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Private Credit and House Prices in the European Union Perspective

(DRAFT PAPER)

Abstract

The interaction between credit supply and house prices can have an important effect on the economy because developments in either the housing markets or the mortgage markets can influence the whole financial sector or even the economy. In fact, the US subprime mortgage crisis which started in the second half of 2007 confirmed the importance of the interaction between both markets. Although there are numerous studies on the interaction between credit and house prices at a country level, there are few cross-country studies. The first aim of the study is to examine the dynamic relationship between private credit and house prices at both cross- country and country level in the EU. Secondly, the effect of the different monetary strategy within the EU on this relationhip will be investigated. Thirdly, the direction and size of this interaction will be explored by considering the different sub-samples as well as some individual countries in the EU. For this purpose, two methods are used: the vector autoregressive (VAR) model and the simultaneous equations model. The latter is applied for robustness check. The findings of the study show that the direction and size of this interaction change among the sub-groups of the EU. This is the same for the individual countries in the Eurozone.

Key Words : House Prices, Private Credit, the European Union.
Classification: E32, E51, G21, R21.

1. Introduction

The housing sector, from both a social and economic point of view, is one of the leading sectors in many economies Due to this, governments most frequently intervene in this sector even in countries in those countries with a liberal economic system. It enjoys its status as a privileged sector in a country's economy because of the contribution that residential construction makes to high employment of unskilled labour and the production of construction inputs within the country. Developments in this sector can have positive and negative impacts on the economy, however. Housing is regarded as sound collateral in credit markets, which has an effect on aggregate consumption, on investments, and also on household indebtedness. Lack of development of housing markets can lead to inadequate housing and homelessness along with social problems.

A house is represents the most expensive commodity for most households, and home buyers need to borrow from the financial sector. Thus, credit affordability is important for people wanting to buy their own homes. Because of this, housing and mortgage markets are closely related, boosting the importance of the mortgage market in many countries. Mortgage debt accounts for a significant portion of household debt and of the GDP in many countries. Cerutti (2017) - examined mortgage markets of 120 developed and developing countries and concluded that housing credits make up 70% of aggregate household debts in most of those countries.[1] Within the European Union (EU), housing credit relative to total credit varies between 60% and 85% credits (EBA, 2017), and the share of mortgage debt in GDP is high in many countries in the EU (53.3% in Belgium, 42.3% in Germany and 95.5% in the Netherlands in 2017) (EMF, 2018).

The diversification[2] of funding sources in mortgage markets and the necessity of insurance for housing credit work to strengthen the connection between mortgage markets and other sub-financial markets (i.e.capital markets, money markets and insurance markets) (see. Figure 1). Because of this, effects of developments in housing markets or mortgage credit markets (e.g. pricevolatility) can be observed in all of the financial sector. Furthermore,

[1] He also found that the rate is lower than 40% in only six of the countries surveyed, and yet even in these countries, housing still constitutes the highest proportion of total credit (See Cerutti, 2017).

[2] With regard to housing credit, developed mortgage markets since the 1990s have seen an increase in capital-market-based funding relative to deposit-account funding. This evinces a steady shift from an 'originate-to-hold' model to an 'originate-to-distribute' one. In the first model, banks originate credits and keep them on their balance sheet until maturity. In the second model, credits are transferred to other entities (e.g. special-purpose vehicles) by the banks for the purpose of structured finance transactions, asset securitisation, etc. Thus, such debts are taken off the banks' balance sheets. They can therefore create additional funds and also isolate any risk deriving from their debt. This process contributes to an increase in non-bank financial intermediaries. See. FCIC, 2010(a).

especially since the 1990s, there has been an increase both in credit payment alternatives and availability of new hybrid financial instruments,[3] which have strengthened the connections between credit markets and other sub-financial markets. As such the importance for the economy of the interaction between housing and credit markets has significantly increased because developments in either of these markets can affect the whole financial sector and even the whole economy (Thompson et al., 2007). The US subprime mortgage crisis confirmed the importance of this interaction between two markets.

[INSERT FIGURE 1]

For these reasons, it is proposed that an investigation of the relationship between credit and housing markets is of key importance with respect to financial and economic stability; it would enhance prediction and allow policy-makers to set appropriate policies thereby mitigating economic instability.

In today's globalised financial markets, shocks occurring in one country can easily spread to other, as evidenced by the latest global crisis (2007-2008). Developments in the US housing and mortgage credit markets soon affected many countries, resulting in the first global crisis of the 21st century. It is also therefore, it is also necessary to investigate the relationship between the two markets, especially with regard to the relationship between credit and house prices at a cross-country level. Most studies in the literature are at country level (e.g. Gerlach and Peng, 2005; Oikarinen, 2009; Öhman and Yazdanfar, 2018) with only few cross-country studies (e.g. Collyns and Sendhadji, 2005; Goodhart and Hofmann (2008). Even so, neither direction nor the size of this interaction at cross-country level has not been fully examined yet.

