions. As monetary policy tools tend to change the short-term interest rate, these changes also influence the long-term interest rate.

When short-term interest rates rise, the long-term interest rate also tends to rise. The linkage between short-term and long-term interest rates makes it clear that when analysing MTM, the linkage between these rates should be included. The effect of the interest rate on housing prices depends significantly on the size and structure of the economy. Bjørnland & Jacobsen (2010) Studied the UK, Norway, and Sweden housing markets. They found that one percentage increase in the interest rate leads to an average 3 – 5 % decrease in housing prices.

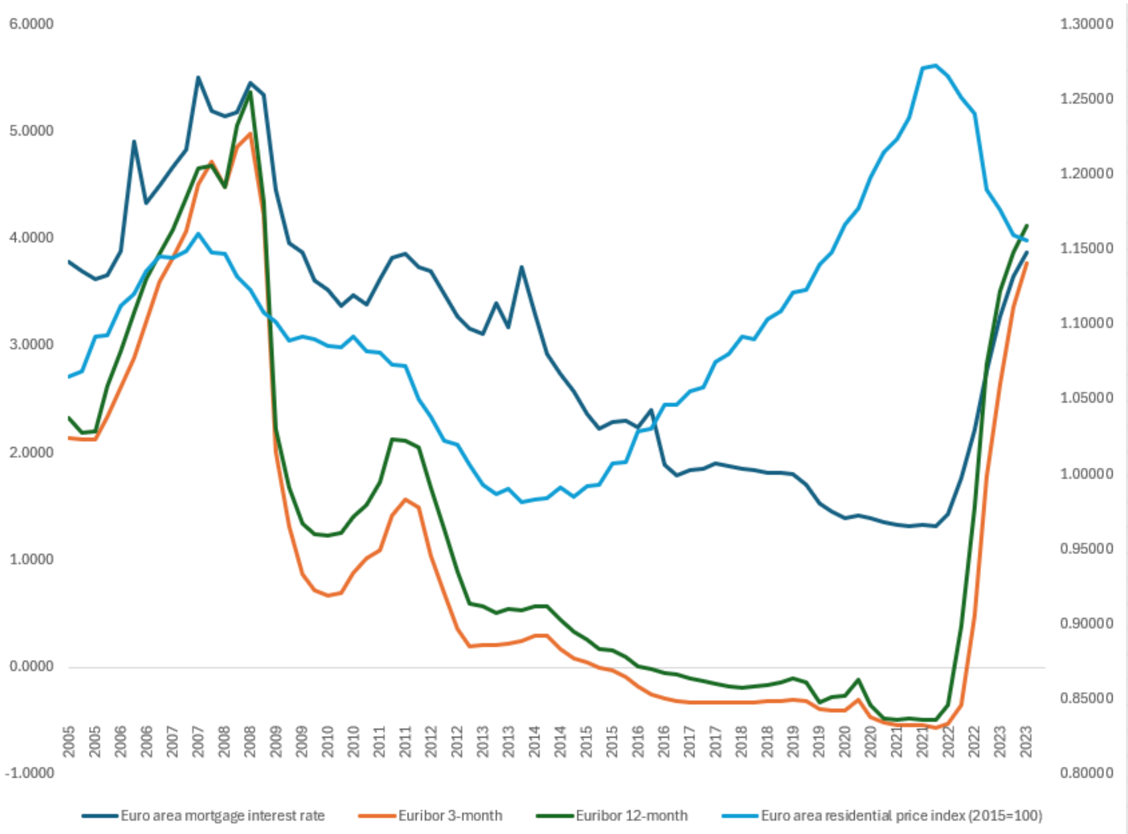


Figure 2. The left y-axis depicts the Euro area mortgage rate, 3-month Euribor, and 12-month Euribor. The right y-axis depicts the Euro area residential property price index. (ECB database)

The effect of the interest rate channel on the housing market and housing prices is intuitively relatively easy to understand. The effect of tightening monetary policy, where the ECB raises the interest rate, would directly impact mortgage rates, thereby affecting the Euro area housing demand and prices.

We can observe this negative correlation between interest rates from Graph 2, where the 3-month Euribor, 12-month Euribor, Euro area mortgage rates, and Euro area residential property price index (2015=100) are plotted. In the graph, the left y-axis values are interest rates for Euribor and mortgage interest rate variables, and the correct y-axis values are the Euro area residential property price index. From the graph, pre-GFC, all the variables seem positively correlated. This could indicate the positive market sentiment, where asset prices such as housing prices kept rising despite the rising interest rates. The graph also illustrates that Euro area residential housing prices have risen rapidly since 2015, while simultaneously Euribor rates were at the ZLB. This could be seen as the ECB's unconventional monetary policy affecting the Euro area housing markets. The interest rate hikes of 2022 are also negatively correlated with the Euro area residential housing price index, which aligns with the credit channel's basic assumption.

As the credit channel emphasises the budget constraints of households, analysing how the household borrowing ability and the housing collateral are influenced by a change in the interest rate could explain the housing price fluctuations and housing market booms. Iacoviello (2005) finds higher interest rates lead to a decrease in house prices due to the increased cost of borrowing. This leads to tighter borrowing constraints as the value of properties falls and the property's collateral value decreases. Vice versa, if the housing demand rises, the housing prices rise, and the property's collateral value also increases. Although this can benefit homeowners with mortgages and further amplify the housing demand, this effect can negatively correlate with economic output and inflation.

2.2 Credit Channel

The Credit Channel of MTM can be seen as an extension of the classical IS-LM theory, where bank lending and balance sheet activities are also seen as part of MTM (Bernanke & Blinder 1988).

2.1.1 Bank lending channel

The bank lending channel focuses on banks' lending activity. Banks do not just issue liabilities such as bank deposits, which contribute to the monetary aggregates; they also hold assets in the form of bank loans. Bank loans can be seen as a unique asset class with few or no substitutes (Ireland, 2010). Many theories and models regarding the bank lending channel highlight that deposits are often the primary funding source for banks, especially for small banks. These loans are often the primary source of funding for investments with smaller firms.

Therefore, when central banks conduct open market operations that reduce the supply of bank reserves, this could lead to a subsequent decrease in bank deposits, ultimately leading to a decrease in bank lending activities. Likewise, firms that are heavily reliant on bank loans must curtail their investment expenditures (Ireland, 2010).

European mortgage markets are national and can differ from each other significantly. In the European mortgage markets, national lenders dominate the market space, even when the regulations have been harmonized and internationalized since the creation of the European Union. The EU is not seen as a single marketplace. Instead, it is a collection of primarily national markets (Aalbers, 2009). The fragmentation of the banking and mortgage markets within the Euro area, where the monetary policy is not conducted nationally, could lead to regional imbalances. An increase in mortgage lending can improve the bank's financial stability. However, mortgage lending becomes a negative factor for the bank's financial stability when mortgages are more than 49-63 % of the bank's total loans (Morgan & Zhang, 2017).

In the years leading up to the GFC, the mortgage lending ratio among its Euro area member nations was very different. For example, the Spanish household debt almost tripled from the late nineties to 2013, mainly due to increased mortgage debt (Sánchez-Martínez et al., 2016). The period leading up to the GFC has had relatively stable inflation and economic growth, which allowed the ECB to maintain a moderately accommodative monetary policy to support the member states' economies. While the housing market of some member states, including Spain, had higher housing demand and housing prices pre-crisis, the development was similar in the Euro area aggregate.

The bright economic outlook and relatively stable asset price growth can also be seen from the outstanding mortgage credit of the Euro area, which doubled from 2000 to 2007 (Philiponnet, 2018). After the GFC, European banks started to tighten their credit conditions and limit their long-term lending. The European banks started to deleverage, raise their capital levels, and focus on core deposits as the main funding source. (Feyen & del Mazo, 2013). As the credit conditions tightened, households also started to deleverage, i.e., fewer mortgages were taken with less leverage. The aftermath of the GFC highlights the effects of the credit channel, and how the housing market can transmit and amplify monetary policy shocks.

2.1.2 Balance sheet channel

The balance sheet channel is the second part of the credit channel in MTM. This channel focuses on the broader effect of the banking and lending sectors. Bernanke & Gertler (1995) highlight the significant role of financial market imperfections. Given these imperfections, the researchers point out that lending costs for a firm rise when its balance sheet weakens. This phenomenon occurs directly when an interest rate hike leads to increased payments for paying a floating-rate debt. The researchers also found that the same interest rate hike diminishes the capitalized value of a firm's long-term assets. Thus, a policy-driven rise in short-term interest rates immediately suppresses spending via the traditional interest rate channel but also elevates the cost of capital for firms through the balance sheet channel.

Although the findings of Iacoviello (2005) are closely related to MEW schemes, Calza et al. (2013) find evidence that these schemes are correlated with how advanced the housing markets are. The researchers highlight that the structure of the mortgage markets matters when housing markets are facing a monetary policy shock. They divide industrialized countries into two groups according to the degree of development of mortgage markets, where the first group is seen to have more developed mortgage markets. Countries belonging to the first (second) group are characterized by low (high) down payments, and Mortgage Equity Withdrawal (MEW) schemes are common (uncommon).

Another classification is to classify the countries according to their most used mortgage interest rate to fixed and variable rate countries. The researchers found that countries within the first group and countries with variable mortgage rates were more sensitive to monetary shocks, where the shock significantly impacted residential investment. These findings align with the effects described in the balance sheet theorem. This is to be expected, as household equity in housing is lower, and the possibility of withdrawing housing equity can adversely affect household balance sheets. These effects are amplified, as the MEW is generally used directly for consumption and home improvement, mainly when the released housing equity is used for consumption (Mian & Sufi, 2011).

2.4 Exchange rate channel

The exchange rate channel displays a scenario where the domestic nominal interest rate surpasses its foreign counterparts. This leads to an equilibrium in the foreign exchange markets, where the domestic currency should gradually depreciate. This depreciation aims to equalize the risk-adjusted returns on different debt instruments, including those denominated in each of the two currencies. This phenomenon is known as the uncovered interest parity. Both traditional Keynesian models, such as Fleming (1962) and the New Keynesian models, Keynesian models acknowledge that this anticipated future depreciation initially prompts an appreciation of the domestic currency. When prices start to adjust slowly, the domestic goods become pricier than foreign-produced goods. This leads to declining net exports, and the new trade balance reduces domestic output and employment levels.

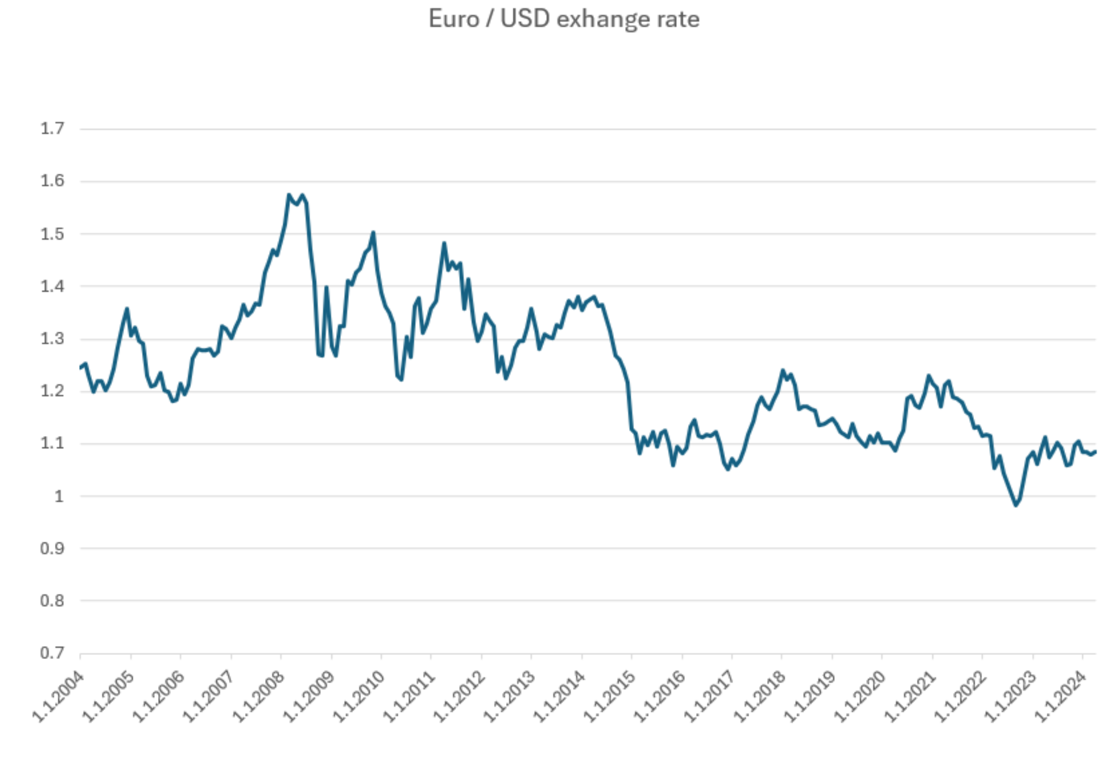


Figure 3. Euro / USD foreign exchange rate. (Yahoo Finance)

When the ECB adjusts its monetary policy, it influences Euro area interest rates. However, it also affects the attractiveness of the Euro and the Euro area as a destination for international capital. Changes in the ECB's monetary policy could impact the Euro's exchange rate. For instance, a decision to lower interest rates can make investments in the Euro area less attractive relative to other regions, leading to capital outflows and a depreciation of the Euro. Conversely, an increase in interest rates can attract foreign capital, appreciating the Euro.

These movements in the exchange rate have direct implications for investor behaviour and capital flows into and out of the Euro area. Brzozowski (2006) found that several Central and Eastern European countries received historically high foreign direct investments (FDI) due to the single currency Euro. The author argues that adopting the euro eliminated foreign currency risks previously associated with these new Euro area countries, and the FDIs enlarged the EMU market size. The economic benefits of the FDIs can raise the host country's domestic economic output, thus raising the host country's demand for goods and services, such as housing.

2.5 Asset price channel

The asset price channel is the fourth and last channel of MTM. This channel can be viewed from two angles, highlighting different wealth and consumption mechanisms. First, it can be viewed from the perspective of Tobin's (1969) q-theory of investment, and second, it can be viewed from the life-cycle theory.

Tobin's q illustrates the relationship between a firm's stock market value and its physical capital replacement cost. When short-term nominal interest rates increase due to monetary policy changes, on aggregate investors' appetite for debt instruments increases over equities, and the tightening of monetary policy leads to lower pricing of equity securities. With the lower value of Tobin's q, firms must issue more shares of stock to fund new investment projects, making investments more expensive. As a result, projects with marginal profitability before the monetary tightening can become unprofitable after the monetary tightening, thus leading to a decline in economic output and higher unemployment. Similarly, fluctuations in the housing prices will directly affect investments in the housing sector, this shifts the Tobin's q for residential property investments, where the Tobin's q is defined as the market value of the residential housing asset divided by the said assets construction costs.

$$\text{Tobin's Q-ratio} = \frac{Market\ value\ of\ firm's\ assets}{Replacement\ cost\ of\ firm'sassets}\ \text{(Tobin, 1969)}$$

Another take on the effects of asset prices on MTM comes from Ando & Modigliani (1963). The paper focuses on the life-cycle theory of consumption. It highlights the role of wealth and income in determining the level of consumer spending. The theory suggests that The Life Cycle Hypothesis (LCH) of savings suggests that individuals plan their consumption and saving behaviour over their lifetime. The individuals aim to smoothen their consumption across different eras of their lives, anticipating different income levels. According to the LCH theorem, people save during their working years to fund retirement when they expect their income to decrease. Thus, the theory identifies another channel of monetary transmission: household financial wealth decreases if any asset class depreciates following a monetary tightening. This leads to reduced consumption, output, and employment.

Although the LCH hypothesis of Ando & Modigliani (1963) has reasonable arguments, the impacts of LCH on housing markets have faced some criticism. The theory implies that all asset classes have a similar wealth effect. As housing wealth is spread out more evenly among the population than stock market wealth (Belsky & Prakken, 2004), thus the wealth effect of the housing market should be greater than the wealth effect from the stock market. Coskun et al. (2018) Found that housing wealth strongly affected consumption, but the stock market wealth and consumption are negatively correlated. Although this is the case, real estate and properties received as inheritance where the price of these assets has increased can be viewed as an increase in the cost of living, not as an increase in disposable income. Higher real estate prices could lead to higher consumer inflation and prompt potential buyers to save more, potentially reducing consumption (Mishkin, 2007).

The effectiveness of the stock market in creating long-term consumption appears to be limited, and in certain instances, it could even negatively correlate with consumption. This could suggest that prioritizing the stock market as a mechanism for stimulating consumption in developed nations might not be the best policy practice. Coskun et al. (2018) Also note that the housing wealth effect seems evident in their whole cross-country panel data, suggesting that housing wealth and housing significantly impact monetary policy shocks irrespective of the size or geographical location of the analysed countries.

3 PREVIOUS STUDIES

In this section, I will show how central banks' conventional and unconventional monetary policies have impacted the housing market in the Euro area. I will start by analysing what kind of MP the Euro area implemented before the GFC and how these policies have affected the housing market in the Euro area. After showing how the housing market developed before the financial crisis, I will showcase how the effects of the crisis have affected monetary policy and its impact on the housing markets.

The focus will be on the development of the Euro area, but I will also include developments in U.S for comparison. When analysing the monetary transmission mechanism (MTM), we see that housing markets play a crucial role in these processes. As asset prices fluctuated greatly in the early 2000s, the housing market's role in MTM was amplified.

Firstly, housing wealth has played a crucial component of household wealth in Western society, especially in the Euro area, where housing has been more than half of households' net worth since 1999 (ECB, 2020). Secondly, compared to financial assets, which tend to be owned mainly by the better-off part of society, home ownership is more equally distributed among the population. Thirdly, housing plays a significant role in the banking and lending sectors, as housing can be used as collateral for household liabilities. The collateralisation of housing assets can be seen as potentially amplifying the real effects of monetary policy shocks.

3.1 Factors leading to the financial crisis

Generally, when studying the effects of MP on any asset class, the critical component is the effects and changes in the central bank's key interest rate. The markets, including the housing markets, are seen to be forward-looking, i.e., the investors' perceptions, expectations, and projections about the market's future performance influence the asset prices. As said, the housing market is deeply connected to the banking and lending sector, and monetary policy shocks can drastically affect the housing market.

Mishkin (2007) defines changes in interest rates impacting the housing market and overall economy through six different channels, where the channels are: (1) direct impacts of the interest rate on the cost of capital, (2) expectations of the future housing prices, (3) housing supply, (4) the wealth effect of housing prices, (5) effects on consumer spending, and (6) effect on housing demand. Generally, when the short-term interest rate is raised, the long-term interest rate also rises, making the cost of capital more expensive and thus leading to lower housing and aggregate demand. Mishkin (2007) found that the housing sector is only moderately sensitive to monetary policy changes. However, the residential property is three times more responsive to changes in interest rates than the whole housing sector.

Mishkin (2007) also notes that when comparing housing wealth to stock market wealth, housing wealth is seen as a more stable source of wealth and has a more significant effect on consumer spending. Although housing wealth can be seen as a stable source of wealth, the high sensitivity to interest rate changes can make the whole sector subject to higher price volatility.

Giuliodori (2005) found that housing markets with more developed mortgage and banking systems seem more efficient in transmitting monetary policy shocks than less developed housing markets, and changes in the interest rates have a more significant effect on the housing market. The study also found that more competitive mortgage markets seem to play an essential role in transmitting interest rate shock to household consumer spending. This aspect of the study suggests that housing prices could be used to assess the effectiveness of interest rate changes on real economic activity.

When comparing the housing markets of Spain and Ireland to the rest of the Euro area, these countries also faced relatively more significant housing market crashes after the GFC. Neal and García-Iglesias (2013) Find that the GFC and European sovereign bond crisis can be attributed to spending bubbles financed by cheap credit and loose monetary policy. While the financial crisis certainly impacted the housing market crashes in these countries, it can be argued that the domestic monetary policy and credit conditions also had a significant impact. Deepening financial integration into the Euro area granted Irish banks unprecedented access to European banks, which led to an influx of capital to Ireland. Initially, housing demand outpaced supply. Even with the heightened demand, the Irish government cut property taxes and was increasingly depended on transaction taxes from the property sector. (Williams & Nedovic-Budic, 2016) During this era, the banks operating in Ireland also had little to no governance or risk management. The poor credit controls led to over-lending in the real estate sector and for individuals (Klaus & Watson, 2010). The poor public finances combined with the unregulated banking sector can be seen as the main reasons for the Irish housing market boom and bust cycle in the 2010s.

Domestic conditions in the Spanish and Irish housing markets contributed to the rapid home price increases. While loose monetary policy played a significant role in this appreciation of the Spanish and Iris housing prices, the appreciation would have occurred even without the stimulating monetary policies (Nocera & Roma, 2018). The aggregate residential property prices of Ireland, Spain, and the Euro area are plotted in Figure 4. From this figure, we can see the boom-and-bust cycle of Spanish and Irish residential home prices, and the relative stability of the Euro area aggregate housing prices during and after the GFC can also be noted.