Neither have eexisting cross-country studies examined separately focused on either the interaction between credit and house prices in the regional block o at an advanced stage of economic integration, such as the EU. The EU comprises two groups of countries with respect to phase of economic integration: Eurozone and non- Eurozone. Eurozone countries[4] belong to the economic and monetary union area of the EU, whereas non-Eurozone countries are yet to fulfil the required criteria (e.g. Hungary and Poland) or choose to remain outside (e.g. Denmark

[3] Adjustable-rate mortgage (ARM) loans, only interest loan and hybrid ARM loans are some of these credit payment alternatives. Collateralised Mortgage Obligations (CMOs), credit default swaps (CDSs) and credit debt obligations (CDOs) are examples of new hybrid financial instruments (for more information see. Fabozzi, 2007).

[4] Countries eligible to join Eurozone need to fulfil certain criteria, known as convergence criteria or Maastricht convergence criteria, namely price stability, interest rate, exchange rate and the government's fiscal position (budget and debt criteria). The last one relates to the position of government budget and debt. For more information see. EC, 2016.

and the UK). Crucially, Eurozone countries cannot implement their own monetary policy, which affects credit supply and hence the relationship between credit and house prices. Research on the relationship between these markets may yield different results for Eurozone and non-Eurozone countries. Nonetheless, even countries are in the same group may be differently affected by markets developments and also show evidence of a different level of relationship between the two markets. The EU's crisis countries, known as GIIPS,[5] exemplify this situation. It may also therefore be useful to examine the GIIPS countries separately.

A literature review reveals no studies that focus on the relationship between credit and house prices in the EU alone. Nor are there any studies on this relationship that consider the Eurozone and non-Eurozone countries separately. Also, the special position of the GIIPS countries, which experienced a sovereign debt crisis, has not been investigated either at cross-country or individual-country level. This study therefore examines the interaction between credit and house prices in EU countries by classifying the countries based on: monetary policy strategy (Eurozone and non-Eurozone); whether they have experienced a sovereign debt crisis (GIIPS); whether they have simultaneously faced a credit boom and house price boom (GIIS); and whether or not the main reason for the crisis was a house price boom–bust (IS). The relationship is also explored at country level by considering the GIIPS countries separately.

Thus, the first aim of the study is to examine the dynamic relationship between private credit and house prices at both cross-country and country level within the EU. Private credit covers loans that deposit money banks and other financial institutions lend to the non-financial sector (households and non-financial companies excluding general government [BIS, n.d.]. Second, the effect on this relationship of differing monetary strategies within the EU will be investigated. Third, the direction and size of this relationship will be explored by considering different sub-samples as well as individual countries within the EU

In this study, three hypotheses are tested. First, there is a dynamic relationship between credit supply and house prices. Second, monetary policy affects this relationship. Third, this relationship looks different at a cross-country and an individual-country level, even when the countries involved have the same monetary policy.

The following research questions will be addressed:

- In what ways are credit supply and house prices linked at a cross-country level?

[5] The GIIPS consists of Greece, Ireland, Italy, Portugal and Spain.

- Does being subject to a common monetary policy make any difference to the relationship between credit supply and house prices with regard to their size and direction?
- Does being a member of the Eurozone make a difference to the relationship between credit and house prices?
- Is this relationship different between countries when they are subject to the same monetary policy?

This study covers the period between 1990q1 and 2017q3, and focuses on 14 EU countries that are early EU members.[6] It estimates the relationship in question by employing two methods: a vector autoregressive (VAR) and a simultaneous equations model. The second method is applied to check robustness. First, the relationship is analysed for the whole sample using the panel VAR model. Then, it is estimated a second time by grouping the countries at EU and Eurozone levels. The EU-level grouping is based on implemented monetary policy strategy, and the Eurozone groups are sorted by: whether the country has experienced a sovereign debt crisis; if so, whether it simultaneously faced a credit boom and housing price boom, and whether the main reason for the crisis was a house price boom–bust cycle. Finally, this relationship is examined for each of the sovereign debt crisis countries (i.e. Greece, Ireland, Italy, Portugal and Spain). Thus, it will be possible to discover whether there is a difference between Eurozone and non-Eurozone countries, as well as between the sub-groups of the Eurozone, and also between individual countries with regard to the size and direction of the relationship between credit and house prices.

The findings from the analysis show differences in the size and direction of the relationship between credit and house prices in the lag order one. There is a two-way relationship between credit and house prices for the whole sample, but, one way relationship for the Eurozone and non-Eurozone groups as well as some of the sub-groups of the Eurozone. These results are similar across individual countries.

The contribution of this study is to examine the relationship between credit supply and house prices at cross country and country level in the EU and reveal the direction and the size of this relationship; to consider the effect of different monetary policy on this relationhip and to compare the sub-groups of the Eurozone as well as individual countries; to identify the diffrences between them; to reveal the importance of the direction of casuality between credit

[6] These countries all joined the EU before 2004. They are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden and the UK. Luxembourg is the 15th in this category, and a founder member, but is not included due to lack of data.

and house prices for governing this relationship in order to implement more efficient micro and macro policies in the economy.

The paper is structured as follows: Section 2 introduces the literature review; Section 3 describes the theoretical framework; Section 3 explains the importance of the Eurozone in the EU; Section 4 includes the theoretical framework. Sections 5 and 6 cover methodology and data description; Section 7 is an empirical analysis and discusses the main findings; Section 8 presents the results of the robustness check; and Section 9 draws the main conclusions.

2. Literature Review

Numerous studies have examined the relationship between credit house prices.[7] There are a number of country based studies (e.g. Fitzpatrick and Mcquin, 2007; Ibrahim and Lae, 2014; Öhman and Yazdanfar, 2018) and there are also few studies examining this relationship at cross-country level (Collyns and Sendhadji, 2005; Goodhart and Hofmann, 2008).

Hofmann (2004) examined the factors that determine the capacity of the banking sector to lend to the non-finance private sector in the long-term by taking into account the 16 industrialized countries. He also emphasizes that credit demand cannot be explained by standard factors (e.g. economic activity and interest rate) in the long term. Hoffman (2004) concludes that house prices are an important determinant in credit movements; that they significantly affect the bank lending; that innovations have a significant impact on both house prices and bank lending; and that house prices are an important determinant in lending to the private sector in the long term due to the widespread use of housing as a collateral. Moreover, the findings of Hoffman (2004) show that there is a one-way relationship between house prices and banking lending, and that the effect of prices on credit is much stronger than the effect of credit on prices.

Collins and Senhadji (2005) investigate the commercial and residential real estate price cycles and other asset prices` relationships with the bank lending and whether there was a link between them and the financial crisis during the Asian crisis of 1997. Their sample covers 10 Asean countries and they employ two techniques; OLS regression for cross-country analysis well as VAR model for country level. They reached similar results with Hofmann (2004), but differently from him, their analysis is at cross country as well as country level. The results of

[7] In fact, there are some studies on the interaction between commercial real estate prices and bank lending (e.g. Vogiazus and Alexiou, 2017; Davis and Zhu. Since this study examines the relationship between bank lending and residential house prices, it focuses on only the literature review on the relationship with respect to residential house prices. .

regression analysis for four East Asian countries point out that property prices are strongly procyclical; bank lending has contributed to real estate prices significantly and the response of real estate prices was stronger pre-1997-98 Asian crisis and the response of real estate prices to credit was asymmetric. The estimations of the VAR model covering eight South East Asian countries support the theory, that there is a two-way relationship between real estate prices and the bank lending. The direction of this interaction is stronger from bank lending to real estate prices. In addition, they found that in these countries, bank lending contributed to both asset and real estate price increases. The relationship between real estate prices and house prices was stronger than the relation of bank lending with other asset prices during pre-crisis period.

Garlach and Peng (2005) explored whether there was causality between house prices and bank lending in Hong Kong. They come to the conclusion that the change in house prices directly (e.g. leading to the appreciation of the real estate portfolios of the banks) or indirectly (e.g. influencing the size of non-performing loans) makes an impact on the banks' financial positions and then, the capacity of bank lending. They also point out that in Hong Kong, the main reason for excessive growth in bank lending is the housing price boom. In addition, their results are similar to that of Hofmann's (2004) and show that in Hong Kong, there is a one-way relationship between house prices and bank lending in the long-term and the direction of this relationship is from house prices to bank lending.

A number of studies examined the relationship between house prices and bank lending in China (e.g. Liang and Cao, 2007; Che et al. , 2011; and Qi and Zheng, 2014). Qi and Zheng (2014), who consider housing loans from 28 commercial banks in China, show that this relationship is bi-directional and positive in the long-run while Liang and Cao (2007) and Che et al. (2011) conclude that the relationship between house loans and house prices is unidirectional. Liang and Cao (2007) indicate that the direction of the relationship is from loans to housing price, while findings of Che et al. (2011) are in the opposite direction (i.e. from housing price to loans). In addition, Liang and Cao (2007), using a different model (i.e. Autoregressive Distributed Lag -ARDL) from previous studies, argue that it is unlikely that the interest rate tool in China will be enough to control housing price fluctuations.