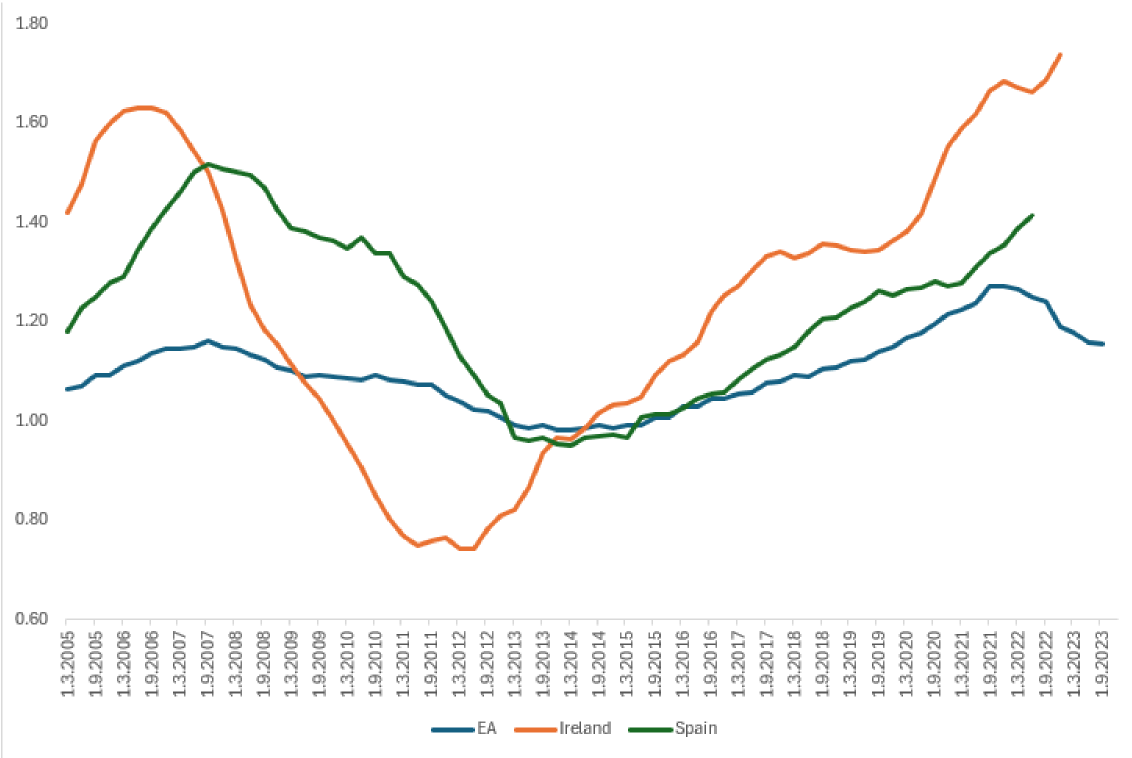


Figure 4. Residential property price indices of the Euro area, Ireland, and Spain. (2015=100). (ECB Database)

One of the critical components of the overheated housing markets and the subsequent housing market crash of 2008 in both the U.S and the Euro area was the accessibility to cheap credit. Many have argued that the GFC was primarily due to the low-interest rate policy implemented by the Federal Reserve (FED) to combat the effects of the dot-com bubble of the early 2000s. For example, Himmelberg et al. (2005) argue that the rapid price increases in the U.S. housing market were primarily caused by fundamental economic factors such as low interest rates.

While cheap credit is attributed to the financial crisis, Martin et al. (2022) found that raising the key interest rates only had a limited effect on the possible housing market overvaluations and housing market crashes. While the key interest rates are not seen as having the most influence on housing prices, the researchers highlight that housing market bubbles are mainly driven by market sentiment, where optimistic expectations significantly influence housing demand. While there is no academic consensus on what has the most significant effect on housing prices, interest rates, or speculative market sentiment, the latter is also supported by many others.

Glaeser et al. (2013) found that changes in the interest rate could only account for just over 25 % of the U.S. housing market boom-and-bust cycle during the GFC. Instead of attributing the booming housing market cycle solely to interest rates, low interest rates can catalyse the boom-cycle. Glaeser, (2013) and

Shiller, (2015) have illustrated that the typical boom-and-bust cycle goes as follows. The decreased interest rates serve as a fundamental justification for higher housing prices. However, the initial higher housing prices tend to transform housing assets into speculative assets as investor sentiment in the housing markets gains optimism. This ultimately results in a housing market boom and the inevitable market crash later.

3.2 Policy measures implemented post-GFC

To mitigate housing bubbles, the need for "leaning against the wind" interest rates as a policy tool has been suggested by Lambertini et al. (2013) and Martin et al. (2022). This policy tool implies that the interest rates should adjust to account for mispricing and fluctuations in the housing market. Lambertini et al. (2013) argue that adjusting the interest rate is not enough to stabilize, i.e., lower the housing market's volatility, and thus macroprudential indicators should also be used.

The authors suggest using countercyclical loan-to-value (LTV) rules and measurements that respond to economic growth, credit growth, and housing prices. As inflation, credit demand, and housing prices increase (decrease), the LTV ratio should be actively raised (lowered) to respond to the new state of the variables. The authors see that macroprudential policies, such as actively regulating the LTV ratio and adjusting the interest rates, could mitigate the cyclical fluctuations of the housing market. A case study of the Hong Kong housing market Funke & Paetz (2012) find similar results. The study finds that LTV policies that target reducing housing price growth can lower the housing market volatility, and the policies help to mitigate the effects of cyclical housing prices on the real economy.

Most macroprudential policy models regarding housing assume a homogeneous housing sector, i.e. all the borrowers are similar, and there are no different segments, such as renters, owners, and investors with differing motives. Baptista et al. (2016) Suggest an agent-based model (ABM). As policymakers usually worry about a subset of agents in the housing markets, the agent-based model accounts for these subclasses. Policies based on such models can be more targeted to the desired subsection of the market. Their model has only three agents: households, banks (mortgage lenders), and the central bank. The researchers found that the model has greater explanatory power on household behaviour. They find that an increase in homeowners who purchase property solely to rent the property correlates with housing price cycles and volatility. The use of counter-cyclical macroprudential policy measures in controlling the development of housing markets pre-GFC can be seen as more of an exception than a consistent policy tool.

The crisis highlighted the need for macroprudential policies, and monitoring the different agencies in the housing sector became more vital. The falling values of asset prices weakened banks' balance sheets and forced them to deleverage. After the crisis, many European countries faced rising unemployment while housing prices fell simultaneously. In the aftermath of the crisis, EU authorities began to devote significant efforts to reshape and strengthen their macroprudential policy bodies at national and supranational levels. The European Systematic Risk Board (ESRB) focuses on the financial stability of financial systems, where the objective is to increase European banks' resilience to shocks and reduce systematic risks. Many of the macroprudential instruments are embedded in the EU legislation, for example, the Basel III standards on bank capital levels have been incorporated into the EU legislation. (Kok et al., 2014)

3.3 Unconventional monetary policies Implemented post-GFC

During the aftermath of the GFC, nominal interest rates of the ECB and FED were already close to zero. The crisis in the Euro area escalated to even worse financial conditions as the Euro area faced another crisis, the banking and sovereign crisis in 2010. After GFC, the key interest rates neared zero lower bound (ZLB) at the end of 2008. As people can always hold cash it is seen that nominal interest rates cannot drastically go below zero.

3.4 Quantitative Easing (QE) programs

Traditional monetary policy tools did not seem to solve the economic problems initiated by the crisis, and central banks were left in unchartered territory and started to adopt new unconventional monetary policy tools. These new policy tools included Quantitative easing (QE) programs. QE programs increase the monetary base through unconventional actions central banks take, including asset purchases and lending programmes.

As discussed, the Euro area economy relies more on classical bank financing, whereas the US and UK economies are market-based. Darmouni and Siani, (2021) Discusses the distinction in debt composition between the US and Europe, highlighting a "bank bias" in Europe compared to the U.S.'s reliance on market financing and bonds. According to the authors, in 2009, bonds represented 13 % of the European firms' total debt, and the exact figure for U.S-based firms was 35 %. The differences in market structures can be seen, for example, from the initial QE programs rolled out after the crisis. The QE programs enrolled by the ECB increased liquidity for the banking sector by lending highly favourable terms. In contrast, the FED and Bank of England injected reserves into their economies by purchasing bonds (Fawley & Neely, 2013).

The large-scale asset purchases (LSAP) of the FED after the crisis targeted assets with medium-term (maturity between 2 to 10 years) and long-term (maturity between 10 to 30 years). The FED's first round of LSAP was in November of 2008, right after the bankruptcy of Lehman Brothers in September of 2008. The LSAP programs targeted the mortgage markets, where the FED purchased up to $600 billion worth of housing agency debts and mortgage-backed securities. In March 2009, FED began to purchase agency-related securities and long-term government bonds, totalling the QE program's $1.75 trillion (Schwartz, 2016). Agency-related securities refer to financial securities issued or guaranteed by federal agencies or government-sponsored enterprises (GSEs) in the United States. The LSAP programs aimed to reduce the supply of bonds with long-term durations, thus reducing the term premium of these bonds. Gagnon et al., (2011) found that the FED's initial QE programs lowered the US long-term real interest rates and term premiums associated with instruments purchased with the LPA programs.

The bankruptcy of Lehman Brothers in 2008 illustrates how the problems in the housing sector can have contagious effects on the whole economy; it also highlighted the rising counterparty risk during the crisis. The uncertainty and higher counterparty risk were especially damaging for the Euro area's financial sector, where the economy is more bank-centric. One of the most common measures of risk in the Euro area interbank markets is the spread between the unsecured deposit rate (EURIBOR) and the overnight-indexed swaps (OIS) (ECB, 2008). OIS are interest rate swaps that involve overnight interest rates being swapped for a fixed rate.

In the Euro area case, the EURIBOR is the fixed rate, and the OIS is the rate banks expect to pay to borrow funds overnight. OIS is also a proxy for the risk-free rate, the ECB's policy rate. The 3-month Euribor overnight indexed swap spread widened to a historical high in October 2008, when the spread was over 198 basis points. ECB responded to this widening spread by announcing its first QE program, where it would lend as much as banks needed and wanted at a fixed rate while expanding its acceptable collateral list (Fawley & Neely, 2013). In financially stable and regular times, the EURIBOR/OIS spread tends to be relatively narrow, as the difference between the cost of short-term borrowing and overnight borrowing is small. The wide EURIBOR / OIS spread indicated high uncertainty in the banking sector, where European banks saw each other as having significant counterparty risk. The increased uncertainty in the banking sector can be seen from the enormous spread between the EURIBOR and the OIS rate.

Following the GFC, Euro area countries had built a lot of debt in their balance sheets, and the expansion of the sovereign debt was funded mainly by the domestic banking sector. The government debt held by the domestic financial sector increased to 13 % of GDP from 2007 to 2012. The more extensive the holding of local sovereign debt among domestic banks, the greater the country's sovereign risk is (Becker & Ivashina, 2018).

The domestic concentration of sovereign debt combined with the fact that in late 2009 many Euro area countries faced more significant than expected increases in government deficit led to concerns that certain Euro area countries could face insolvency, where the countries could not pay their interest payments nor the capital of their sovereign bonds. Before the financial crisis, Euro area sovereign bond yields were extremely similar, and the bond spread between member nations of the Euro area was almost absent. The Euro area bond spread started to rise after the crisis, and the rising estimates of possible banking sector losses due to bad loans in several Euro area countries also had a negative impact on the sovereign bond values, as international investors started to domicile and reinvest their capital in domestic markets. (Mody & Sandri, 2012)

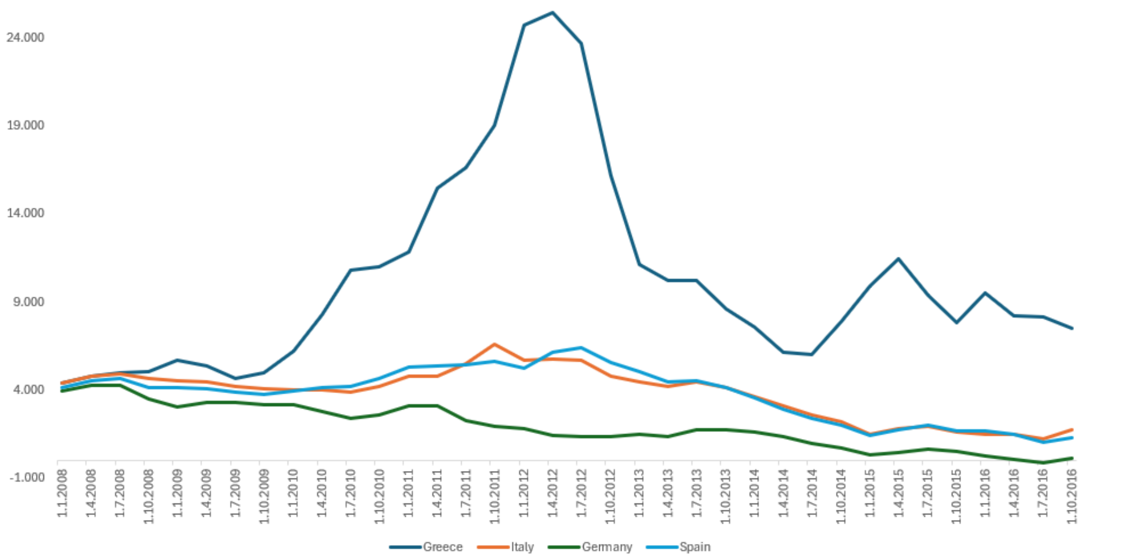


Figure 5. 10-year government bond yields for Greece, Italy, Germany, and Spain. (Federal Bank of St. Louis)

Despite the generous lending practices of the ECB, the counterparty risk stayed persistent and plagued the European interbank lending markets. At the beginning of 2009, the interbank lending activity virtually dried up completely due to a lack of confidence in their respective counterparts (Beirne et al., 2011). Under normal conditions, the ECB's conventional policy instruments include the Main Refinancing operations (MROs) and long-term Refinancing Operations (LTROs). MROs mature in two weeks, and LROs mature in three months. To counter the eroding trust among Euro area banks, the ECB lowered its main refinancing rate to 1 percent and introduced 12-month Long-term Refinancing Operations (LTROs). While these actions seemed to help the interbank lending conditions, in 2010, the European sovereign debt crisis devastated the European financial markets. The sovereign debt crisis prompted the ECB to take drastic actions, and it began the Securities Markets Programme (SMP), in which the ECB purchased government debt instruments directly from the secondary markets.

The SMP purchases seemed to hold down Euro area yield spreads, mainly affecting the Spanish and Italian yields (Fawley & Neely, 2013).

While the GFC and Euro area sovereign debt crisis can be seen as two different crises, they are interconnected. The recession following the GFC reduced tax revenues and raised government spending. As banks held substantial quantities of domestic sovereign bonds, countries, and their domestic financial institutions became more riskier and at greater risk of default. Combined with the fact that governments insure bank deposits, it would further increase the country's insolvency risk (Fawley & Neely, 2013).

3.5 Zero Lower Bound (ZLB)

As the crisis deepened and conventional monetary policy was limited due to ZLB, the signalling channel became a critical form of monetary policy. ZLB refers to the situation where the short-term nominal interest rate is near or close to zero. Forward guidance at ZLB was first adopted by the Bank of Japan in the late 1990s, as Japan was already facing ZLB before the financial crisis. The main objective of forward guidance during ZLB has been clarifying or signalling the central banks' intended policy rates.

As the global economy was at its weakest after the GFC, clear communication about the future of policy rates can reduce uncertainty in the market, thereby lowering the volatility of interest rates and lowering the risk premia of bonds (Filardo & Hofmann, 2014). Contrastingly, asset purchase programs (QE programs) are widely seen to impact the term premium of bonds mainly via the balance sheet channel. Cahill et al. (2013) see that the pre-announcement of FED's QE programs had an explanatory power equal to that of asset purchases. Once the policy interest rate of the central bank has reached ZLB, forward guidance can help the economy avoid a deepening recession by committing to a stimulating policy rate longer than expected, as it lowers the expected future interest rates Eggertsson & Woodford (2003).

While extending the low interest rates to the point when interest rate hikes should be implemented, it has drawbacks. This approach requires the central bank to have a pre-commitment to low interest rates in the future while simultaneously, the economy could be recovering and starting to normalize. This highlights the possible trade-offs between the strength of commitment and future adjustability of the interest rates. The stronger the markets see the central bank's commitment to low interest rates, the higher the impacts the reversal of the interest rate policy would have on financial markets. The prolonged commitment to low interest rates could lower future interest rate flexibility (Filardo & Hofmann, 2014).

The traditional consensus among economists about ZLB has been that the policy rates cannot go below zero, as holding cash would yield-wise always be a superior alternative. This theory has been proven wrong in the recent decade, as many central banks have implemented negative policy rates. In June 2014, the ECB decided to lower its deposit facility rate to -10 basis points, and a further rate cut of – 10 basis points followed three months later. Simultaneously, the interbank lending rate of EONIA and EONIA-linked OIS rates also fell below zero. (Lemke & Vladu, 2016)

3.6 The Shadow Interest Rate

As lowering the key interest rate is to provide a stimulus for the economy and raising it reflects efforts to control inflation and to slow down economic activity, understanding and measuring the effects of unconventional monetary policy and negative interest rates are vital. Shadow rates are used to understand these factors better. The first attempt to analyse the effects of UMP and the relations between yields is the shadow rate term structure proposed by (Black, 1995). The author argues that the nominal short-term interest rate cannot be zero, as people can always hold cash. Thus, the nominal short-term interest rate becomes an option. When the short rate becomes negative, investors can hold currency instead of investing in assets with negative returns. This implies that the short rate can effectively be treated as an option; if the short-term rate is negative, it will be replaced with zero (the return of holding cash). Thus, the shadow rate is defined as the short-term interest rate without the option to hold cash when it is negative.

While the idea of short shadow rate (SSR) has been discussed by Black (1995), implementing the said discovery has been challenging. Evaluating the effect of UMP can be challenging for several reasons. Firstly, the shadow rate can be calculated from different metrics, and the estimated shadow rate can differ depending on the model used (Christensen & Rudebusch, 2015). One of the most cited studies regarding the use of shadow rate is the study by Wu & Xia (2016). The authors base their study on the federal funds rate, as most of the literature regarding the shadow rate is based on the U.S. economy and the monetary policy stance of the FED.

As the key short-term interest rates of central banks were bound by the ZLB or even negative interest rates, the short-term interest rates have a lower ability to reflect economic development. The model imposed by Wu & Xia (2016) also assumes that the short-term interest rate is the maximum of the shadow rate and lower bound. The authors note that, in case the short-term interest rate is at ZLB, the shadow rate gives more information about the state of the economy than the short-term rate itself. They found that at ZLB -15 basis point shock to the policy rate decreases unemployment by 0.1 %; according to the authors, similar effects were reached by the FED by extending the ZLB period by one year with forward guidance. Lemke and Vladu (2016) argue that the perception of ZLB being bound by zero has changed. While the recovery from the GFC and sovereign bond crisis was slow and GDP growth was stagnant, the 3-month EURIBOR rate was simultaneously at ZLB or negative. This led to market perception of ZLB being one basis point from 1999 to August 2014 and an estimated -11 basis points from September 2014 onwards. This change reflects how the markets perceive monetary policy. The negative ZLB can be seen as market anticipation of long-lasting low interest rates in the Euro area.

Similar to the methods of Wu & Xia (2016), where the SSR is calculated based on methods using the term structure of the yield curve, where the analysis was done for the U.S economy, Damjanović & Masten (2016) have done a similar analysis for the Euro area economy. The shortest interest rate in the Euro area is the marginal lending rate, at which the Euro area banks can borrow overnight from their respective central banks.

Damjanović & Masten (2016) Use the Euro Overnight Index Average Swap (EONIA) to calculate the Euro area's SSR and use the country-specific SSR on government bond yields. In principle, the EONIA swaps could indicate how market participants see the marginal lending rate developing in the near future. The authors analysed the Euro area on aggregate, as well as Spain and Italy, as these two countries were severely affected by the GFC and the sovereign bond crisis. From their analysis, the authors found that the SSRs of Italy and Spain started to deviate from the Euro area aggregate SSR during the sovereign bond crisis but started to converge to aggregate levels after the ECB took direct actions to revive the sovereign bond markets.

Although the ECB’s unconventional monetary policies translated into easing financing conditions for Euro area aggregate, Spain, and Italy, the UMP measures ECB took to combat the sovereign debt crisis only had limited stimulating effects on the Euro area financial markets. This indicates that the stimulus provided during the sovereign debt crisis only mitigated the country-specific credit and liquidity risks.

While the literature has prevalently used shadow rates to calculate and evaluate the effects of UMP, the effects can also be measured by analysing the balance sheet expansions of central banks. As discussed previously, the ZLB can limit the information that could be gathered from the short-term interest rate. Thus, the balance sheets of central banks became the central bank's main policy instrument. Including the shadow rate can be problematic when differentiating the effects of MP and UMP. Rosenberg (2020) Argues that including the shadow rate as the basis for evaluating UMP does not allow these two policy measures to be distinguished separately. Following the rationality of Rosenberg (2020), I will also measure the ECB’s unconventional monetary policy stance from the perspective of the ECB’s total balance sheet, and shadow rates will not be used as part of my methodology.

3.7 Differences between U.S. and Euro area housing markets

As the burst of the financial crisis originated in the U.S. housing sector, where the problems were transmitted to the financial sector, it is beneficial to distinguish the structural differences between the U.S. and Euro area housing sectors. This section also helps to highlight structural differences between the U.S. and Euro area housing markets, as a vast amount of the literature focuses specifically on the U.S. housing markets.

Firstly, the US housing markets are more market-oriented than their Euro area counterparts. The US housing market is more securitized, and thus, greater liquidity is provided. Meanwhile, the Euro area housing market relies more on traditional bank financing. Leading up to the GFC, only a small percentage of European mortgages were securitized. However, roughly two-thirds of the mortgages in the US mortgage market were securitized and traded in the secondary markets (Aalbers, 2009). As discussed, the housing sector can be vulnerable to monetary policy shocks and market mania. While one could assume that the more significant market size of the US markets would indicate a greater correlation with monetary shocks (interest rate changes), this might not be the case.

The transmission of monetary shocks to housing markets is more significant in the Euro area than in the U.S. Positive monetary shock (downward adjustments to the interest rate) is a significant source of economic fluctuation in the Euro area. Interest rate inclines lead to a 0.49 % increase in mortgages in the Euro area, whereas the figure for the UK is 0.21 % and 0.13 % for the US. Given the Euro area's banking-centred mortgage system versus the more securitized model of the US, it is not surprising that the credit supply and bank lending channels of MTM are more prevalent in the Euro area (Iacoviello & Minetti, 2008). This chapter aims to characterize the key differences between these two markets. This is to illustrate that a lot of the literature on the financial crisis and the housing market crashes is written from the perspective of the U.S. housing market. The following is a collection of stylized facts that I found to be the most significant differences in these two markets.

Nocera and Roma (2017) Compare how housing demand changes in selected Euro area countries when facing monetary policy shocks. The researchers found that aggregate housing demand shocks in the Euro area had muted effects on private consumption, but Spain and Ireland differed from the rest of the Euro area. The authors point to the fact that the housing markets of these countries can be seen as more developed, and they have the largest homeownership rates across the Euro area.

One of the most notable differences between these two markets is that mortgage equity withdrawal (MEW) schemes, also known as equity release schemes, are more prevalent in the US than in the Euro area. MEWs allow homeowners to access their housing equity without selling the property. Thus, an increase in housing prices can directly be liquidated for cash. Mian and Sufi (2009) find that in the US, most of the money extracted via MEWs is not spent to purchase additional real estate. They find that the equity extracted from mortgages is mainly used for private consumption. Similar findings have been made by Catte et al. (2004), they found that MEWs have significant implications for private consumption, and the housing equity liquidation is highly correlated with consumption. This correlation is highest for countries such as Canada, Australia, and the United States, where MEWs are available and used.

Nocera and Roma (2018) find that higher house prices improve credit availability in the US, UK, and Euro area. However, the effects of higher housing prices on real consumption are more muted in the Euro area than in the US or UK. While these schemes are rarer in the Euro area, they are gaining attraction and have been used, for example, in the Irish housing market. Lydon and O'Hanlon (2012) Find a robust positive correlation between local residential construction and equity withdrawals, as a significant percentage of the equity withdrawals were reinvested in the housing market. At the peak of the real estate boom, these equity withdrawals were seen as a contributing factor in pushing the average Irish mortgage to over € 113.000 in 2007. After the financial crisis, the figure had fallen to €60.000 in 2010 (Lydon & O'Hanlon, 2012). Meanwhile, the MEWs taken by Irish households were mainly used for house renovations and new properties.

While some European countries have MEW schemes, the linkage between house appreciation and private consumption is more complex than in the U.S. This relationship can be seen in Figures 6 and 7, where the private consumption and home prices are plotted for the U.S and Euro area. From Figure 6, we can see the findings of Mian and Sufi (2009), where private consumption and housing prices have a clear positive correlation. The same effect on the Euro area is unclear, and correlations between these variables are more complex to establish.

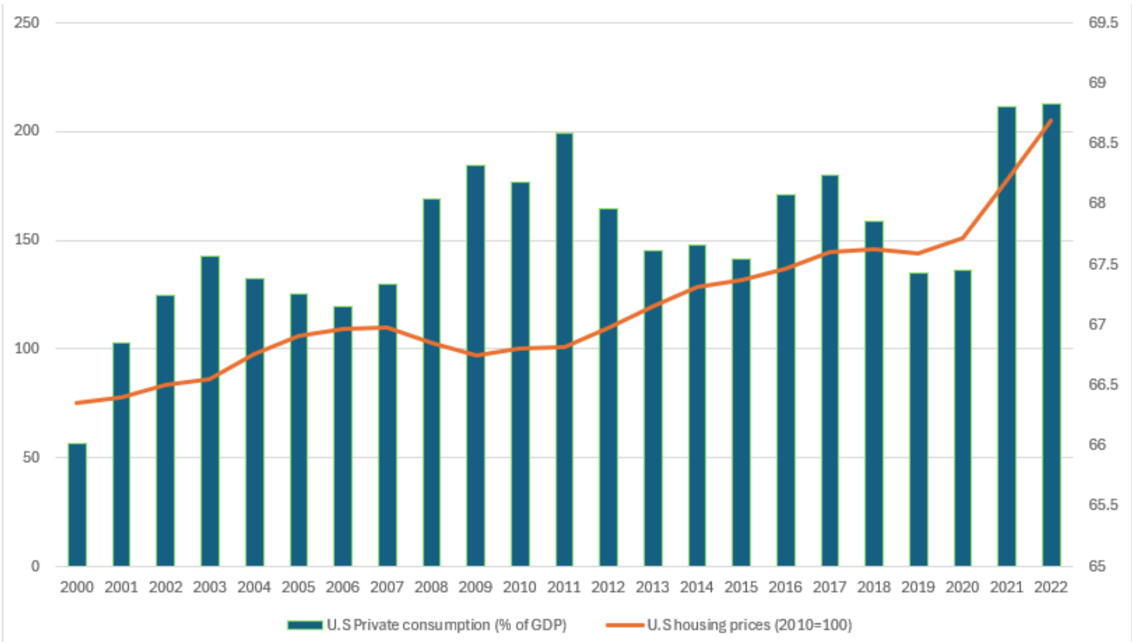


Figure 6. The right y-axis depicts the Median Sales Price of Houses Sold in the United States, and the left y-axis depicts the U.S. households and NPISHs' final consumption expenditure (% of GDP) (World Bank database & Federal Bank of St. Louis)

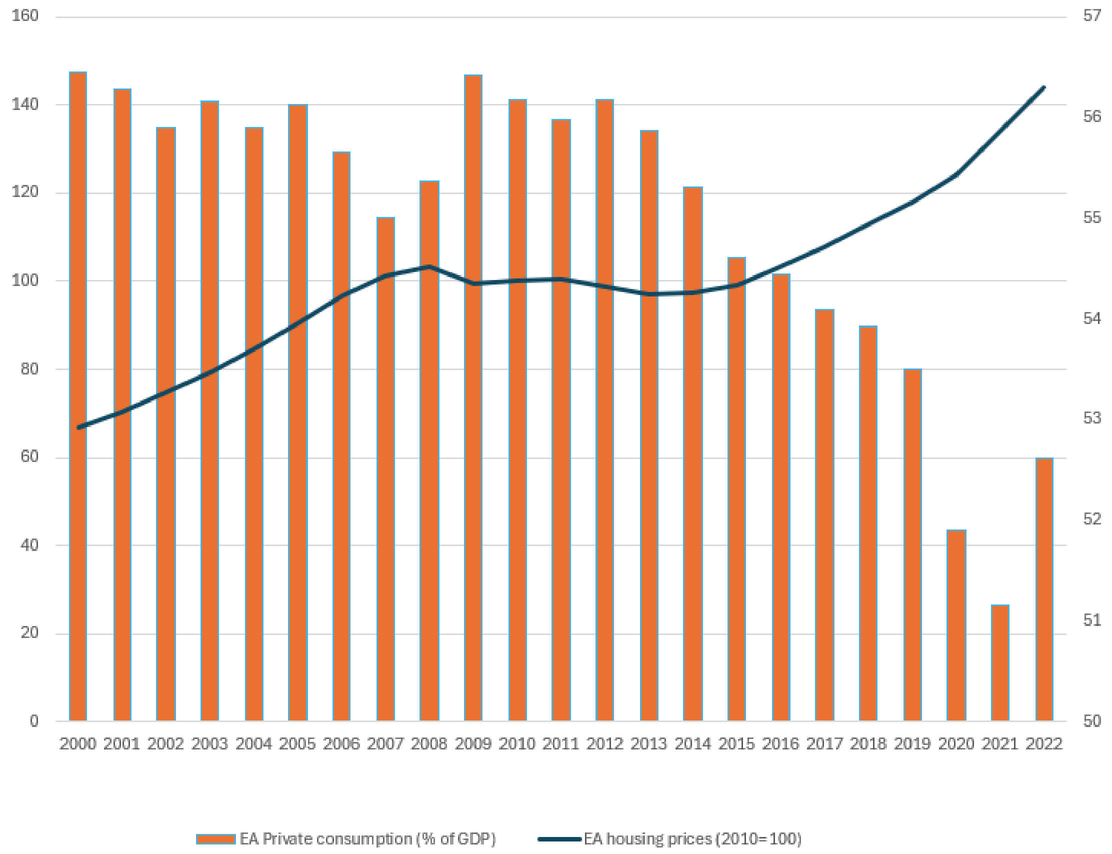


Figure 7. The right y-axis depicts the Residential Property Prices for the Euro area, and the left y-axis depicts the Euro area Households and NPISHs' final consumption expenditure (% of GDP) (World Bank & Federal Bank of St. Louis)

Based on the evidence of the US housing market, Pavlidis et al. (2009) and Buiter (2010) argue that the increasing housing prices only tend to increase private consumption, if the housing market is heading or amid a housing bubble. During the GFC, many asset prices, including the housing market, faced a severe downfall. Mian and Sufi (2009) find that the increased borrowing against MEWs by homeowners with multiple properties was responsible for most of the increase in household mortgage leverage in the buildup period to the financial crisis from 2002 to 2006. The increased consumption based on increased house prices could be seen as an unsustainable source of wealth, increasing inflation, and increasing systematic risks in the economy, as bank and household balance sheets could be under significant pressure during a housing market bust.

When comparing how mortgages are financed, the U.S. mortgages are mainly financed with fixed rates. In contrast, in the Euro area, mortgage rates are mainly variable or a mix of fixed and variable rates. For example, Calza et al. (2013) calculated the different mortgage rate adjustments for selected Euro-area countries and for the U.S. From these calculations, we can see that when compared to the selected group of countries, U.S mortgages have the highest percentage of fixed rates, (85%). Compared to the selected Euro area countries, Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, and Spain, only German mortgage interest rate adjustment is comparable with the U.S. The rest of the Euro area countries have significantly lower percentages of fixed mortgage rates, and in some of the countries, the dominant mortgage is variable.

While few countries and their housing markets within the Euro area can be more sensitive to monetary policy shocks, (Musso et al. 2011) found that the transmission of monetary policy shocks, such as changes in the interest rates, has a more significant effect on the US housing market than in the Euro area. This finding is interesting, as the housing wealth (housing wealth as a share of GDP) is more significant in the Euro area than in the US.

4 DATA AND METHODOLOGY

In this paper, I will analyse the effects of UMP from the point of view of innovations in the central bank balance sheet, and I will exclude the use of shadow interest rates. The decision to use the ECB's balance sheet as the UMP variable instead of the shadow interest rate is based on the work of Rosenberg (2020), where the author argues that using the shadow interest rate would make the identification of conventional and unconventional monetary policy harder to distinguish from themselves. This approach in determining the effects of UMP can also be seen from Gambacorta et al., (2014), Rahal (2016) and Boeckx et al. (2014). To measure the effects of MP, I will use the Euro Overnight Index Average (EONIA). This money market interest rate can be used as a proxy for the MP shock, a common practice in the literature.

Much of the previous literature on the topic has been based on aggregate levels for the U.S., U.K., and Euro area economies. However, country-specific analyses of conventional and unconventional monetary policy impacts have been conducted less. As discussed, the Euro area is more bank-centric, and national differences between member states affect how policies implemented by the ECB are received.

This study aims to illustrate how ECB policies have influenced the Euro area on aggregate while simultaneously providing further country-specific information. I have chosen to do the country-specific analysis for Germany and Italy. These countries are selected because they represent very different economies within the Euro area, where the housing structure varies greatly, the impacts of the GFC and the following UMP measures of the ECB have had differing magnitudes.

4.1 Data and descriptive statistics

The variables for my model contain several macroeconomic factors for Germany, Italy, and the Euro area. The variables are Gross Domestic Product per capita (GDP_{DEU_t} , GDP_{ITA_t} , GDP_{EA_t}), residential building permits index, 2015 = 100 ($BUILD_{DEU_t}$, $BUILD_{ITA_t}$, $BUILD_{EA_t}$, residential housing prices (RES_{DEU_t} , RES_{ITA_t} , RES_{EA_t}), mortgage interest rates (MR_{DEU_t} , MR_ITA_t, MR_EA_t), and the harmonized indexes of consumer prices ($HICP\_DEU_t$, $HICP\_ITA_t$, $HICP\_EA_t$).The data ranges from Q1 2003 to Q4 2021.

The proxy of monetary policy rate (Eonia) and the ECB's balance sheet (ECBB) are only available for the Euro area. When discussing financial data and time series analysis, using log-transformed variables is an industry standard in macroeconomic forecasting and VAR modelling. Following the previous literature, for example, Rosenberg (2020), excluding the interest rate variables, all variables have been log-transformed.

GDP, residential property prices, and the ECB's total balance sheet variables have been adjusted for inflation with the HICP variable. The HICP is a measure of inflation used by the European Union and produced by each EU member state. Its primary purpose is to provide a consistent and comparable measure of consumer price inflation across all EU countries.

In my model, the monetary policy rate has been substituted with a proxy of the policy rate, the Euro Over Night Index Average (Eonia), as the movements in the policy rate are discrete. The interbank rate can be seen reflecting all of the current information about the future movements in the monetary policy rate (Elbourne et al., 2018). All the variables have been calculated to quarterly data from monthly, daily, and weekly data. Only the population variables were based on yearly data. The yearly population data have been linearly adjusted to quarterly and are not seasonally adjusted.

4.2 Methodology

The chosen analysis method uses a Vector Autoregressive (VAR) model. VAR models are suitable for economic analysis rather than fundamental regression analysis. This is further amplified, especially when the variables of the model are assumed to be interconnected (Pecican, 2010). The basic assumption of VAR models is that the variables are stationary, where the variable means and variances are constant over time. The benefits of using a VAR model can be seen as its flexibility and capability to capture relationships between multiple variables simultaneously.

Multiple methods can be used to test the stationarity, but one of the most common tests is the augmented Dickey-Fuller test. This test determines whether the variables contain a unit root, i.e., whether they are nonstationary. A simple example of a unit root is the random walk process, which is illustrated below.

$$Y_t = Y_{t-1} + \varepsilon_t$$

Where Y_t is the dependent variable at time t. ε_t is the error term at time t. and is the independent variable with zero mean and variance σ^2. In a random walk process, the mean stays constant, but the variance grows over time (Rajbhandari, 2016).

The null hypothesis of Dickey-Fuller assumes that the time series has either a random walk process or a random walk process with a trend, which is only time dependent. Thus, we can determine the time series as stationary if the null hypothesis of the Dickey-Fuller test can be rejected. If the null hypothesis cannot be rejected, we can take the first differences from the variables and retest the stationarity of the time series variables. For robustness Phillips-Perron, Ziwor-Andrews, and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test are also used.

The results of the VAR analysis can be illustrated with the Granger causality test and impulse responsive analysis, which allow results to be interpreted visually. Although the Granger causality test is being used, it is important to note that it is only viable for predicting the development of a time series based on other time series. The test does not allow one to determine possible cause-and-effect relationships between the variables. The impulse-responsive analysis helps to determine how an external shock/impulse responds to an individual variable affecting the model variables.

5 ANALYSIS AND RESULTS

A VAR analysis is conducted to analyse further the effects of UMP and MP on Euro area housing markets. The analysis will be performed on two different time horizons: first for the whole sample period Q1 2003 to Q3 2021 and then for the subsample from Q1 2008 to Q3 2021. This is done to differentiate the periods from pre- and post-UMP eras. The results of the subcategorised VAR analysis are compared and evaluated for the whole period.

The data ranges from Q1 2003 to Q4 2021, and it's worth noting that the ECB started its QE programs after the financial crisis of 2008. Therefore, the following VAR analysis might not provide a complete picture of the effects of unconventional monetary policy on Euro area housing markets, also as the data is quarterly, the amount of datapoints might not be suitable for the following analysis. A common practice with VAR analyses is arranging the variables of the VAR analysis with Cholesky decomposition. To gain reliable results from a VAR analysis, the analysis variables are arranged according to the Cholesky decomposition, where the variables are arranged from the most exogenic to the least exogenic.

As a result, the chosen VAR model described in equation form can be seen below:

$$Y_t = A + \sum_{v=1}^{V} \sum_{k=1}^{K} \beta_{vk} Y_{k,t-v} + \delta_{2008} + \varepsilon_t$$

Where Y_t is the vector of endogenous variables, A is the vector of constants, ε_t is the vector of residual errors at time t. δ_{2008} is a dummy variable, that has a value of 1, if time is equal or greater than Q1 2008.

When selecting the optimal lag structure for a macroeconomic VAR analysis with quarterly data, much of the previous literature uses two lags, such as Calza et al. (2013), Baumeister and Benati (2010), Aspachs-Bracons and Rabanal (2011), and Rosenberg (2020). As in the previous literature, I will also use two lags for my analysis.

5.1 Unit roots

After taking the natural logarithms from the variables, we can see that the variables are nonstationary, as some have a trend factor and nonconstant means. This is illustrated in Table 2. The unit root tests are conducted using the augmented Dickey-fuller (later ADF), Phillips-Perron (later PP), Kwiatkowski–Phillips–Schmidt–Shin tests (later KPSS), and the Zivot-Andrews (later ZW) tests. The test results are in Figure 11. After visually inspecting the variables, I included a trend factor in the tests. Although visually inspecting the variables, many seem to have a trend factor, but the trend factor was dropped, if it was deemed statistically insignificant when testing. All the unit root tests are conducted with two lags, as the optimal lag structure of two lags has been established in previous similar studies.

The log of HICP-adjusted residential prices of the Euro area has a strong trend and possible autocorrelation problem, where taking the first difference does not entail stationarity according to the ADF test. This could indicate that the test itself is not powerful enough to measure stationarity, as the data is within somewhat limited time frame. After running the Zivot-Andrews (ZA) test for unit roots and structural breaks in the time series, the test also indicates a unit root and found a structural change in Q4 2011. This could indicate that ZLB and QE programs have affected the Euro area housing markets, as the region's housing prices increase rapidly in the following years. Based on extensive unit root testing, all Euro area variables seem to have a unit root problem, excluding the mortgage interest rate (mr) variable. The ZA test value is significant at the 5 % level. It indicates that when allowing for a single structural break in both the intercept and the trend, the minimum t-statistic (-5.19) occurs in Q1 of 2009, which means that the variable is stationary when accounting for its trend.

Unit roots

	Euro area				Italy			
Stat/Var	*res*	*mr*	*build*	*GDP per capita*	*res*	*mr*	*build*	*GDP per capita*
Log-transformation	No	No	Yes	Yes	No	No	Yes	Yes
HICP-adjustment	No	No	Yes	Yes	No	No	Yes	Yes
ADF	-1.24	-1.28	-1.47	-1.42	-2.57	-3.32*	-1.1	-1.1
PP	-0.17	-2.18	-1.54	-2.23	-2.52	-0.99	-1.04	-1.68
KPSS	0.39	0.27	0.5	0.39	0.39	-2.01	0.44	0.43
Z-A	-3.7	-5.19**	-4.51	-3.47	-2.86	-6.04***	-3.74	-3.30
	(Q4 2011)	(Q1 2009)	(Q4 2007)	(Q4 2011)	(Q4 2016)	(Q4 2008)	(Q1 2013)	(Q4 2011)

	Germany				ECB		
	res	*mr*	*build*	*GDP per capita*	*eonia*	*dfr*	*ecbb per capita*
Log-transformation	No	No	Yes	Yes	No	No	Yes
HICP-adjustment	No	No	Yes	Yes	No	No	Yes
ADF	2	-1.9	-2.23	-2.88	-1.47*	-2.37	-3.76**
PP	1.74	-1.97	-2.94	-4.36***	-165	-2.08	-3.41*
KPSS	0.64	-2.26	0.41	0.14**	0.17*	0.15*	0.13*
Z-A	-1.65	-3.00	-5.0**	-5.46**	12.50***	-8.5***	-4.76
	(Q3 2012)	(Q4 208)	(Q4 2006)	(Q1 2009)	(Q4 2008)	(Q1 2009)	(Q4 2008)

Table 2. Unit root test results from the variables. The table reports if have the variables been log-transformed and/or HICP-adjusted. It also reports the results from the Augmented Dickey-Fuller test (ADF, H_0: unit root), The Phillips-Perron (PP, H_0: unit root) the Kwiatkowski–Phillips–Schmidt–Shin tests (KPSS, H0: stationarity) and the Zivot and Andrews (Z-A), that allow for possible breaks in the time series when testing for a unit root (break in parentheses). The significance levels are denoted by 10 % = *, 5 % = **, and 1 % = ***.