Considering the example of Ireland, Fitzpatrick and Mcquinn (2007) modelled the determinants of house prices and residential mortgage credits. In both short and long-term analyses, they took into account the newly opened housing loans and, unlike previous studies,

they used many estimation techniques.[8] At the end of their analysis, they reached similar results Collyns and Senhadji (2005) Their results indicate that there is a mutual relationship between house prices and housing loans in the long run. Moreover, they point out that in the short term, credit growth had a significant positive impact on housing price increases in Ireland, but house prices did not have a similar effect on credit growth.

Greiber and Setzer (2007) examined the relationship between monetary developments and the housing market by using vector error correction model (VECEM). Their model , that was tested for the US and the Eurozone, covers residential property price index, economic activity (GDP), interest rates at real terms like previous studies. Unlike Hofmann (2004), they added more macroeconomic variables (e.g. inflation and broad money) to the standard credit model. The results of empirical analysis are in line with the results of earlier studies, i.e. the loose monetary conditions and house prices are related phenomena. In both the Eurozone and the US, there is also significant two way relationship between monetary variables and house prices. Another finding is that monetary policy affects the developments in housing markets through as well as interest rates, but also via liquidity of money.

In contrast to previous studies, Goodhart and Hofmann (2008)'s analysis is at cross-country level. take into account the group of countries (17- industrialized country). In contrast to previous studies, their analysis is not at individual country level, but at cross-country level like Collyns and Senhadji (2005). Their model specification was similar to that of Hofmann (2004) and Greiber and Setzer (2007) and they added more macroeconomic variables (e.g. inflation and money supply)to the standard credit model, which consists of economic activity and the short term interest rates. They also investigate which monetary variables (credit size or money supply) were more relavant in the interaction between house prices and bank lending as well as the effects of fluctuations in both house prices and monetary variables on total production and inflation. Their findings show that there is a multifaceted relationship between house prices, monetary variables and macro economy; the relationship between house prices and credit as well as money supply is strong and bi-directional; that this relationship is further strengthened, particularly after financial liberalization; that all shocks to housing price, credit and money supply have a significant impact on economic activity and inflation. Their suggestion is that monetary policy can be used to mitigate asset price boom cycles and the probability of financial instability in the long term.

[8] They are used such as the dynamic ordinary least squares, fully (DOLS), modified OLS (FM-OLS) and static OLS (SOLS).

Following the approaches of Hoffman (2004), Garlach and Peng,(2005), Oikarinen (2009) ve Gimeno and Martinez-Carrascal (2010) have used the same technique (VECEM) to examine the relationship between credit and house prices for Finland and Spain respectively. Unlike Hoffman (2004), both put the long term interest rates and housing loans in their model instead of short term interest rates and total private credit. Oikarinen (2009), who also examined the relationship between stock prices and credit along with the role of financial liberalization and reached the similar conclusions to that of Collyns and Senhadji (2005). His findings show that there is no correlation between stock prices and household borrowing in Finland; not only the impact of the mortgage credit supply on price movements, but also considerably positive impact on consumer credit ; since the beginning of the financial liberalization, there is a two-way and significant relationship between house prices and credit stock; this relationship towards the house prices from the bank lending is stronger in the long run. In addition, he shows that this relationship has increased significantly after the financial deregulation started at the end of the 1980s. This result coincides with the results of Wolswijik (2006), who found that financial deregulation has an important role in mortgage debt growth in some EU countries. The results of Gimeno and Martinez-Carrascal (2010) different from Oikarinen (2009), but similar to those of Garlach and Peng (2005). They found that there is a one-way relationship between house prices and bank lending in Spain and the direction of the relationship is from the house prices to the loan. However, their findings for a short-term differ from those of Garlach and Peng (2005), who found a two-way relationship between these two variables.

Brissimis and Vlassopoulos (2009) investigated the relationship between house prices and banking lending in Greece in both the short and long term, considering mortgage and housing markets. But unlike Hoffman (2004) and Gerlach and Peng (2005), but similar to Oikarinen (2009), they consider the housing loans. The findings of the analysis show that in the long term, there is a one-way relationship between credit and house prices while there is a two-way relationship in the short-term. They also find that the direction of the relationship is from the house prices to the credit.

Park et al. (2010) estimated a casual relationship between access to bank lending and house prices for five sub-markets in and outside Saoul in Korea using the VAR method. For this purpose, they consider the sub-market, where has experienced the rapid increase in house prices (the hottest market) in Seoul and four sub-markets with normal prices (cold market) outside Seoul. Their findings indicate that the short-term impact of bank lending on house prices is clearly seen, and that it is stronger in the hottest markets; that tight credit conditions

in 2005 affect bank lending in cold markets, but not affect the overheated markets. However, there is mixed evidence in related to the direction of relationship between bank lending and house prices.