For Italy, the residential property prices act in a similar fashion, where the trend factor is statistically significant when testing for unit roots. As with the Euro area residential property price variables, taking the first difference with the trend factor does not indicate stationarity with the ADF test, but the PP test shows low p-values indicating stationarity. The Italian mortgage rate variable shows similar findings, where the variable is trend-stationary, rest of the variables have a unit root problem.

Interestingly the German GDP per capita and building permit index variables are trend stationary, and the mortgage rate variable is not, when looking at the ZA test results. From the ECB variables, the Eonia and DFR rates are noted being stationary based on the ZW test. The variables that have a unit root problem are differenced. For example, the Euro area residential property price variable has a unit root problem, and for further analysis, the variable will be in its differenced form $\text{log\_real\_res\_ea}_t - \text{log\_real\_res\_ea}_{t-1}$.

5.2 Whole sample period VAR analysis

When testing the VAR model for the whole sample period, the optimal lag structure is two lags, similar to the previous literature. The second lag includes the smallest Akaike (later AIC) and Hannan-Quinn (later HQIC) information criterions for the Euro area and Italy. The lower the information criterion is, the preferable. For Germany the Information criterions suggested a one period lag model but based on previous literature and for the unity of the VAR analysis results the lag structure for Germany is also two lags. Also to be noted the difference between the information criterions on lag 1 and 2 for Germany is minimal. Further information on the lag structures for the whole sample period can be seen in appendix 5-7.

After validating the lag structure used in previous studies, I will start the VAR modelling. When conducting a VAR model, the order of the variables in the model impacts the results of the analysis. In the macroeconometric literature, the economic activity is ordered first, followed by housing prices, housing supply, mortgage rates, and lastly monetary policy variables. Following the example of Rosenberg (2020) and Rahal (2016) the variable order in the VAR model for the three regions are GDP per capita, residential housing price index, residential building permit index, mortgage rates, Eonia rate, and ECB's total balance sheet variable.

The null hypothesis for the Granger causality test is that the coefficient estimates of the lagged terms of variable x are jointly zero in the equation that explains variable y. The results of the Wald test used for testing Granger causality in the VAR model are described in appendix 8-10. Since the lag length is 2, there are two lagged terms. If the null hypothesis can be rejected, then the variable x Granger-causes y.

The Granger causality is not an actual cause-effect relationship but rather it's more about how the movements of x predict the movements of y. In addition to individual variables, the test can also be used to test the impact of the lagged terms of all other variables in the model's left-hand side variable y. These results are for the whole sample period Euro area reported in Appendix 8. If the null hypothesis of the Granger causality test remains valid, it implies that the variable under consideration is exogenous compared to the other variables in the model. This is not desirable, as the idea of the VAR model is to consist of endogenous variables that can predict each other's movements. The Granger Causality test results for the sample period can be seen in appendix 8-10.

After the Granger causality test, I modelled the impulse response functions of the VAR analysis. The impulse responses are cumulative, as these impulse functions depict the total cumulative shock of the impulse on the response variable. The size of the impulses is one standard deviation, and the response time is two years (eight quarters). The coefficient interval of 68 % reflects the limited number of observations in the data, where the standard 90 % coefficient interval might not give relevant COIFs (Cumulative orthogonalized Impulse Response functions). Rosenberg (2020) has also used the 68 % coefficient interval in their study.

The important COIRFs for this paper are related to impulses of the *Eonia, ecbb_per_capita, build_, and mr_* variables. This paper hypothesizes that the ZLB and the Eonia rate reflecting these policy decisions should lower mortgage interest rates and raise residential property prices. Similarly, the ECB's QE programs and the following expansions in the ECB's total balance sheet should increase residential property prices.

Figure 10 shows the cumulative impulse response functions (COIRFs) for the whole sample period of the Euro area. From the figure, we can see that for the whole sample, a shock in the ECB's balance sheet leads to an increase in Euro area residential property price index, but the effect is statistically insignificant.

Based on Eonia COIRFS, Eonia rate decreases residential housing prices in Euro area. Like the Eonia rate, a shock on the mortgage interest also has a negative effect on the residential housing prices of the Euro area.

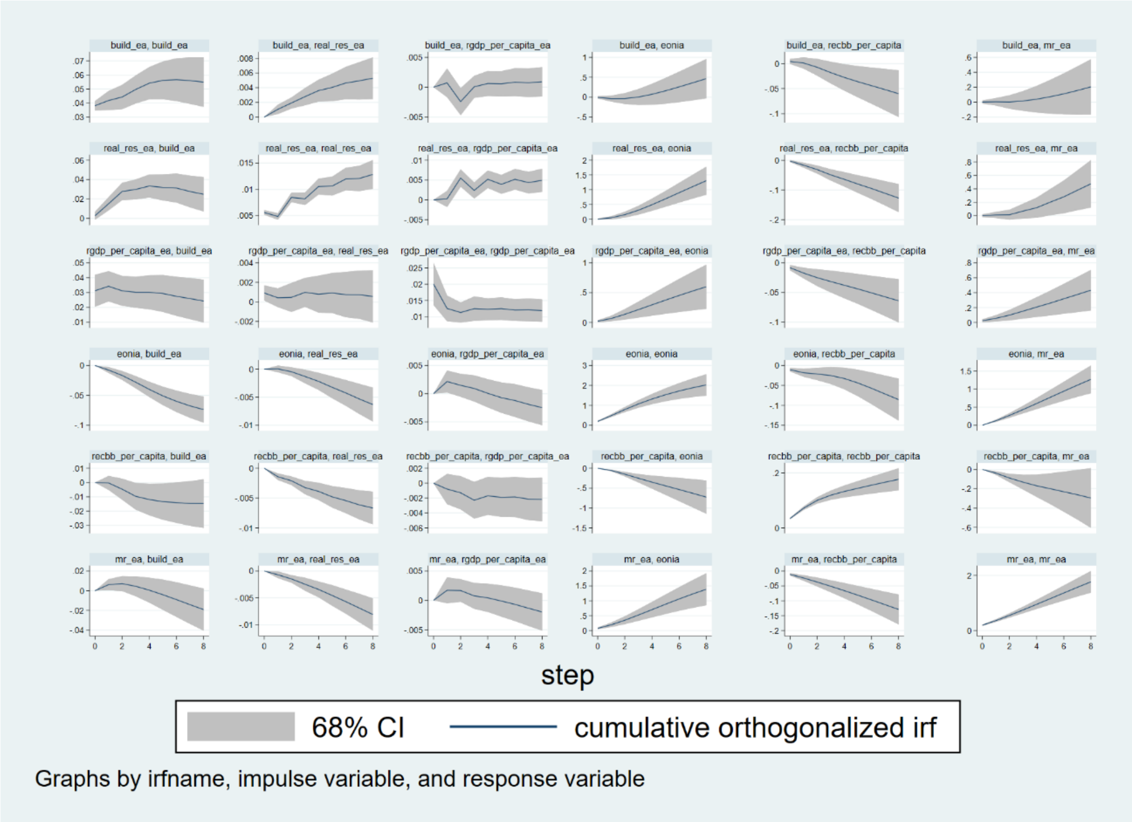


Figure 10. Cumulative orthogonalized Impulse Response functions for Euro area from Q1 2003 – Q4 2021.

Interestingly, the expansion of ECB's total balance sheet decreases the Italian residential property prices, and Eonia rate seems to have a positive impact on residential housing prices, while the mortgage interest rate has a negative impact. This differs from the Euro area aggregate, where both interest rate variables have a negative impact on the pricing of residential housing. This could imply that the policy decision of the ECB to lower key interest rates has had a positive impact on Italian housing prices, but the national mortgage rate was still high enough to have a negative impact on residential housing prices.

Statistically significant variables influencing the Italian mortgage interest rate variable are the ECB's total balance sheet, Eonia, and mortgage rate itself. The expansion of the ECB's total balance sheet lowers the mortgage interest rate, while the Eonia rate has a positive correlation in the whole sample period. The COIRFs for Italy in the whole sample period can be seen in figure 11.

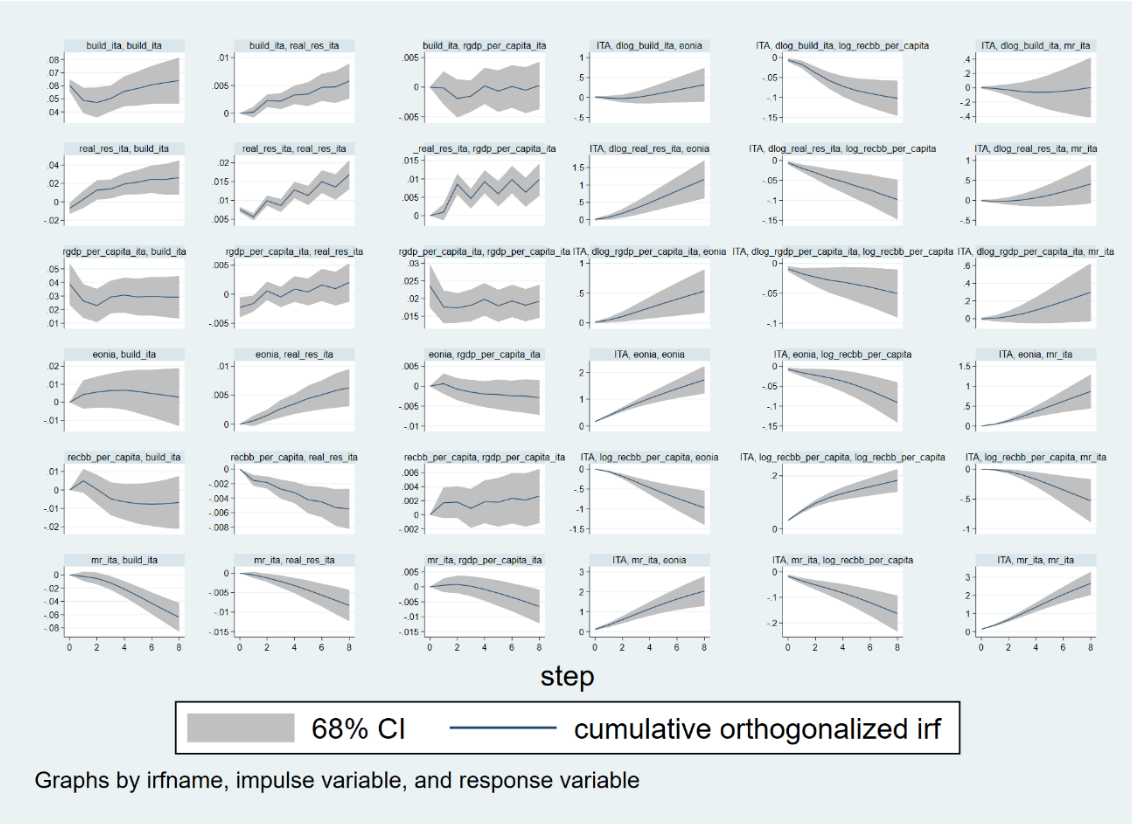


Figure 11. Cumulative orthogonalized Impulse Response functions for Italy from Q1 2003 – Q4 2021.

The COIRFs for Germany give us differing results when compared to the Euro area aggregate and Italy. From Figure 12 below we can see the expansion of ECB's total balance sheet has a positive effect on the residential house prices, where the effect is statistically significant after six quarters. Mortgage interest rates do not have a statistically significant effect. Building permits and the real GDP per capita have a positive and statistically significant relation on the real residential housing price index.

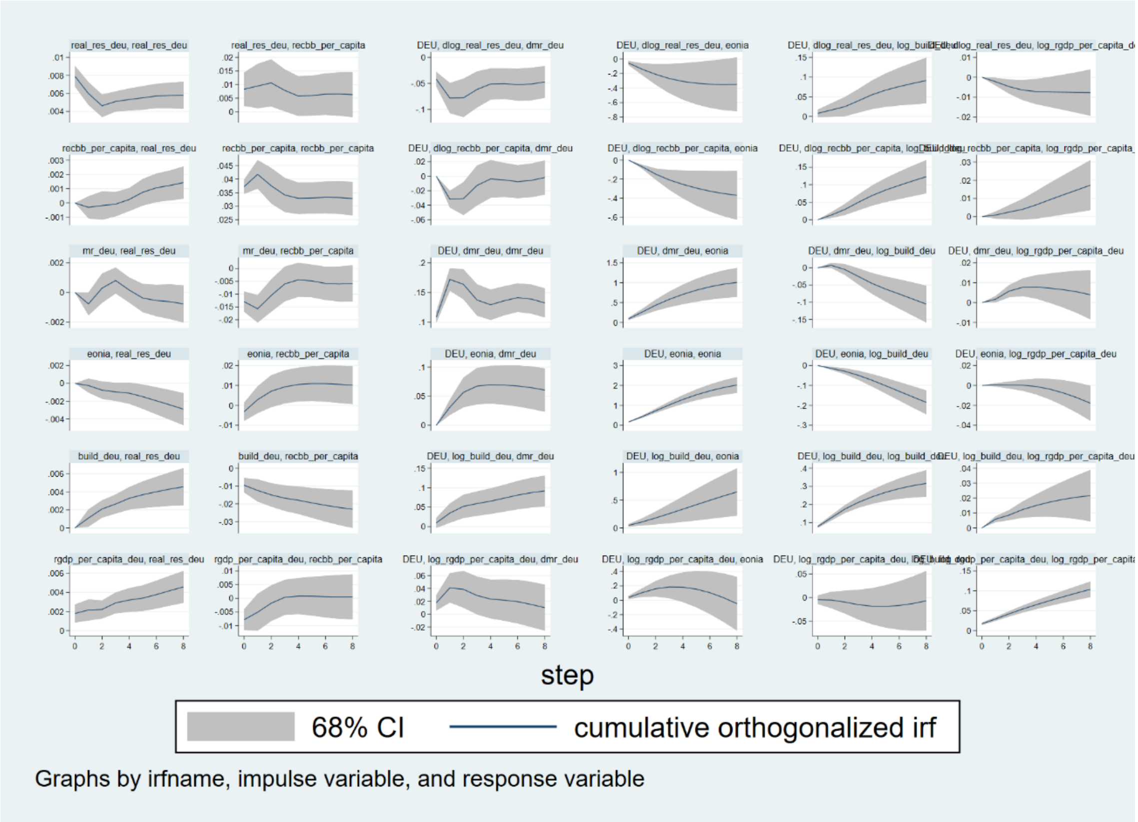


Figure 12. Cumulative orthogonalized Impulse Response functions for Germany from Q1 2003 – Q4 2021.

As the whole sample analysis has shown, unconventional monetary policies such as expansionary monetary policy (expansion of the ECB's total balance sheet) seem to positively contribute to the residential housing prices of Germany and the Euro area aggregate, while having a negative effect on Italian housing prices. The Eonia rate, which could be used as an indicator of conventional monetary policy, has mixed effects on residential prices. The impulse responses show that there is a negative and statistically significant impact for Germany and the Euro area aggregate, while the impact on Italy is the opposite. This prompts further investigation, focusing on the post-GFC era, as unconventional monetary policies were enrolled after the GFC. As the Zivot Andrews test in Table 2 suggests, the data has a break around the time of GFC. These results also show the need to analyse the effects of GFC separately. Also, one possible explanation for these mixed results is that monetary policy decisions might not be detected after a two-lag period. The residential housing market is also less liquid than the stock market, further prompting a longer lag structure.

5.3 post-GFC VAR analysis

As discussed, the whole sample period from Q1 2003 to Q3 2021 might not capture the effects of unconventional monetary policy on the Euro area housing markets, as the ECB's first QE programs were enrolled post-2008 financial crisis. As this study focuses on the Euro area and the ECB's monetary policies, the following analysis is conducted using data from Q1 2008 to Q3 2021. As the number of available data points has also been reduced, the initial VAR model with six variables might be ill-suited for the following analysis. The whole sample period analysis will serve as a benchmark for the post-crisis era analysis.

The whole sample model shows that housing supply, GDP per capita, mortgage interest rates, and Eonia rate have excellent explanatory power over the development of residential housing prices in the selected three regions. The variables and VAR modes for the following analysis are:

1. *rgdp (Real GDP per capita), res (real residential property price index), ecbb (ECB's total balance sheet)*
2. *rgdp, res, eonia*
3. *rgdp, res, mr (mortgage interest rate)*
4. *rgdp, res, build (residential building permit index)*

The information criteria suggest a lag structure of two, which is expected considering the number of available data points and variables. The lag structure of the following VAR models is four, even though the third and fourth lag seem to indicate the possibility of autocorrelation with the VAR models. This structure is chosen to mitigate the risk that a smaller one would not capture the effects of monetary policy. As with the whole sample period model, I will start the analysis by checking the variables' stationarity. The unit root test results for the post-GFC variables are in Appendix 11. The order of the variables follows the economic reasoning of the whole sample period VAR model.

When analysing the post-GFC era, the expansion of the ECB's balance sheet does not have similar implications on the price development of the Euro area residential property prices. The post-GFC analysis implies that the expansion of the ECB's balance sheet has a negative impact on the Euro area and German residential property prices. The effect is statistically significant for the Euro area for the first four quarters and for Germany for eight quarters. The effect is positive but statistically insignificant for the Italian residential housing prices. Also, the expansion of the ECB's balance sheet seems to have a statistically insignificant effect on the real GDP of the selected regions. COIRFs for GDP per capita, EA Residential property prices, and ECB's total balance sheet can be seen in Figure 13. Similar COIRFs for Germany and Italy can be seen in Appendix 13 and 17.

These findings differ from those of Rosenberg (2020), who also studied the effects of the ECB's expansionary monetary policy on Euro area housing markets.

The study found that these monetary policies had a statistically significant and positive impact on Euro area residential housing prices.

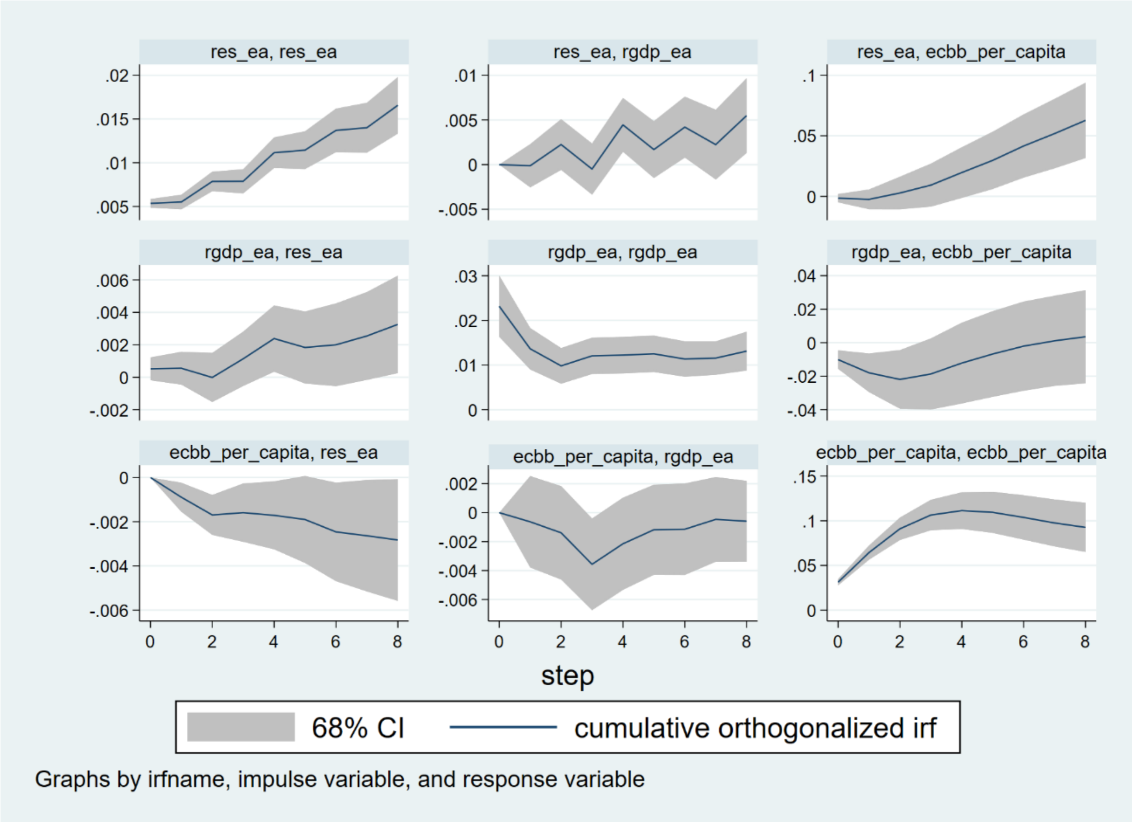


Figure 13. Cumulative orthogonalized Impulse Response functions for the Euro area, variables real GDP per capita, real residential price index, ECB's Total balance sheet per EA capita. Q1 2008 – Q4 2021.

As mentioned, the Eonia rate is a substitute for the short-term interest rate, and changes in the Eonia rate can be seen as being adaptive to changes in the ECB's monetary policy. Next, I will analyse the effects of the Eonia rate on Euro area housing prices. The three variable VAR model COIRFs for GDP per capita, Eonia rate, and EA Residential property prices can be seen in Figure 14, and similar COIRFs for Germany and Italy can be seen in Appendix 14 and 18. The post-GFC analysis also shows that a shock in the Eonia rate has a statistically significant and negative effect on the Euro area residential housing prices. The negative relation between interest rates and asset prices is intuitively understandable, but after the GFC, the Eonia rate was at its historical lows. From Figure 14, we can see that even when analysing the post-GFC era, the historically low Eonia rate has a negative impact on the Euro area residential property prices. The Eonia rate has similar effects on German and Italian residential housing prices. The effect is also persistently negative, implying that the Eonia rate, even in negative levels, has a negative impact on residential housing prices.

As the shock in the Eonia rate is statistically significant and cumulatively negative for the three regions, this implies that conventional monetary policy actions have a more significant impact on the Euro area housing markets than unconventional monetary policy, where the impulses are not as statistically significant. This effect can also be seen in relations between mortgage interest rates and housing prices, where the COIRFs for mortgage interest rates have similar cumulatively adverse effects on residential housing prices. This further proves that short- and long-term interest rates are essential, even when unconventional monetary policies are enrolled.

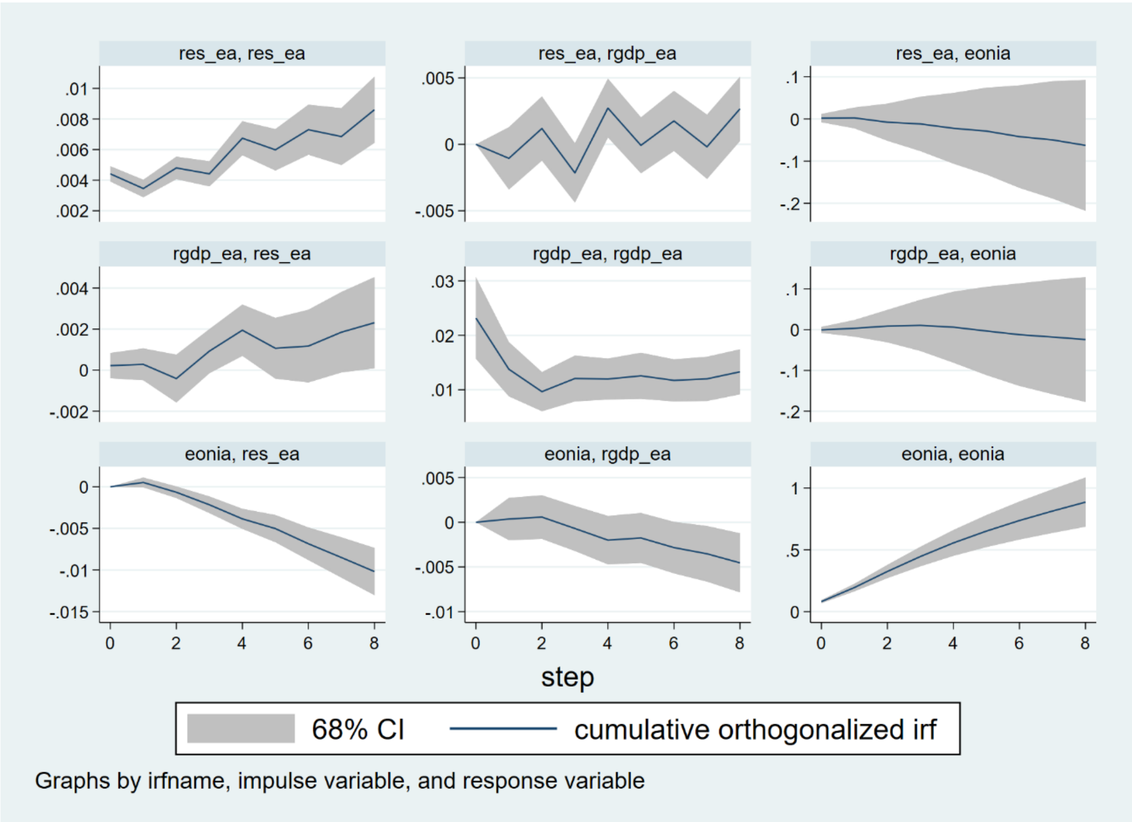


Figure 14. Cumulative orthogonalized Impulse Response functions for the Euro area, variables real GDP per capita, real residential price index, and Eonia rate. Q1 2008 – Q4 2021.

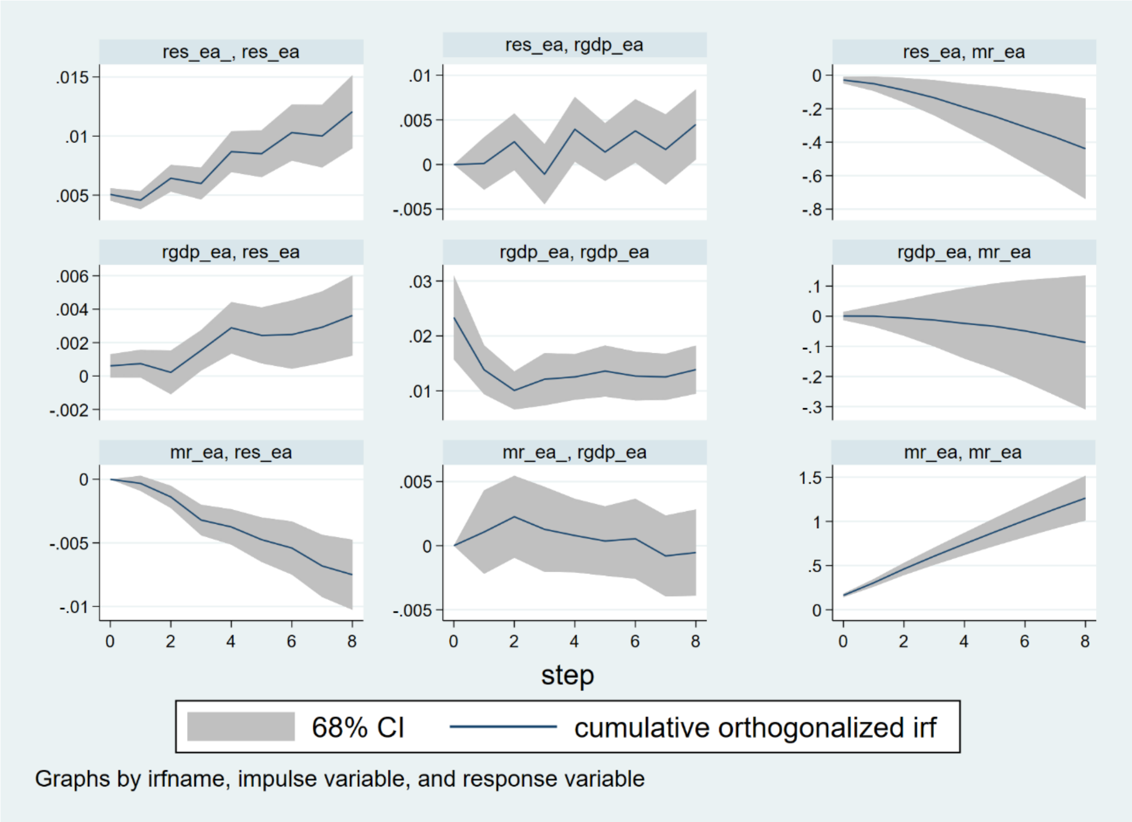


Figure 15. Cumulative orthogonalized Impulse Response functions for the Euro area, variables real GDP per capita, real residential price index, and EA mortgage interest rate. Q1 2008 – Q4 2021.

After analysing the effects of MP and UMP variables on the residential housing markets, the focus will be on the housing market supply on the housing markets. From Figure 16, we can see that when building permits for residential properties increase, residential housing prices start to decline. The effect becomes statistically significant in the third quarter. Increases in residential housing prices also increase the building permits of residential housing, and the effect is statistically significant after one year. Interestingly, increasing housing prices have a more significant effect on residential building permits than the permits have on residential housing prices. The demographic changes in the two years cannot justify the increase in housing prices. One explanation could be that part of the housing demand assumes that housing prices will keep rising, thus possibly introducing more speculative investors in the housing market.

Although the effect of the residential building permit index on residential housing prices is not as nuanced in Germany or Italy, the increase in residential property prices increases the GDP per capita in all the regions with a strong upward trend. These findings could be explained with the credit and asset price channels of MTM, where the low interest rates have increased bank lending for the housing sector, which increases the housing demand. As the demand for housing increases, the market value of housing increases compared to the housing building cost. The increased demand and higher valuations of residential housing could further increase new housing projects, which are also positively affected by the low interest rates. This could help to explain that a shock in building permits leads to a development in housing prices and vice versa.

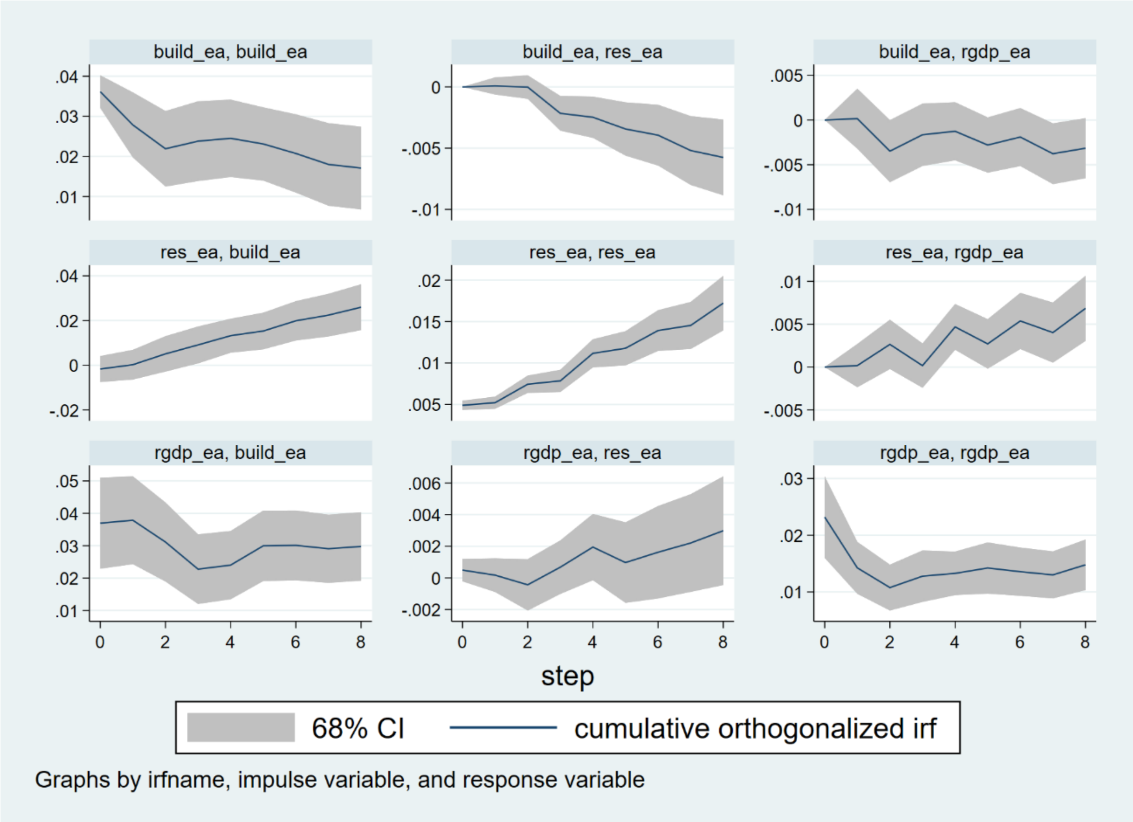


Figure 16. Cumulative orthogonalized Impulse Response functions for the Euro area, variables real GDP per capita, real residential price index, and Euro area residential building permit index. Q1 2008 – Q4 2021.

6 CONCLUSIONS

The financial crisis of 2008, with its profound impact on housing markets and the subsequent transmission of disruptions into the economy, serves as a crucial backdrop for our analysis of the European Central Bank (ECB) monetary policy's influence on the housing market.

This thesis studies the effects of conventional and unconventional monetary policies on Euro area housing markets. The study focuses on the Euro area in aggregate, Germany, and Italy. The inclusion of Germany and Italy illustrates that even after joining the common currency, national legislation and market structures have a significant role in how the ECB’s monetary policies affect the national housing markets.

The results of this paper are mixed, and the effects of unconventional monetary (UMP) differ from the previous studies. The results of this paper indicate that Quantitative Easing (QE) programs and expansion of the ECB’s balance sheet have not statistically increased the residential housing prices in Euro area aggregate, Germany, or Italy significantly. In this paper, the conventional monetary policy (MP) factor is the Eonia rate, which can be used as a proxy for the short-term interest rate. Although the Eonia rate and short-term interest rates have been close or near to zero after the financial crisis, I found that the indications that increasing the Eonia rate (even from negative levels) negatively impacts residential property prices in the Euro area aggregate, Germany, and Italy. The housing market response is stronger to an MP shock than to a UMP shock. This finding is like the findings made by Rosenberg (2020) and Huber and Punzi (2020).

Although UMP shocks did not present similar results to those in the previous studies, the interest rate and asset price channels of MTM seem to play a crucial role in the housing markets. Policymakers could use housing prices as an indicator to assess the effectiveness of interest changes in the real economy. As shown in the study, the housing markets are vulnerable to interest rate shocks, and raising residential property prices positively impacts the real GDP.

The results in this study were based on a simple VAR model, which might not be adequate for analysing the housing market development. The model contains a significant number of variables, and the quarterly data used in the analysis might lack enough data points for a meaningful analysis. Even though in theory the GDP per capita variable should be a good indicator for economic development, this thesis does not include variables that model economic uncertainty nor employment. Both variables effect consumer confidence, and thus have an indirect effect on housing demand and supply. Also, the data used in the analysis is not seasonally adjusted, which might also affect the results.

Further studies on the country-specific impacts of the ZLB and expansionary monetary policy on the national level are needed. As this study demonstrates, country-specific differences among Euro area nations can have differing results.

Identifying and finding regional differences among the Euro area nations could be beneficial for policymakers when enrolling in possible future QE programs. Also, the Euro area interest rates have begun to normalize and rise from the end of 2021, as the ECB has changed its outlook on inflation and the unconventionally low interest rates have ended (Bank of Finland, 2022). Normalising interest rates could reduce liquidity, leading to asset pricing bubbles, including in the housing markets. Malovaná et al., (2023) found that prolonged negative nominal rates in the Euro area could lead to systematic risks in the EU. Normalizing the monetary policy could lead to financial vulnerabilities, as concerns for government deficits and high household indebtedness could lead to crashing asset prices. After being negative or near zero from mid-2014, the Euribor 3-month interest rate has been positive from mid-2022 and over 3 % since February 2023 (Refinitiv Eikon / ECB). As inflation and interest rates have normalized relatively lately and the literature about this topic is still scarce, analysing the impact of normalizing interest rates and higher inflation can provide insights into the housing market development in the future.

REFERENCES

Aalbers, M. B. (2009). The Globalization and Europeanization of Mortgage Markets. International Journal of Urban and Regional Research, 33(2), 389–410. https://doi.org/10.1111/j.1468-2427.2009.00877.x

Ando, A., & Modigliani, F. (1963). The "Life Cycle" Hypothesis of Saving: Aggregate Implications and Tests. The American Economic Review, 53(1), 55–84.

Aspachs-Bracons, O., & Rabanal, P. (2011). The Effects of Housing Prices and Monetary Policy in a Currency Union. International Journal of Central Banking, 7(1).

Bank of Finland (2022). What is monetary policy normalisation? Bank of Finland Bulletin. https://www.bofbulletin.fi/en/2022/3/what-is-monetary-policy-normalisation/

Baptista, R., Hinterschweiger, M., Low, K., & Uluc, A. (2016). Macroprudential Policy in an Agent-Based Model of the UK Housing Market. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2850414

Baumeister, C., & Benati, L. (2010). Unconventional Monetary Policy and the Great Recession—Estimating the Impact of a Compression in the Yield Spread at the Zero Lower Bound. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.1691633

Becker, B., & Ivashina, V. (2018). Financial Repression in the European Sovereign Debt Crisis*. Review of Finance, 22(1), 83–115. https://doi.org/10.1093/rof/rfx041

Beirne, J., Dalitz, L., Ejsing, J., Grothe, M., Manganelli, S., Monar, F., Sahel, B., Susec, M., Tapking, J., & Vong, T. (2011). The Impact of the Eurosystem's Covered Bond Purchase Programme on the Primary and Secondary Markets (SSRN Scholarly Paper 1646280).

https://doi.org/10.2139/ssrn.1646280

Bernanke, B. S., & Blinder, A. S. (1988). Credit, Money, and Aggregate Demand (Working Paper 2534). National Bureau of Economic Research. https://doi.org/10.3386/w2534

Bernanke, B. S., & Gertler, M. (1995). Inside the Black Box: The Credit Channel of Monetary Policy Transmission. Journal of Economic Perspectives, 9(4), 27–48. https://doi.org/10.1257/jep.9.4.27

Bjørnland, H. C., & Jacobsen, D. H. (2010). The role of house prices in the monetary policy transmission mechanism in small open economies. Journal of Financial Stability, 6(4), 218–229. https://doi.org/10.1016/j.jfs.2010.02.001

Black, F. (1995). Interest Rates as Options. The Journal of Finance, 50(5), 1371–1376. https://doi.org/10.1111/j.1540-6261.1995.tb05182.x

Boeckx, J., Dossche, M., & Peersman, G. (2014). Effectiveness and Transmission of the ECB's Balance Sheet Policies (SSRN Scholarly Paper 2482978). https://doi.org/10.2139/ssrn.2482978

Brzozowski, M. (2006). Exchange Rate Variability and Foreign Direct Investment: Consequences of EMU Enlargement. Eastern European Economics, 44(1), 5–24. https://doi.org/10.2753/EEE0012-8755440101

Buiter, W. H. (2010). Housing Wealth Isn't Wealth. Economics, 4(1), 20100022. https://doi.org/10.5018/economics-ejournal.ja.2010-22

Cahill, M., D'Amico, S., Li, C., & Sears, J. (2013). Duration Risk Versus Local Sup-ply Channel in Treasury Yields: Evidence from the Federal Reserve's Asset Pur-chase Announcements (SSRN Scholarly Paper 2976836). https://papers.ssrn.com/abstract=2976836

Calza, A., Monacelli, T., & Stracca, L. (2013). Housing and monetary policy. Journal of the European Economic Association, 11, 101–122. https://doi.org/10.1111/j.1542-4774.2012.01095.x

Catte, P., Girouard, N., Price, R., & André, C. (2004). Housing Markets, Wealth and the Business Cycle. https://doi.org/10.1787/534328100627

Christensen, J. H. E., & Rudebusch, G. D. (2015). Estimating Shadow-Rate Term Structure Models with Near-Zero Yields. Journal of Financial Econometrics, 13(2), 226–259. https://doi.org/10.1093/jjfinec/nbu010

Coskun, Y., Sencer Atasoy, B., Morri, G., & Alp, E. (2018). Wealth Effects on Household Final Consumption: Stock and Housing Market Channels. In-ternational Journal of Financial Studies, 6(2), 57. https://doi.org/10.3390/ijfs6020057

Damjanović, M., & Masten, I. (2016). Shadow short rate and monetary policy in the Euro area. Empirica, 43(2), 279–298. https://doi.org/10.1007/s10663-016-9328-4

Darmouni, O., & Siani, K. Y. (2021). Corporate Bond Issuance and Bank Lending in the United States. European Economy, 1, 145–156.

Eggertsson, G. B., & Woodford, M., Professor. (2003). Zero Bound on Interest Rates and Optimal Monetary Policy. Brookings Papers on Economic Activi-ty, 2003(1), 139–233.