In examining this relationship for Norway, Anundsen and Janse (2013), unlike most of the previous studies, consider household expectations in their model and their analysis is a system based cointegration analysis. Anundsen and Janse (2013) have examined this relationship in the short and long term by using the structural vector error correction model (SVAR) and found that there is a two-way relationship between credit expansion and house price in long-run; the expectations of households have a significant impact on this relationship; the effect of interest rates on house prices is indirectly through credit aggregates; when the supply side of the housing market is added to the model, this interaction weakens. They also point to the presence of credit-housing price spiral in Norway.

The findings of Addae-Dapaah and Anh (2014), who have analyzed the relationship between housing loans and house prices in short and long run for Singapore, have showed that there is a significant and two-way relationship between both variables in the long-termi.e., but not significant relationship in the short term. In addition, their findings indicate that direction of this relationship is obscure. This study also points out that the borrowing of households in Singapore provide important information on housing demand and house prices. They suggest that it is not possible to control housing price increases in a short time as a means of housing credit targeting.

In contrast to previous studies, Ibrahim and Law (2014) have examined the long-term interaction of house prices with bank loans on both macro and micro level from both the aggregate and disaggregate perspectives. For thiss purpose, they take into consideration the aggregate house prices index and the house prices sub-indices. Like Goodhart and Hofmann (2008), they also have examined the interaction of macroeconomic variables (real output and interest rates) with house prices as well as bank loans. From aggregate perspective, their results show that there is a causal relationship between both house prices and bank loans with real output and interest rates in the long run; there is also strong interaction between house prices and bank loans; the direction of interaction is from housing loans to bank loans. They suggest that the changes in house prices as well as in credits might have substantial impacts on real GDP in the short term.

Basten and Koch (2015) have investigated whether there is a casual effect of house prices on both mortgage demand and supply at canton level in Switzerland. They use instrumental variable methodology to determine the direction of this relationship. For this aim,

immigration is included in their model as an instrumental variable. Their analysis result on a canton level covering Geneva and Zurich show there is a strong mutual relationship between the mortgage loans and the real estate boom-bust cycles; there is positive reverse casulity from the mortgage loan to house prices is stronger; and higher house prices means an increasing mortgage demand.

For four developed countries (the Netherlands, Norway, Sweden and the US), Punzi (2016) has examined whether there is a simultaneous movement between three variables (i.e. asset prices, bank lending and economic activity) during the period between 1896 and 2014. Their results indicate that both the relationship between this trio as well as between house prices and credit has strengtend much more since the World War II , especially since the 1928 Great Depression and the 2007-2008 global financial crisis. In addition, she conclude that monetary shocks are more important in explaining these co- movements and that inflation shocks also play an important role in the relationship between house prices and credit in Scandinavian countries.

Nobli and Zolina (2017) have examined the multidimensional interaction between house prices and private credit, considering lending to households and construction firms in Italy. Unlike previous studies, they consider both housing and construction loans and use different method (ı.e simultaneous equations model with three-stage least squared technique). In addition, their model include a large number of control variables that affect both housing supply and demand as well as both mortgage loan supply and demand. Their findings show that in Italy, house prices are affected more by disposable income and demographic factors and that bank lending conditions (especially mortgage lending) have a significant impact on house prices through its impact on housing demand.

Unlike previous studies, Öhman and Yazdanfar (2018) have considered the prices of the two types of housing (apartment and villa) separately and also added the inflation to the standard credit model. Then, they explore the interaction of house prices with both inflation and mortgage interest rates. Their results confirm previous studies and indicate that there is an interaction between bank lending and house prices in long-term in Sweden. Their results are similar to the results of analysis of Fitzpatrick and Mcquinn (2007) and Okikarinen (2009) and show this interaction is bidirectional. Their findings also support the existence of the financial accelerator mechanism. However, the relationship between house prices and interest rates as well as inflation is mixed. The relationship of apartment prices with both interest rates and inflation is two-way, while the relationship of the villa prices with the same variables are one-way and its direction is from the villa prices to the bank loan.