Elbourne, A., Ji, K., & Duijndam, S. (2018). The effects of unconventional monetary policy in the Euro area (CPB Discussion Paper 371). CPB Netherlands Bureau for Economic Policy Analysis. https://econpapers.repec.org/paper/cpbdiscus/371.htm?fbclid=IwAR3TH3Xg7DD6ZTN-KEee0hSLxSVskwP5xZYEXjqv3hgTXTzGmbuc0zLaNCL8

European Central Bank. (2008). Evidence on Liquidity and Credit risk from deposit-OIS spreads

European Central Bank. (2020a). Economic Bulletin Issue 1, 2020. https://www.ecb.europa.eu/pub/economic-bulletin/html/eb202001.en.html

European Central Bank. (2020b, February 5). Household wealth and consumption in the Euro area. European Central Bank. https://www.ecb.europa.eu/pub/economic-bulletin/articles/2020/html/ecb.ebart202001_01~6ce994a1f7.en.html

Fawley, B. W., & Neely, C. J. (2013). Four Stories of Quantitative Easing. Review, 95(1). https://doi.org/10.20955/r.95.51-88

Feyen, E., & del Mazo, I. G. (2013). European Bank Deleveraging and Global Credit Conditions: Implications of a Multi-Year Process on Long-Term Finance and Beyond (SSRN Scholarly Paper 2239542). https://papers.ssrn.com/abstract=2239542

Filardo, A. J., & Hofmann, B. (2014). Forward Guidance at the Zero Lower Bound (SSRN Scholarly Paper 2457107). https://papers.ssrn.com/abstract=2457107

Fratzscher, M., Lo Duca, M., & Straub, R. (2016). ECB Unconventional Monetary Policy: Market Impact and International Spillovers. IMF Economic Review, 64(1), 36–74. https://doi.org/10.1057/imfer.2016.5

Funke, M., & Paetz, M. (2012). A DSGE-Based Assessment of Nonlinear Loan-to-Value Policies: Evidence from Hong Kong (SSRN Scholarly Paper 2049783). https://doi.org/10.2139/ssrn.2049783

Gagnon, J., Raskin, M., Remache, J., & Sack, B. (2011). Large-Scale Asset Purchases by the Federal Reserve: Did They Work?

Gambacorta, L., Hofmann, B., & Peersman, G. (2014). The Effectiveness of Unconventional Monetary Policy at the Zero Lower Bound: A Cross-Country

Analysis. Journal of Money, Credit and Banking, 46(4), 615–642. https://doi.org/10.1111/jmcb.12119

Giuliodori, M. (2005). The Role of House Prices in the Monetary Transmission Mechanism Across European Countries. Scottish Journal of Political Econ-omy, 52(4), 519–543. https://doi.org/10.1111/j.1467-9485.2005.00354.x

Glaeser, E. L. (2013). A Nation of Gamblers: Real Estate Speculation and American History. American Economic Review, 103(3), 1–42. https://doi.org/10.1257/aer.103.3.1

Glaeser, E. L., Gottlieb, J. D., & Gyourko, J. (2013). Can Cheap Credit Explain the Housing Boom? In Housing and the Financial Crisis (pp. 301–359). University of Chicago Press. https://www.nber.org/books-and-chapters/housing-and-financial-crisis/can-cheap-credit-explain-housing-boom

Hicks, J. R. (1937). Mr. Keynes and the "Classics"; A Suggested Interpretation. Econometrica, 5(2), 147–159. https://doi.org/10.2307/1907242

Huber, F., & Punzi, M. T. (2020). International housing markets, unconventional monetary policy, and the zero lower bound. Macroeconomic Dynamics, 24(4), 774–806. https://doi.org/10.1017/S1365100518000494

Iacoviello, M. (2005). House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle. American Economic Review, 95(3), 739–764. https://doi.org/10.1257/0002828054201477

Iacoviello, M., & Minetti, R. (2008). The credit channel of monetary policy: Evidence from the housing market. Journal of Macroeconomics, 30(1), 69–96. https://doi.org/10.1016/j.jmacro.2006.12.001

Ireland, P. N. (2010). Monetary Transmission Mechanism. In S. N. Durlauf & L. E. Blume (Eds.), Monetary Economics (pp. 216–223). Palgrave Macmillan UK. https://doi.org/10.1057/9780230280854_26

Jappelli, T., & Pagano, M. (2008). Financial Market Integration Under EMU (SSRN Scholarly Paper 1344670). https://papers.ssrn.com/abstract=1344670

Klaus, R., & Watson, M. (2010). A Preliminary Report on The Source's of Ireland's Banking Crisis.

Kok, C., Martin, R., Moccero, D., & Sandström, M. (2014). Recent Experience of European Countries with Macro-Prudential Policy.

Lemke, W., & Vladu, A. (2016). Below the Zero Lower Bound: A Shadow-Rate Term Structure Model for the Euro area (SSRN Scholarly Paper 2848045). https://doi.org/10.2139/ssrn.2848045

Lydon, R., & O'Hanlon, N. (2012). Housing Equity Withdrawal, Property Bubbles and Consumption (Research Technical Paper 05/RT/12). Central Bank of Ireland. https://econpapers.repec.org/paper/cbiwpaper/05_2frt_2f12.htm

Malovaná, S., Bajzík, J., Ehrenbergerová, D., & Janků, J. (2023). A prolonged period of low interest rates in Europe: Unintended consequences. Journal of Economic Surveys, 37(2), 526–572. https://doi.org/10.1111/joes.12499

Martin, C., Schmitt, N., & Westerhoff, F. (2022). HOUSING MARKETS, EXPECTATION FORMATION AND INTEREST RATES. Macroeconomic Dynamics, 26(2), 491–532. https://doi.org/10.1017/S1365100520000279

Mian, A., & Sufi, A. (2011). House Prices, Home Equity-Based Borrowing, and the US Household Leverage Crisis. American Economic Review, 101(5), 2132–2156. https://doi.org/10.1257/aer.101.5.2132

Mishkin, F. S. (1995). Symposium on the Monetary Transmission Mechanism. Journal of Economic Perspectives, 9(4), 3–10. https://doi.org/10.1257/jep.9.4.3

Mishkin, F. S. (2007). Housing and the Monetary Transmission Mechanism (Work-ing Paper 13518). National Bureau of Economic Research. https://doi.org/10.3386/w13518

Mody, A., & Sandri, D. (2012). The eurozone crisis: How banks and sovereigns came to be joined at the hip: EUROZONE CRISIS. Economic Policy, 27(70), 199–230. https://doi.org/10.1111/j.1468-0327.2012.00281.x

Morgan, P. J., & Zhang, Y. (2017). Mortgage lending, banking crises, and financial stability in Asia and Europe. Asia Europe Journal, 15(4), 463–482. https://doi.org/10.1007/s10308-017-0489-y

Neal, L., & García-Iglesias, M. C. (2013). The economy of Spain in the euro-zone before and after the crisis of 2008. The Quarterly Review of Economics and Finance, 53(4), 336–344. https://doi.org/10.1016/j.qref.2013.01.002

Ngo, P. V. (2015). Household leverage, housing markets, and macroeconomic fluctuations. Journal of Macroeconomics, 44, 191–207. https://doi.org/10.1016/j.jmacro.2015.02.005

Nocera, A., & Roma, M. (2018). House Prices and Monetary Policy in the Euro area: Evidence from Structural VARs. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.3256380

Pavlidis, E. G., Paya, I., Peel, D. A., & Spiru, A. (n.d.). Bubbles in House Prices and their Impact on Consumption: Evidence for the US.

Philiponnet, N. (2018). The start of a new cycle: Recent housing price dynamics in Europe and their macroeconomic implications. Quarterly Report on the Euro area (QREA), 16(3), 57–68.

Rahal Charles. (2016). Housing markets and unconventional monetary policy. Journal of Housing Economics, 32, 67–80. https://doi.org/10.1016/j.jhe.2016.04.005

Rosenberg, S. (2020). Conventional and unconventional monetary policies: Effects on the Finnish housing market. Baltic Journal of Economics, 20(2), 170–186. https://doi.org/10.1080/1406099X.2020.1792085

Sánchez-Martínez, M. T., Sanchez-Campillo, J., & Moreno-Herrero, D. (2016). Mortgage debt and household vulnerability: Evidence from Spain before and during the global financial crisis. International Journal of Housing Markets and Analysis, 9(3), 400–420. https://doi.org/10.1108/IJHMA-07-2015-0038

Schwartz, H. M. (2016). Banking on the FED: QE1-2-3 and the Rebalancing of the Global Economy. New Political Economy, 21(1), 26–48. https://doi.org/10.1080/13563467.2015.1041480

Shiller, R. J. (2015). Irrational Exuberance: Revised and Expanded Third Edition. In Irrational Exuberance. Princeton University Press. https://doi.org/10.1515/9781400865536

Tobin, J. (1969). A General Equilibrium Approach To Monetary Theory. Journal of Money, Credit and Banking, 1(1), 15–29. https://doi.org/10.2307/1991374

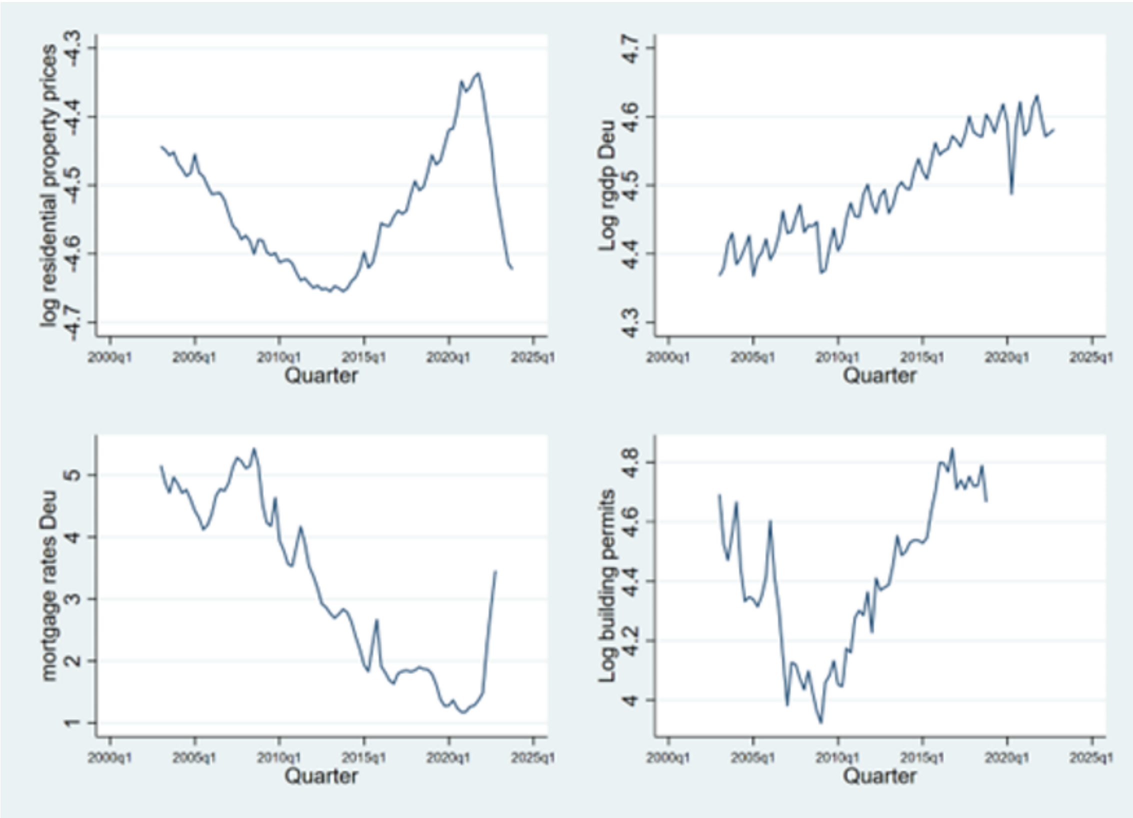
Williams, B., & Nedovic-Budic, Z. (2016). The real estate bubble in Ireland. Policy context and responses. Urban Research & Practice, 9(2), 204–218. https://doi.org/10.1080/17535069.2016.1174401

Wu, J. C., & Xia, F. D. (2016). Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound. Journal of Money, Credit and Banking, 48(2–3), 253–291. https://doi.org/10.1111/jmcb.12300

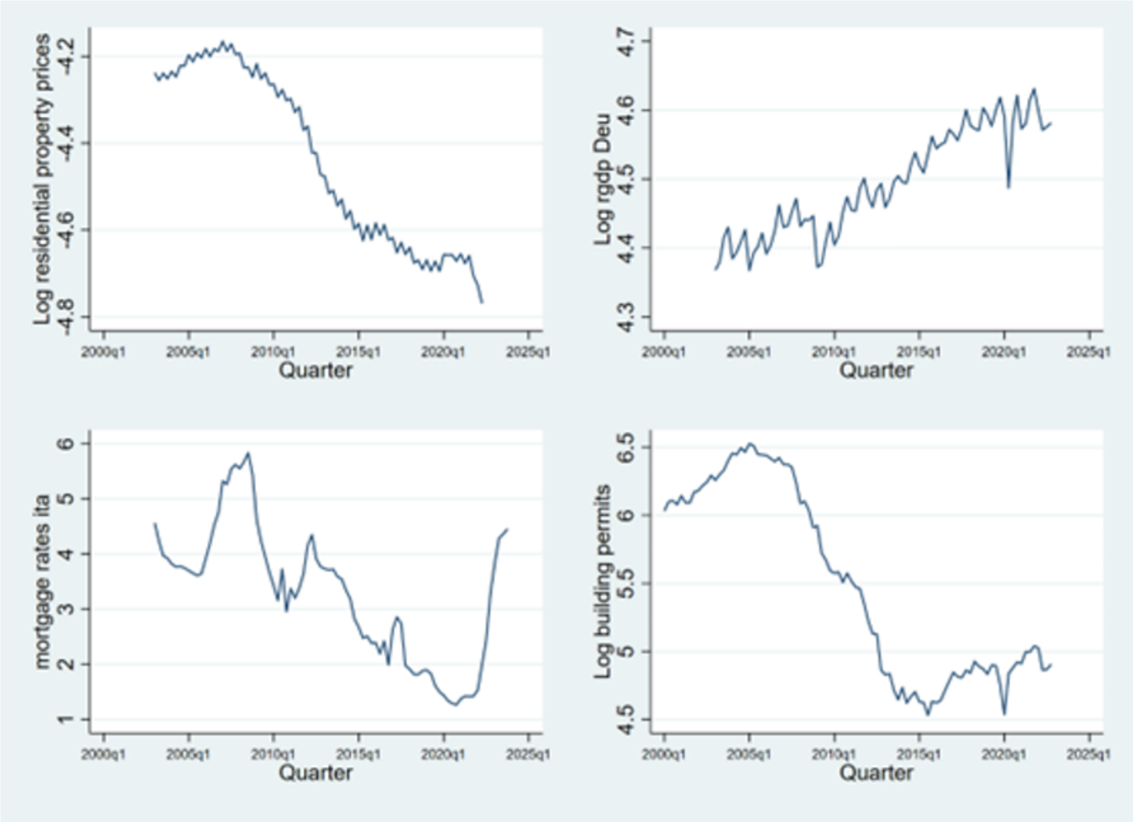
APPENDIX

Variable	Description	Source	Original time format
gdp_deu	GDP of Germany at current USD prices	OECD Database	Quarterly
gdp_ita	GDP of the Euro area at current USD prices	OECD Database	Quarterly
gdp_ea	GDP of Italy at current USD prices	OECD Database	Quarterly
hicp_deu	Harmonized index of consumer prices of Germany. Values indexed to 2015.	ECB dataportal	Quarterly
hicp_ea	Harmonized index of consumer prices of the Euro area. Values indexed to 2015.	ECB dataportal	Quarterly
hicp_ita	Harmonized index of consumer prices of Italy. Values indexed to 2015.	ECB dataportal	Quarterly
res_deu	Residential property price index of Germany. Values indexed to 2015.	ECB dataportal	Quarterly
res_ea	Residential property price index of the Euro Area. Values indexed to 2015.	ECB dataportal	Quarterly
res_ita	Residential property price index of Italy. Values indexed to 2015.	ECB dataportal	Quarterly
build_deu	Construction permits Issued for dwellings and residential Buildings for Germany.	Federal Reserve Bank of St. Louis	Monthly
build_ea	Construction permits Issued for dwellings and residential Buildings for the Euro Area.	Federal Reserve Bank of St. Louis	Monthly
build_ita	Construction permits Issued for dwellings and residential Buildings for Italy.	Statista.com	Quarterly
mr_deu	Mortgage interest rate for house purchases in Germany.	Bank of Germany statistical warehouse	Monthly
mr_ea	Mortgage interest rate for house purchases in Euro area.	ECB dataportal	Monthly
mr_ita	Mortgage interest rate for house purchases in Italy.	Bank of Italy Statistical database	Monthly
DFR	ECB deposit facility rate.	Federal Reserve Bank of St. Louis	Daily
eonia	Euro overnight index average (EONIA)	Federal Reserve Bank of St. Louis	Daily
European Central Banks total assets	ECB total assets diveded by Euro area population.	ECB dataportal	Monthly

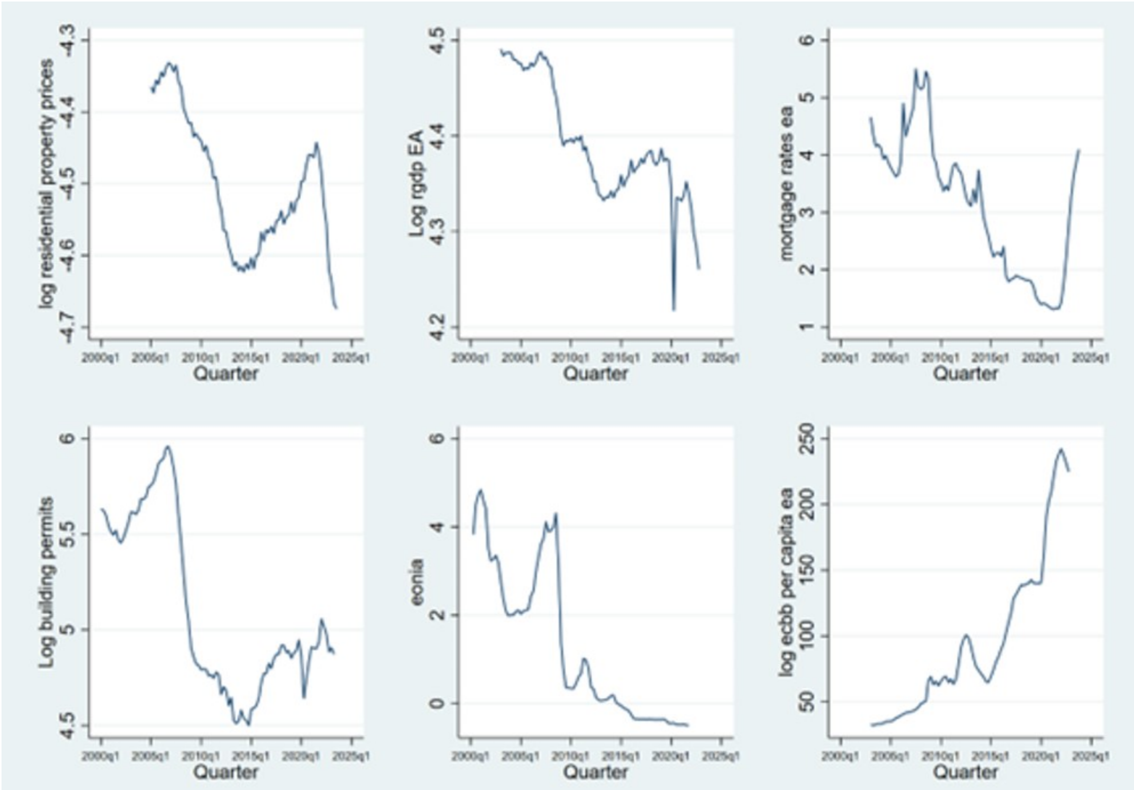
Appendix 1. Description and sources of the variables.



Appendix 2. Mortgage interest rates, log of RDGP per capita and log of building permits index 2015 = 100. Whole sample period Q1 2003 – Q4 2021, Germany.



Appendix 3. Mortgage interest rates, log of RDGP per capita and log of building permits index 2015 = 100. Italy



Appendix 4. Mortgage interest rates, log of RDGP per capita and log of building permits index, residential property price index (2015 = 100), EONIA and ECB's assets per Euro area capita. Euro area.

Selection-order criteria
Sample: 2003q4 - 2021q4 Number of obs = 73

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	455.208				1.8e-13	-12.3071	-12.232	-12.1188
1	701.344	492.27	36	0.000	5.8e-16	-18.0642	-17.5391	-16.7464*
2	758.031	113.37*	36	0.000	3.3e-16*	-18.631*	-17.6557*	-16.1837

Endogenous: dlog_rgdp_per_capita_ea dlog_real_res_ea dlog_build_ea mr_ea eonia dlog_recbb_per_capita
Exogenous: _cons

.

Appendix 5. Optimal lag structure for Euro area variables. Whole sample period.

Selection-order criteria
Sample: 2004q2 - 2021q4 Number of obs = 71

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	197.885				3.0e-09	-5.43339	-5.37002	-5.27404
1	458.454	521.14	25	0.000	4.0e-12	-12.0691	-11.6889	-11.1131
2	521.134	125.36	25	0.000	1.4e-12*	-13.1305*	-12.4335*	-11.3777*
3	543.434	44.601*	25	0.009	1.5e-12	-13.0545	-12.0406	-10.505
4	552.416	17.963	25	0.844	2.5e-12	-12.6033	-11.2726	-9.25704

Endogenous: dlog_real_res_ita mr_ita dlog_build_ita eonia dlog_recbb_per_capita
Exogenous: _cons

Appendix 6. Optimal lag structure for Italy. Whole sample period.