On the other hand, some studies focused on the role of monetary policy in the relationship between credit and house prices (e.g.Calza et al. 2013; Igan et al., 2011; Zhu et al. 2017. Calza et al. (2013) have explored the relationship between the structure of the housing finance system and the monetary transmission mechanism and the effects of the monetary policy shocks on house prices as well as on investments. Their work is based on cross-country. In this study, that countries are grouped according to interest structures (e.g. fixed or variable rate contracts), they use the VAR model. Their findings show that the structure of the mortgage finance system significantly affect the transmission mechanism of the monetary policy; the size of this effect varies from country to country; the monetary policy in the more advanced and flexible mortgage markets has a strong impact on house prices and investments; the effect of the monetary transmission mechanism on consumption is stronger only in countries where mortgage equity release is widespread and mortgage loans are lent with more variable interest rates. In addition, the flexibility of the mortgage markets (e.g. LTV ratio or mortgage debt to GDP ratio) is not relevant for consumption that have different responses to monetary policy.

Zhua et al. al (2017) have examine how the house price stability are influenced by the structure of mortgage market as well as by monetary policy. They consider eleven Eurozone countries and concluded that in countries with more regulated markets, monetary policy has no significant impact on non-fundamental house prices; the less liberal housing markets react less to changes in interest rates. Similar to previous studies, their findings show that; the LTV ratio is very important determinant for the housing markets. They suggest that the LTV ratio may be used as a macro-prudential policy tool; policymakers should observe the LTV ratios and tax policy and limit mortgage equity withdrawals in order to mitigate the negative impacts of monetary policy on the housing markets.

In conclusion, the literature review shows that there are many studies that focus on the interaction between credit and house prices covering the countries in Europe and Asia. There are some similarities and differences between them.

In general, one of the common features of previous studies is that most of them is based on country level even if the study considers many countries (e.g. Hofmann, 2004). The second one is that they follow the VAR approach, except for a few.[9] The third is that they use the standard credit model and add housing price variable to this model. However, the monetary

[9] For example, Nobli and Zolina (2017) use simultaneous equation model. Liang and Cao (2007), and Qi and Zheng (2014) used autoregressive distributed lag (ARDL) and simultaneous equation model (2SLS) respectively while Fitzpatrick and McQuin (2007) apply many techniques, such as the dynamic ordinary least squares, fully (DOLS),modified OLS (FM-OLS) and static OLS (SOLS). Anundsen and Janse (2013) also used structural vector error correction model (SVAR).

variables in their model (e.g. bank lending and interest rates) are differentiated. Some, for example, have included credits to the private sector as a credit variable (e.g. Hofmann, 2004, Stephanyan and Guo, 2011); some have considered both total credits and housing credits (e.g. Gerlach and Peng, 2005); some have just included housing loans (e.g. Oikarinen, 2009; Brissimis and Vlassopoluos, 2009) or some have both construction loans and housing loans (e.g. Nobli and Zolina, 2017). Again, it is observed that some studies use the funding cost of financial institutions (i.e. short term interest rate) to stick to the standard model (e.g. Hofmann, 2004) while others only include long-term interest rates it (e.g. Gimeno and Martinez-Carrascal, 2010) or both (e.g. Nobli and Zolina, 2017) or variable mortgage interest rates in analysis (e.g. Brissimis and Vlassopoulos, 2009). On the other hand, while investigating the relationship between credit and house prices some studies have added some macroeconomic indicators (e.g. inflation, employment financial wealth, population) to the standard model (e.g. Liang and Cao, 2007; Goodhart, and Hofmann, 2008; Nobli and Zolina, 2017; Öhman and Yazdanfar, 2018)

Furthermore, the findings of previous studies show that even though similar model specification is used, the relationship differs from country to country in both short and long term. The findings of some studies support the theory, and show that there is a bidirectional relationship between house prices. (e.g Fitzpatrick and McQuin, 2007, Oikarinen, 2009; Qi and Yang,2009; Addae-Dapaah and Anh, 2014; Öhman and Yazdanfar, 2018). Some have concluded that there is a one-way relationship(e.g.; Garlach and Peng, 2005; Gimeno and Martinez-Carrascal, 2010).. Again, in some cases, the long-term relationship is stronger from house prices to loans (e.g. Hofmann, 2004; Brissimis and Vlassopoluos, 2009; Che et al, 2011), whereas in others this relationship seems to be the opposite (e.g. Liang and Cao, 2007; Gimeno and Martinez-Carrascal, 2010) or it is not clear which direction of the effect is stronger. (e.g.Addae-Dapaah and Anh, 2014). Moreover, some other studies have concluded that there is a two-way relationship in the short term (e.g. Garlach and Peng, 2005), while others have found that there is one-way relationship (e.g. Fitzpatrick and McQuin, 2007) or no such a relationship in the short term (e.g. Addae-Dapaah and Anh, 2014).