Selection-order criteria
Sample: 2004q2 - 2021q4 Number of obs = 71

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-421.424				1.88188	11.9838	12.0345	12.1112
1	-233.207	376.43	16	0.000	.014728	7.1326	7.38606*	7.76998*
2	-213.932	38.55	16	0.001	.013492	7.04034	7.49658	8.18762
3	-195.038	37.789*	16	0.002	.012576*	6.95881*	7.61781	8.61598
4	-182.724	24.627	16	0.077	.014251	7.06265	7.92443	9.22972

Endogenous: dlog_real_res_deu dmr_deu log_build_deu rgdp_per_capita_deu
Exogenous: _cons

Appendix 7. Optimal lag structure for Germany. Whole sample period.

Euro Area	chi2	Prob > chi2
Δ log of residential house price index ⇏ Δ Log of real gpdp per capita	**6.06**	**0.037**
Δ log of building perimit index ⇏ Δ Log of real gpdp per capita	2.10	0.330
mortgage interest rate ⇏ Δ Log of real gpdp per capita	1.20	0.540
eonia ⇏ Δ Log of real gpdp per capita	4.26	0.110
Δ log of ECB's total balance sheet per capita ⇏ Δ Log of real gpdp per capita	2.06	0.350
All ⇏ Δ Log of real gpdp per capita	**17.71**	**0.060**
Δ Log of real gpdp per capita ⇏ Δ log of residential house price index	**7.2**	**0.027**
Δ log of building perimit index ⇏ Δ log of residential house price index	**7.56**	**0.023**
mortgage interest rate ⇏ Δ log of residential house price index	**7.24**	**0.027**
eonia ⇏ Δ log of residential house price index	**5.05**	**0.080**
Δ log of ECB's total balance sheet per capita ⇏ Δ log of residential house price index	2.94	0.230
All ⇏ Δ log of residential house price index	**19.13**	**0.039**
Δ Log of real gpdp per capita ⇏ Δ log of building perimit index	0.11	0.940
Δ log of residential house price index ⇏ Δ log of building perimit index	**20.389**	**0.000**
mortgage interest rate ⇏ Δ log of building perimit index	**13.98**	**0.001**
eonia ⇏ Δ log of building perimit index	**20.52**	**0.000**
Δ log of ECB's total balance sheet per capita ⇏ Δ log of building perimit index	4.53	0.103
All ⇏ Δ log of building perimit index	**35.35**	**0.000**
Δ Log of real gpdp per capita ⇏ mortgage interest rate	0.14	0.920
Δ log of residential house price index ⇏ mortgage interest rate	**4.63**	**0.098**
Δ log of building perimit index ⇏ mortgage interest rate	0.39	0.860
eonia ⇏ mortgage interest rate	**32.93**	**0.000**
Δ log of ECB's total balance sheet per capita ⇏ mortgage interest rate	3.23	0.190
All ⇏ mortgage interest rate	**45.144**	**0.000**
Δ Log of real gpdp per capita ⇏ eonia	1.29	0.520
Δ log of residential house price index ⇏ eonia	**4.83**	**0.089**
Δ log of building perimit index ⇏ eonia	2.05	0.350
mortgage interest rate ⇏ eonia	2.49	0.280
Δ log of ECB's total balance sheet per capita ⇏ eonia	**7.37**	**0.025**
All ⇏ eonia	**20.4**	**0.025**
Δ Log of real gpdp per capita ⇏ Δ log of ECB's total balance sheet per capita	**4.5**	**0.100**
Δ log of residential house price index ⇏ Δ log of ECB's total balance sheet per capita	1.93	0.380
Δ log of building perimit index ⇏ Δ log of ECB's total balance sheet per capita	0.093	0.950
mortgage interest rate ⇏ Δ log of ECB's total balance sheet per capita	2.13	0.330
eonia ⇏ Δ log of ECB's total balance sheet per capita	**15.3**	**0.000**
All ⇏ Δ log of ECB's total balance sheet per capita	**27.93**	**0.002**

Appendix 8. Granger causality test results for Euro area whole sample period. Δ notes that the variable is differenced, and the bolded variable and results indicate that the null hypothesis of the test has been rejected at 10 % significance level. Whole sample period Q1 2003 – Q4 2021.

Italy	chi2	Prob > chi2
Δ log of residential house price index ⇏ Δ Log of real gpdp per capita	**16.23**	**0.000**
Δ log of building perimit index ⇏ Δ Log of real gpdp per capita	0.38	0.820
mortgage interest rate ⇏ Δ Log of real gpdp per capita	2.70	0.330
eonia ⇏ Δ Log of real gpdp per capita	**5.44**	**0.060**
Δ log of ECB's total balance sheet per capita ⇏ Δ Log of real gpdp per capita	**5.49**	**0.060**
All ⇏ Δ Log of real gpdp per capita	**31.88**	**0.000**
Δ Log of real gpdp per capita ⇏ Δ log of residential house price index	4.2	0.120
Δ log of building perimit index ⇏ Δ log of residential house price index	4.06	0.130
mortgage interest rate ⇏ Δ log of residential house price index	**6.23**	**0.044**
eonia ⇏ Δ log of residential house price index	**6.99**	**0.030**
Δ log of ECB's total balance sheet per capita ⇏ Δ log of residential house price index	1.05	0.590
All ⇏ Δ log of residential house price index	**38.23**	**0.000**
Δ Log of real gpdp per capita ⇏ Δ log of building perimit index	0.12	0.940
Δ log of residential house price index ⇏ Δ log of building perimit index	2.9	0.230
mortgage interest rate ⇏ Δ log of building perimit index	1.39	0.490
eonia ⇏ Δ log of building perimit index	1.62	0.440
Δ log of ECB's total balance sheet per capita ⇏ Δ log of building perimit index	1.39	0.490
All ⇏ Δ log of building perimit index	**25.04**	**0.005**
Δ Log of real gpdp per capita ⇏ mortgage interest rate	0.677	0.710
Δ log of residential house price index ⇏ mortgage interest rate	3.7	0.150
Δ log of building perimit index ⇏ mortgage interest rate	0.39	0.300
eonia ⇏ mortgage interest rate	**6.88**	**0.032**
Δ log of ECB's total balance sheet per capita ⇏ mortgage interest rate	**3.04**	**0.210**
All ⇏ mortgage interest rate	**23.58**	**0.009**
Δ Log of real gpdp per capita ⇏ eonia	3.94	0.130
Δ log of residential house price index ⇏ eonia	**5.69**	**0.058**
Δ log of building perimit index ⇏ eonia	3.98	0.130
mortgage interest rate ⇏ eonia	4.04	0.130
Δ log of ECB's total balance sheet per capita ⇏ eonia	**9.64**	**0.008**
All ⇏ eonia	**25.24**	**0.005**
Δ Log of real gpdp per capita ⇏ Δ log of ECB's total balance sheet per capita	**7.19**	**0.027**
Δ log of residential house price index ⇏ Δ log of ECB's total balance sheet per capita	0.24	0.880
Δ log of building perimit index ⇏ Δ log of ECB's total balance sheet per capita	0.84	0.650
mortgage interest rate ⇏ Δ log of ECB's total balance sheet per capita	1.74	0.410
eonia ⇏ Δ log of ECB's total balance sheet per capita	**6.06**	**0.049**
All ⇏ Δ log of ECB's total balance sheet per capita	**26.57**	**0.003**

Appendix 9. Granger causality test results for Italy whole sample period. Δ notes that the variable is differenced, and the bolded variable and results indicate that the null hypothesis of the test has been rejected at 10 % significance level. Whole sample period Q1 2003 – Q4 2021.

Germany	chi2	Prob > chi2
Δ log of residential house price index ↛ Log of real gpdp per capita	1.51	0.460
log of building perimit index ↛ Log of real gpdp per capita	**8.79**	**0.012**
Δ mortgage interest rate ↛ Log of real gpdp per capita	1.48	0.470
eonia ↛ Log of real gpdp per capita	**4.88**	**0.080**
Δ log of ECB's total balance sheet per capita ↛ Log of real gpdp per capita	2.05	0.350
All ↛ Log of real gpdp per capita	**24.16**	**0.007**
Log of real gpdp per capita ↛ Δ log of residential house price index	**9.56**	**0.008**
log of building perimit index ↛ Δ log of residential house price index	**6.87**	**0.035**
Δ mortgage interest rate ↛ Δ log of residential house price index	1.46	0.480
eonia ↛ Δ log of residential house price index	0.23	0.880
Δ log of ECB's total balance sheet per capita ↛ Δ log of residential house price index	1.53	0.460
All ↛ Δ log of residential house price index	**50.49**	**0.000**
Log of real gpdp per capita ↛ log of building perimit index	0.3	0.850
Δ log of residential house price index ↛ log of building perimit index	0.39	0.820
Δ mortgage interest rate ↛ log of building perimit index	**5.03**	**0.081**
eonia ↛ log of building perimit index	**5.12**	**0.077**
Δ log of ECB's total balance sheet per capita ↛ log of building perimit index	0.348	0.840
All ↛ log of building perimit index	**21.7**	**0.017**
Log of real gpdp per capita ↛ Δ mortgage interest rate	1.01	0.600
Δ log of residential house price index ↛ Δ mortgage interest rate	0.69	0.708
log of building perimit index ↛ Δ mortgage interest rate	**4.97**	**0.083**
eonia ↛ Δ mortgage interest rate	**6.86**	**0.032**
Δ log of ECB's total balance sheet per capita ↛ Δ mortgage interest rate	3.15	0.200
All ↛ Δ mortgage interest rate	14.73	0.140
Log of real gpdp per capita ↛ eonia	4.5	0.105
Δ log of residential house price index ↛ eonia	0.24	0.880
log of building perimit index ↛ eonia	1.15	0.560
Δ mortgage interest rate ↛ eonia	1.31	0.510
Δ log of ECB's total balance sheet per capita ↛ eonia	**6.08**	**0.048**
All ↛ eonia	**17.15**	**0.071**
Log of real gpdp per capita ↛ Δ log of ECB's total balance sheet per capita	**6.38**	**0.041**
Δ log of residential house price index ↛ Δ log of ECB's total balance sheet per capita	1.5	0.460
log of building perimit index ↛ Δ log of ECB's total balance sheet per capita	0.99	0.800
Δ mortgage interest rate ↛ Δ log of ECB's total balance sheet per capita	0.92	0.630
eonia ↛ Δ log of ECB's total balance sheet per capita	**11.53**	**0.003**
All ↛ Δ log of ECB's total balance sheet per capita	**24.16**	**0.007**

Appendix 10. Granger causality test results for Germany whole sample period. Δ notes that the variable is differenced, and the bolded variable and results indicate that the null hypothesis of the test has been rejected at 10 % significance level. Whole sample period Q1 2003 – Q4 2021.

Unit roots Q1 2008 - Q3 2021

Stat/Var	Euro area *res*	Euro area *mr*	Euro area *build*	Euro area *GDP per capita*	Italy *res*	Italy *mr*	Italy *build*	Italy *GDP per capita*
Log-transformation	No	No	Yes	Yes	No	No	Yes	Yes
HICP-adjustment	No	No	Yes	Yes	No	No	Yes	Yes
ADF	-0.94	-2.87	-1.88	-2.09	-1.94	-4.14***	-3.22***	-1.44
PP	-0.24	-2.76	-3.71**	-3.18*	-1.55	-2.81	-3.92***	-2.23
KPSS	0.36	0.10***	0.24	0.25	0.25	0.05***	0.29	0.26
Z-A	-4.56	7.49***	-4.51	-5.28**	-3.10	-7.32***	4.5*	-3.76
	(Q4 2011)	(Q2 2014)	(Q1 2015)	(Q2 2012)	(Q2 2016)	(Q2 2014)	(Q2 2013)	(Q3 2015)

	Germany *res*	Germany *mr*	Germany *build*	Germany *GDP per capita*	ECB *eonia*	ECB *ecbb per capita*
Log-transformation	No	No	Yes	Yes	No	Yes
HICP-adjustment	No	No	Yes	Yes	No	Yes
ADF	-0.92	-2.18	-2.23	-1.44	-3.05	-2.70*
PP	-0.62	-2.45	-2.94	-2.23	-4.56***	-3.17**
KPSS	0.3	0.25	0.41	0.26	0.17*	0.081***
Z-A	-1.59	-3.92	-5.35**	-3.76	-14.86***	-3.27
	(Q4 2019)	(Q1 2017)	(Q1 2017)	(Q3 2015)	(Q4 2017)	(Q2 2012)

Appendix 11. Unit root test results for post-GFC variables. The table reports if have the variables been log-transformed and / or HICP-adjusted. It also reports the results from the Augmented Dickey-Fuller test (ADF, H_0: unit root), The Phillips-Perron (PP, H_0: unit root) the Kwiatkowski–Phillips–Schmidt–Shin tests (KPSS, H0: stationarity) and the Zivot and Andrews (Z-A), that allows for possible break in the time series when testing for a unit root (break in parentheses). The significance levels are denoted by 10 % = *, 5 % = ** and 1 % = ***.

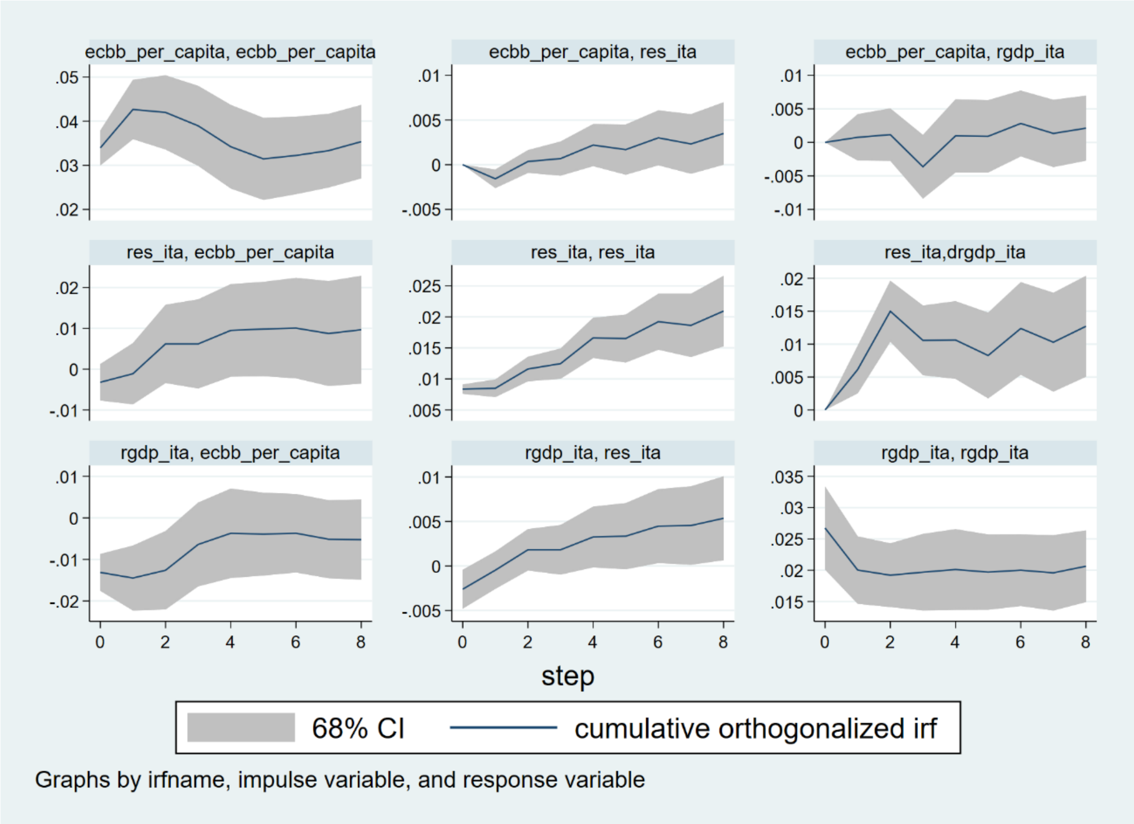
var rgdp_ea_ res_ea ecbb_per_capita	chi2	Prob > chi2
Δ log of residential house price index ↛ Δ Log of real gpdp per capita	6.59	0.150
Δ log of ECB's total balance sheet per capita ↛ Δ Log of real gpdp per capita	1.37	0.840
All ↛ Δ Log of real gpdp per capita	8.39	0.340
Δ Log of real gpdp per capita ↛Δ log of residential house price index	**9.15**	**0.050**
Δ log of ECB's total balance sheet per capita ↛Δ log of residential house price index	5.67	0.220
All ↛Δ log of residential house price index	14.06	0.080
Δ Log of real gpdp per capita ↛ Δ log of ECB's total balance sheet per capita	**12.73**	**0.013**
Δ log of residential house price index ↛ Δ log of ECB's total balance sheet per capita	**8.79**	**0.060**
All ↛ Δ log of ECB's total balance sheet per capita	**22.623**	**0.004**

var rgdp_ea_res_ea eonia	chi2	Prob > chi2
Δ log of residential house price index ↛ Δ Log of real gpdp per capita	5.02	0.280
eonia ↛ Δ Log of real gpdp per capita	1.33	0.850
All ↛ Δ Log of real gpdp per capita	8.88	0.350
Δ Log of real gpdp per capita ↛Δ log of residential house price index	**13.58**	**0.010**
eonia ↛Δ log of residential house price index	**30.72**	**0.000**
All ↛Δ log of residential house price index	**42.88**	**0.000**
Log of real gpdp per capita ↛ eonia	0.63	0.950
Δ log of residential house price index ↛ eonia	3.52	0.470
All ↛ eonia	4.92	0.766

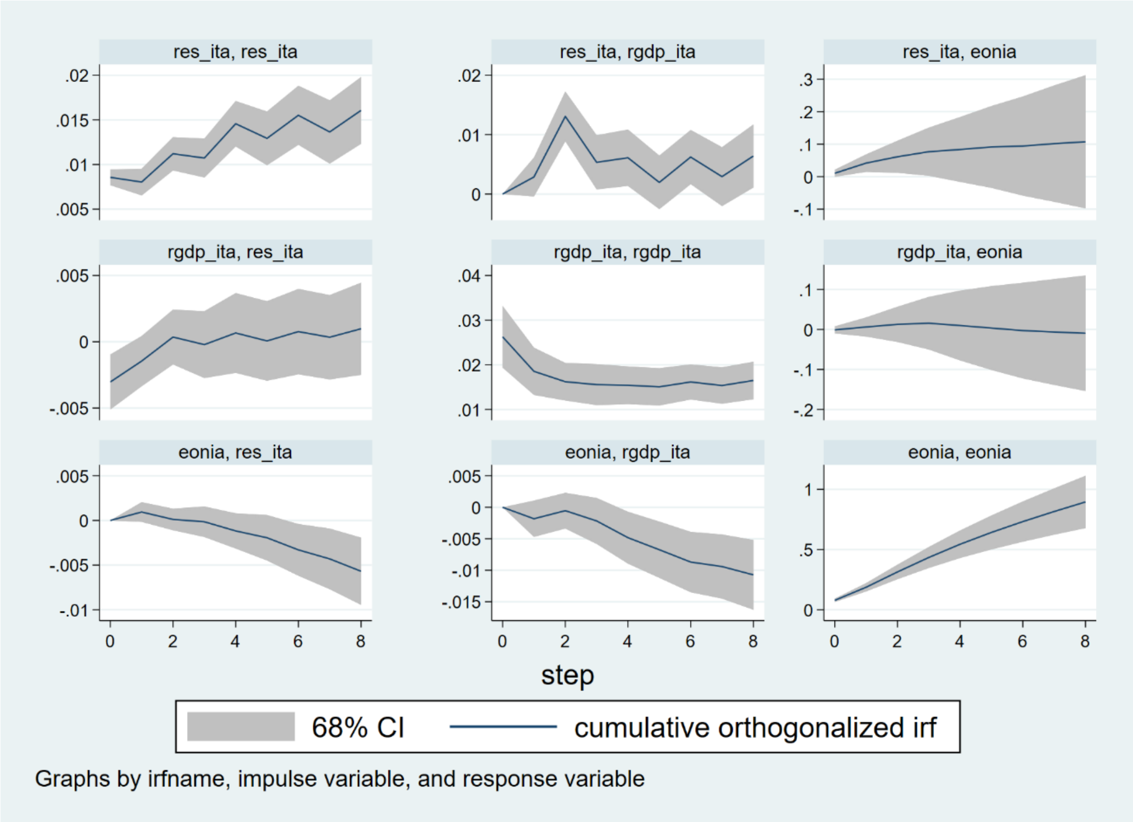
var rgdp_ea res_ea mr_ea		
Δ log of residential house price index ↛ Δ Log of real gpdp per capita	4.96	0.290
mortgage interest rate ↛ Δ Log of real gpdp per capita	0.57	0.966
All ↛ Δ Log of real gpdp per capita	7.98	0.430
Δ Log of real gpdp per capita ↛Δ log of residential house price index	**9.19**	**0.056**
mortgage interest rate ↛Δ log of residential house price index	**10.75**	**0.029**
All ↛Δ log of residential house price index	**19.90**	**0.029**
Δ Log of real gpdp per capita ↛Δ mortgage interest rate	0.081	0.990
Δ log of residential house price index ↛Δ mortgage interest rate	1.23	0.870
All ↛ Δ mortgage interest rate	1.45	0.990

var rgdp_ea_res_ea build_ea	chi2	Prob > chi2
Δ log of residential house price index ↛ Δ Log of real gpdp per capita	6.33	0.170
Δ log of building perimit index ↛ Δ Log of real gpdp per capita	1.32	0.850
All ↛ Δ Log of real gpdp per capita	8.85	0.355
Δ Log of real gpdp per capita ↛ Δ log of residential house price index	**22.5**	**0.000**
Δ log of building perimit index ↛ Δ log of residential house price index	**15.08**	**0.005**
All ↛ Δ log of residential house price index	**54.88**	**0.002**
Δ Log of real gpdp per capita ↛ Δ log of building perimit index	1.57	0.810
Δ log of residential house price index ↛ Δ log of building perimit index	6.1	0.190
All ↛ log of building perimit index	8.46	0.390