In conclusion, in the current empirical literature, the relationship between credit and house prices is examined largely at the country level: I found only two at cross-country level (Collyns and Senhadji, 2005; Goodhard and Hofmann, 2008). Because of this gap, it is suggested that the examination of the relationship at a cross-country level will contribute to the literature. Moreover, the literature review demonstrates that, although these cross-country studies may include some European countries, there is no study on the EU specifically. As

such, the examination of this relationship may also contribute to the literature in this regard. Furthermore, the EU is a regional economic bloc in which two separate monetary policies are implemented, i.e. a common policy and national monetary policies, and as such EU member countries belong to one of two groups: Eurozone countries being subject to common monetary policy and non-Eurozone countries implementing their national monetary policies. However, no study exists examining the subject in question with reference to the distinction between Eurozone and non-Eurozone countries. Thus, in considering a sample of EU countries, this research makes a further novel contribution to the literature.

3. European Union versus Eurozone

One of the objectives of this study is to see whether the monetary policy causes a change in the interaction between credit and house prices in the economy. For that end, the EU member countries, which are considered in this study and divided into two groups as the Eurozone and non-Eurozone countries. Even though they are all part of the same regional bloc (i.e. EU), non-Eurozone countries are able to regulate their own monetary policies, whereas the countries in the Eurozone are subject to the common monetary policy. Among the current examples of international economic integration in the world, established in 1957, EU (formerly known as European Economic Community-EEC) is the regional bloc at the most advanced integration stage. The Eurozone, created in this regional bloc on 1 January 1999, is the economic and monetary union of the EU, also known as "the Euro area (or Eurozone)". (For more ınformation see. Baldwin and Wyplosz, 2009; El-Agraa, 2011)

Currently, in the EU with the 28-member states, the member states need to meet some criteria to join the Eurozone. These criteria are clustered into three groups; legislative criterion, convergence criteria and other criteria. The legislative criterion aims to harmonize legislation of the member countries as to the central bank. Thus, it is expected that the legislation of the central bank of the member country is to be in compliance with the Articles number 130 and 131 of the the Treaty on the Functioning of the European Union (TFEU) and the Protocol on European Central Banks System (ECBS) and European Central Bank (ECB).

Convergence criteria are composed of four criteria: price stability, interest rate, exchange rate, and government's fiscal position criterion (TFEU, article 140). The last criterion relates to the government's budget and debt position. The aim of the first three of these criteria (üçü (price stability, interest rate and exchange rate criteria) is to establish the

monetary discipline of the Eurozone, the last one has the aim of ensuring fiscal discipline.[10] Another criteria include economic indicators which affect economic integration and also fall outside the convergence criteria. For example, the level of integration of product and financial markets, developments in the balance of payments, developments in labour unit costs and other price statistics are considered within the scope of the other criteria.

Fulfilling of these criteria is aimed at increasing the economic convergence between the EU economies and the sustainability of macroeconomic stability in the Eurozone and. The Eurozone which was established in 1999 with the participation of 11 EU countries, today comprises 19 states.

The main characteristics of the Eurozone are the existence of a single monetary authority (i.e.) in this region, the use of a single currency and the implementation of a single monetary policy as well as a single exchange rate policy. For Eurozone countries, the only monetary authority is the European Central Bank (ECB). The primary objective of the ECB, which operates the fully independent, is to ensure and maintain price stability in the Eurozone; the secondary objective is to implement monetary policy in line with the objectives of the European Union Treaty (e.g. full employment, economic and social progress, etc.). The countries in this area have gave up their national currency and used the common currency (euro). In Eurozone, the monetary policy and exchange rate policy are the common policies and the sole responsibility lies in the hands of the ECB. The exchange rate policy is based on an adjustable fixed exchange rate system. (See. Chang, 2009; ECB 2011).

Consequently, in the EU, there are two group countries according to monetary policy: the Eurozone countries, that have a common monetary policy determined by the ECB and outside of the Eurozone (i.e. non-Eurozone) countries, that determine own monetary policy.

4.Theoretical Framework

Theory views housing as a dual good, since it is both an investment good and a consumption good. This aspect is important when examining the relationship between credit

[10] In calculating the price stability and the interest criteria, the unweighted arithmetic average of the three member states with the lowest inflation rate (HICP) and the lowest long-term interest rates are taken into account. The upper limit of the price stability criterion is, the average of three countries with the lowest inflation rate plus 1.5% points, while the upper limit of the interest rates is limit and the lowest long-term interest rate should be 2% more than the average. the average of three countries with the lowest long term interest rates plus 2% points. Unlike these two criteria, the upper limit of the government fiscal position is determined by the Treaty. Member states' budget deficits should not exceed 3% of the GDP of the country (budget criterion), and public debt should not exceed 60% of the GDP of the country (debt criterion). The member state's fulfilment of the exchange rate criterion means that the national currency of the member state has not been devalued for the last two years and the fluctuation margin of the national currency remains within the range of ± 15%. See. EC (2016).

lending and house prices. Theory suggests that there is a causal relationship between credit and house prices. There are different approaches to explain this relationship: the financial accelerator mechanism approach, the life-cycle approach of household consumption, and adjustment mechanisms of optimal portfolio.