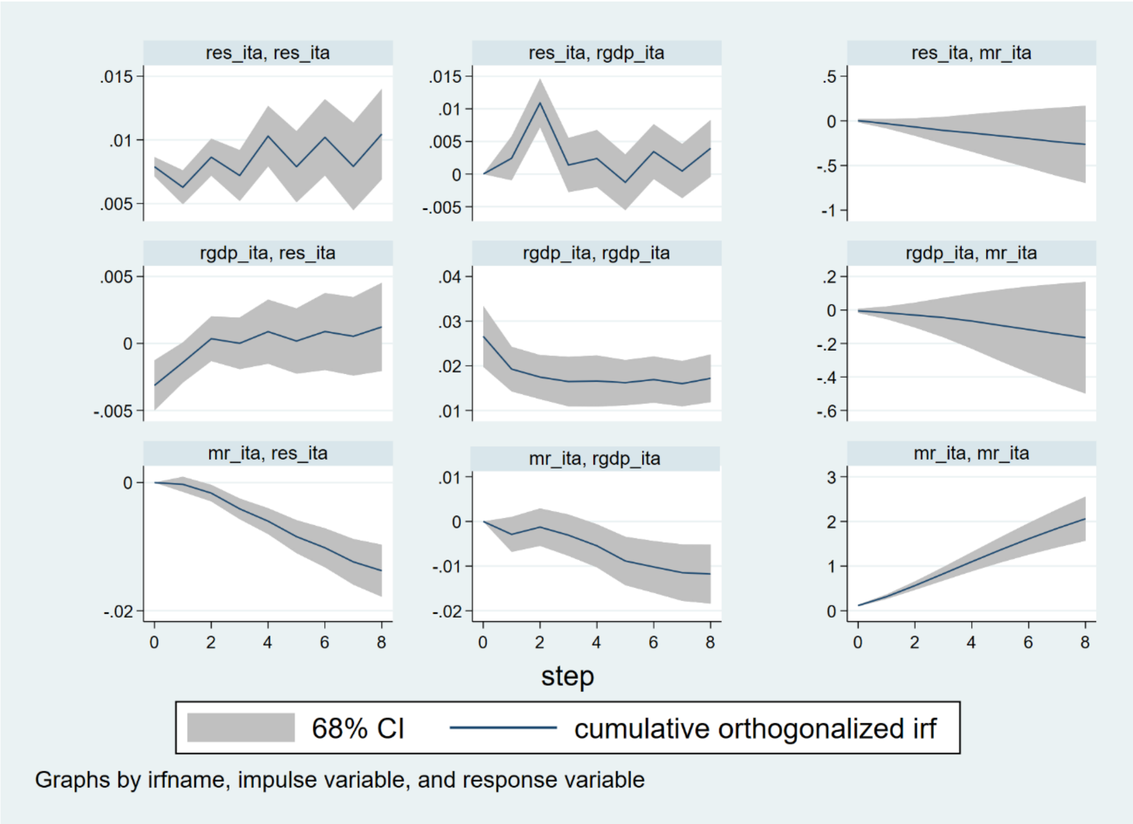
Appendix 12. Granger causality test results for Euro area post GFC period. Δ notes that the variable is differenced, and the bolded variable and results indicate that the null hypothesis of the test has been rejected at 10 % significance level. Q1 2008 – Q4 2021.



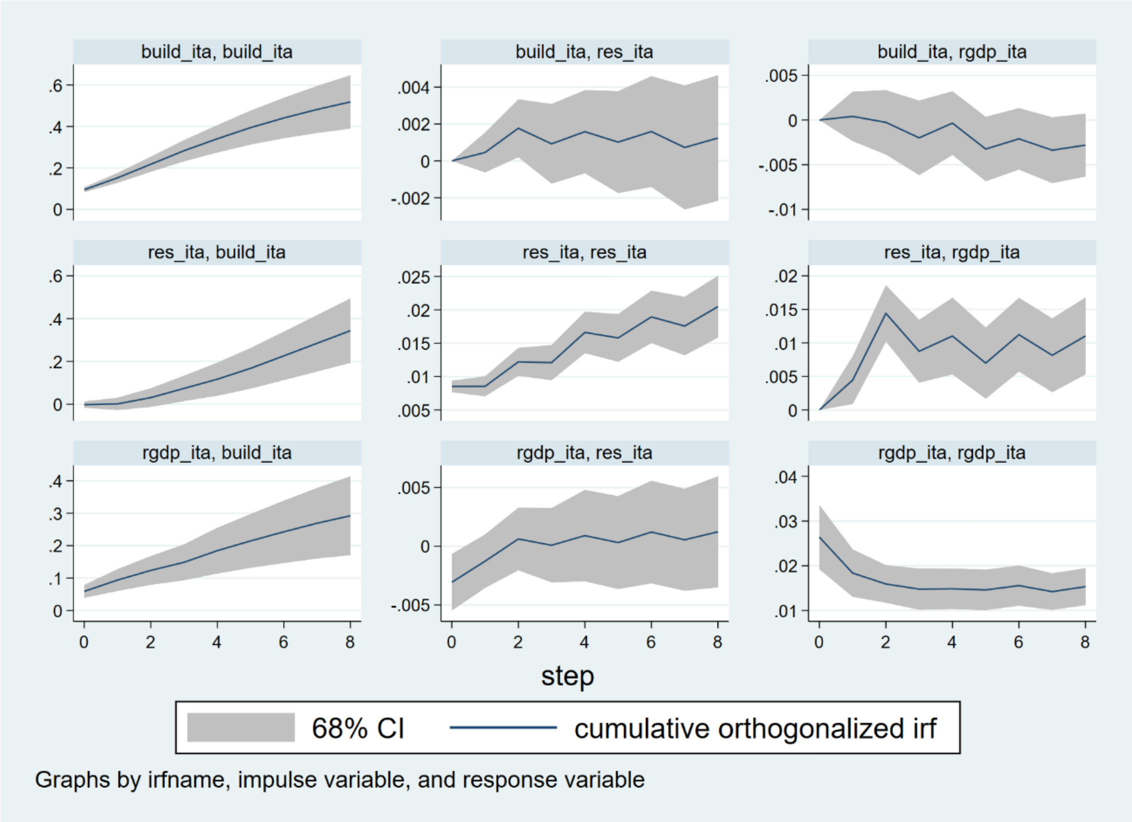
Appendix 13. Cumulative orthogonalized Impulse Response functions for Italy, variables real GDP per capita, real residential property price index, and ECB's total balance sheet. Q1 2008 – Q4 2021.



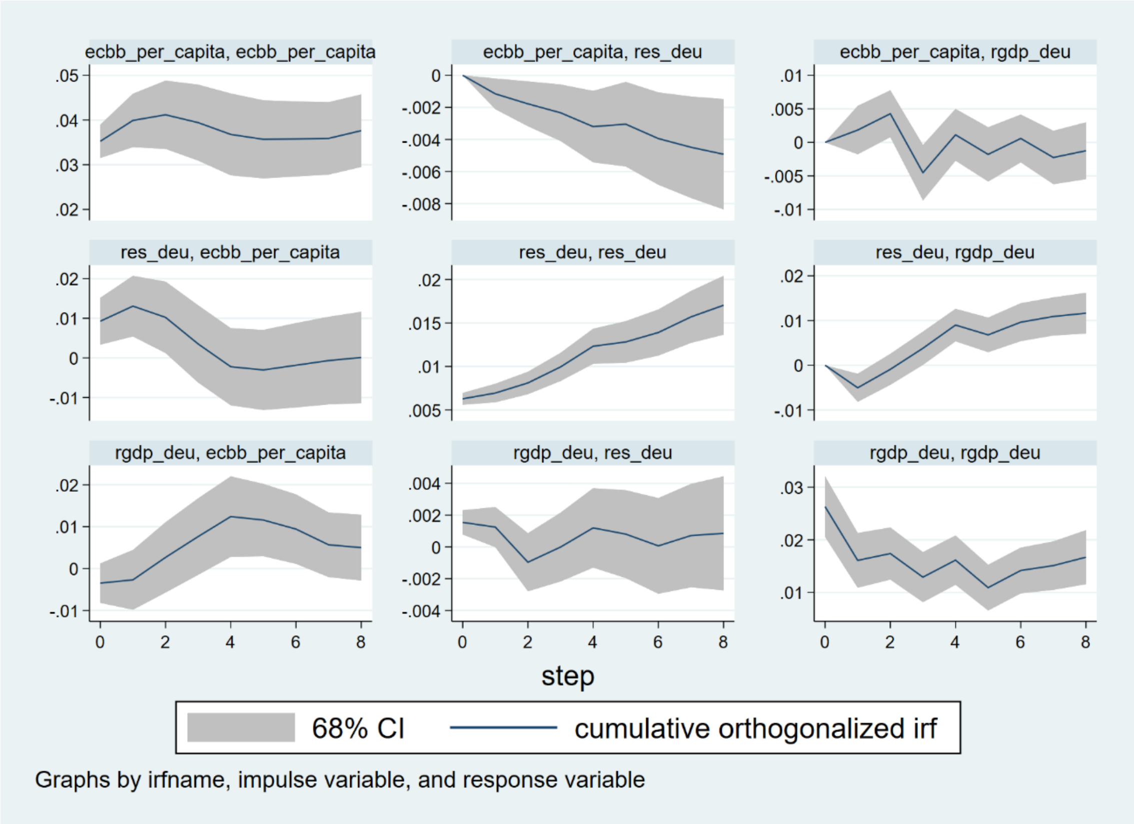
Appendix 14. Cumulative orthogonalized Impulse Response functions for Italy, variables real GDP per capita, real residential property price index, and Eonia rate. Q1 2008 – Q4 2021.



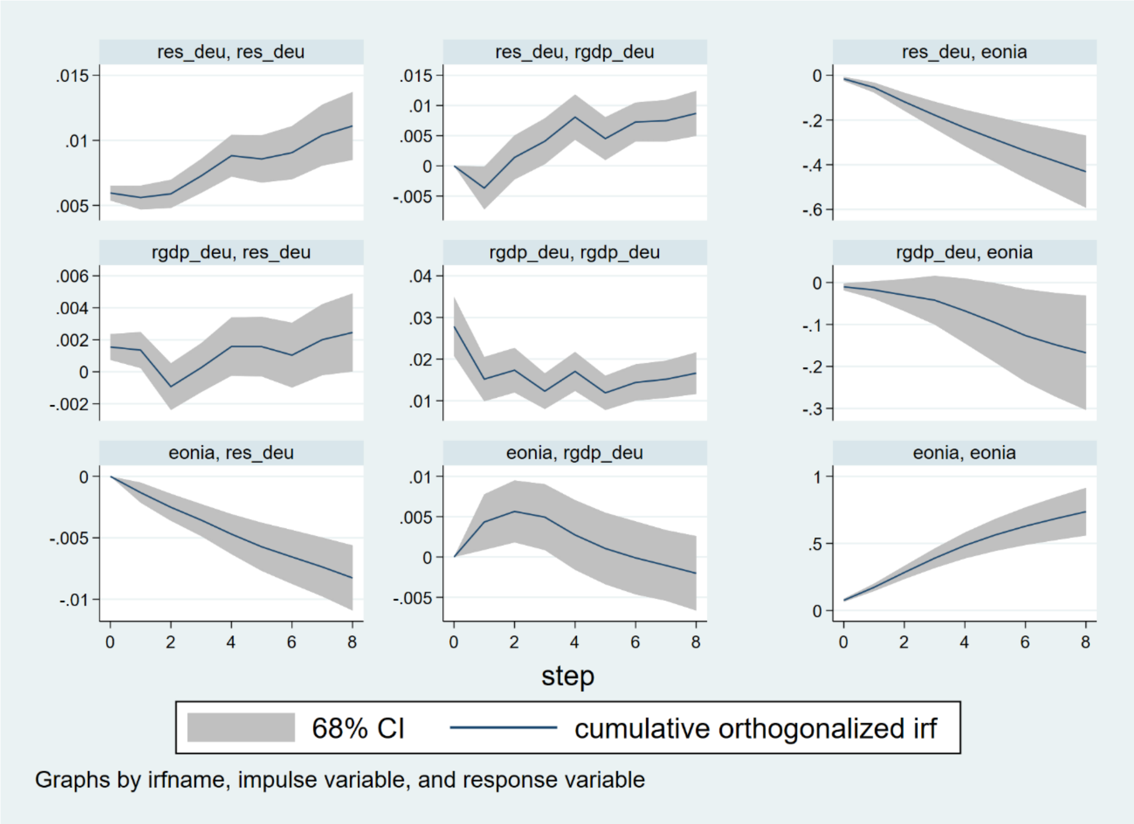
Appendix 15. Cumulative orthogonalized Impulse Response functions for Italy, variables real GDP per capita, real residential property price index, and mortgage interest rate. Q1 2008 – Q4 2021.



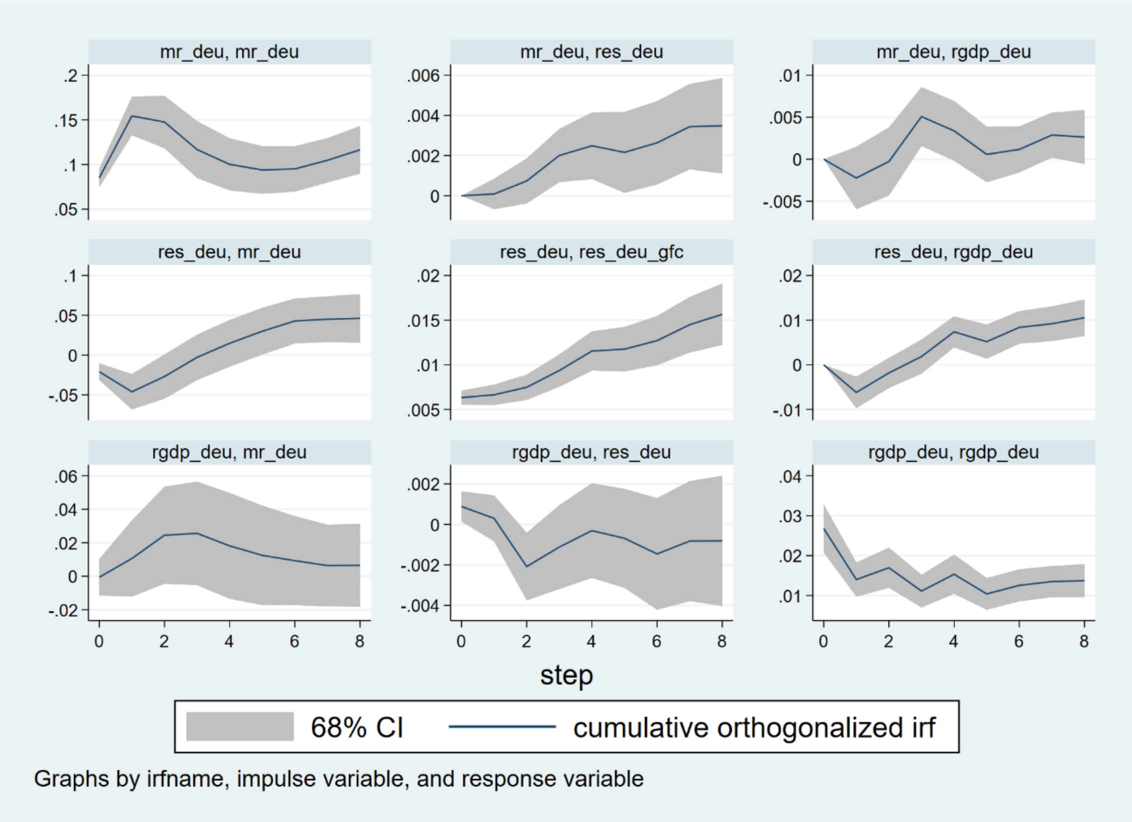
Appendix 16. Cumulative orthogonalized Impulse Response functions for Italy, variables real GDP per capita, real residential property price index, and residential property building permit index. Q1 2008 – Q4 2021.



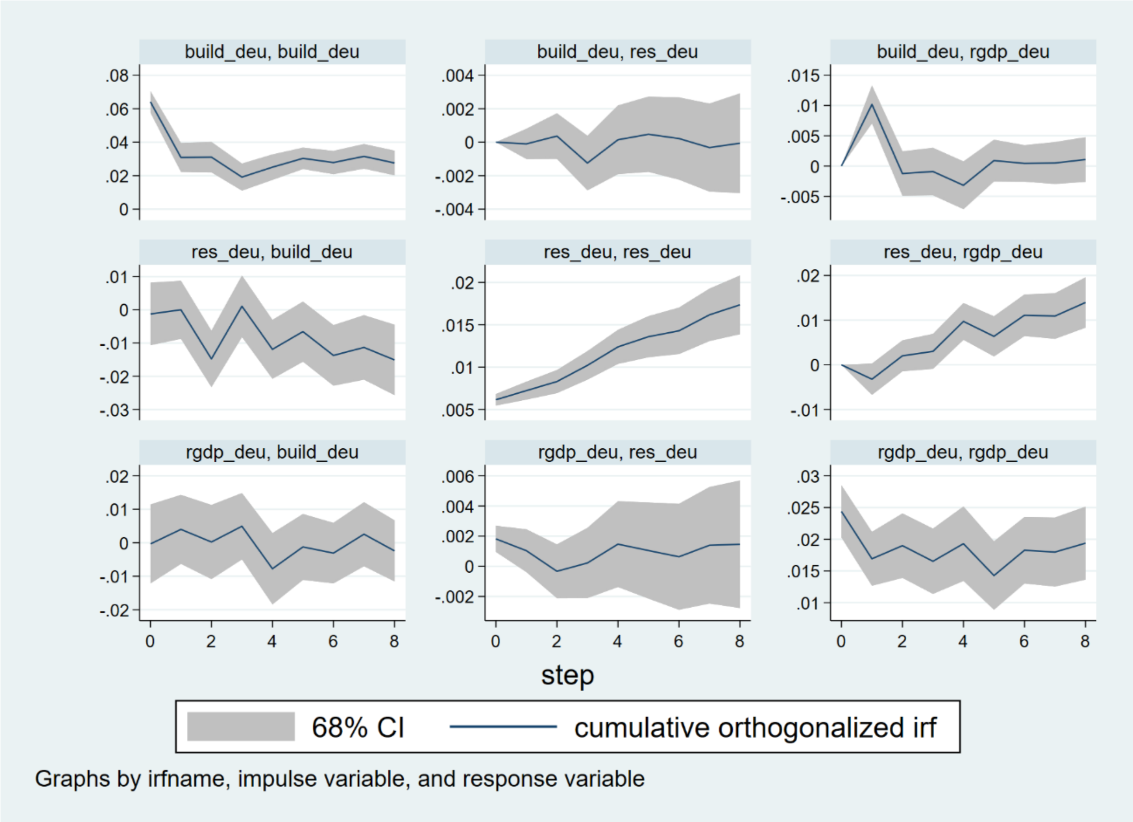
Appendix 17. Cumulative orthogonalized Impulse Response functions for Germany, variables real GDP per capita, real residential property price index, and ECB's balance sheet. Q1 2008 – Q4 2021.



Appendix 18. Cumulative orthogonalized Impulse Response functions for Germany, variables real GDP per capita, real residential property price index, and the Eonia rate. Q1 2008 – Q4 2021.



Appendix 19. Cumulative orthogonalized Impulse Response functions for Germany, variables real GDP per capita, real residential property price index, and mortgage interest rate. Q1 2008 – Q4 2021.



Appendix 20. Cumulative orthogonalized Impulse Response functions for Germany, variables real GDP per capita, real residential property price index, and residential building permit index. Q1 2008 – Q4 2021.

USAGE OF ARTIFICIAL INTELLEGENCE (AI)

In this master's thesis, some of the text was created with the help of Artificial Intelligence (AI). The text in this paper has been checked for grammar and syntax issues with the Grammarly AI application. Grammarly is a writing assistance tool that uses machine learning and deep learning in natural language processing (NLP).

The writing process and all the ideas are the author's original content, and the final output has been analysed for possible grammar errors using the Grammarly Premium application. Grammarly Premium allows the user to rewrite their original text with AI for better clarity, where the sentence construction might be altered. Some of the text has been rewritten with this feature. This feature of the Grammarly app does not alter the message of the text and is not able to add or deduct information to the text.

AI applications have not been used to write the thesis in any other shape or form.