According to the approach of financial accelerator mechanism, monetary policy affects the size of bank lending (see Bernanke and Gertler, 1995; Kasyap and Stein, 1997; Anunsend and Jansen, 2013) and there is a mutual relationship between house prices and credit supply. When monetary expansion occurs, it causes an increase in banks' credit supply by affecting the level of interest rates as well as that of the external finance premium (the credit channel of monetary policy transmission). The credit channel causes the size of lending in the economy to change by influencing both lending of overall depository institutions (e.g. banks) and the behaviour of households and firms, as well as the allocation of credit. This approach explains how the credit channel influences household and firm behaviour by using two mechanism: the bank lending channel and the balance sheet channel (i.e. the net worth channel). Both channels can play significant roles in housing markets by affecting the financial positions of both households and firms, which in turn affects investment and spending decisions. When credit supply increases, households prefer to buy housing and durable goods, while firms choose to invest or buy more inventory.[11] The balance sheet channel arises by changing both market interest rates and, directly or indirectly, the financial positions of potential borrowers (i.e. their net worth, liquid assets and cash flows). The bank lending channel focuses on the possible impact of monetary policy on banks' credit supply

. For example, an increase in credit supply encourages an increase in demand for housing and hence inflates house prices because housing supply cannot immediately meet the increase in demand. Increasing house prices also encourage firms to invest in housing[12] and raises the value of collateral secured against credit. Thus, the borrowing capacity of both households and firms will increase.

In addition, higher house prices also increase house value and its collateral effect. Since housing is considered strong collateral by banks, this puts homeowners and firms in a stronger financial position. In this case, they will borrow more, invest more and also spend more.

[11] In this study, firm behaviour will not be analysed in detail.

[12] Iacoviello (2005) and Anundsen and Jansen (2013) show that a financial accelerator impact occurs in the household sector via house prices, when the borrowing capacity of a household depends on the collateral value of housing.

The life-cycle model of household consumption suggests that the relationship between credit and house prices may be a result of the wealth and collateral effects that increasing house value has on credit demand and credit supply. According to this approach, households plan their consumption and investment decisions at every stage of their life and try to keep them stable (see. Meen, 2001; Deaton, 2005; Muellbauer, 2007). In this case, the increase in house prices leads to an increase in household expenditures and debts by creating both a wealth effect and a collateral effect. Increasing house prices mean increased house value which makes people feel more secure. Thus, they save less and consume more (the wealth effect).

In addition, the increase in the value of housing positively impacts households' borrowing capacities, facilitating more borrowing due to the fact that housing is secure collateral as far as lenders are concerned (the collateral effect). The banks' willingness to lend is dependent on the strength of the collateral. As a result, the banks can lend more and households can borrow from the financial intermediaries more and spend more.[13]

Another approach that explains the relationship between credit and house prices in an environment of monetary expansion is the optimal portfolio adjustment approach. This is based on the traditional monetarist view. According to this approach, there is a two-way relationship between monetary variables and house prices. Monetary expansion changes the return on stock and the marginal utility of both liquid assets and other assets relative to the stock. In other words, this approach claims that extensive changes in interest rates and asset prices can be explained by monetary expansion (Meltzer, 1995; Goodhart and Hofmann, 2008). In this case, the result is that economic actors try to adjust their balances by controlling their spending and asset portfolios. For example, in the case of decreasing interest rates, households will enjoy greater affordability, and their housing demand as well as their credit demand will increase, and house prices will rise.

Similarly, in the case of house price increases, the value of the housing asset and the portfolio balance will change due to the welfare effect and collateral effect of the housing (Greiber and Setzer, 2007; Goodharth and Hoffmann, 2008). These effects either cause the economic actors to review their current investment or they lead to new investments. This, in turn, causes housing to bring about welfare, collateral and investment effects within the economy by increasing the affordability of credit. Thus, interaction can occur in two different

[13] Mian and Sufi (2014), who investigate the effects of increasing house prices in the U.S. on spending and borrowing of households show that housing price increases between 2002-2006 had a large impact on their spending. Borrowing of American homeowners bacame 0.19 dollars on average per 1 dollar when their home equity gains increase 2002 to 2006.

ways: a change in house prices can lead to changes in house value, or monetary expansion can change interest rates. Both encourage a portfolio rebalancing.

The common factor in these approaches is that they all acknowledge a causal relationship between credit supply and house prices and accept that this is a mutual interaction, as illustrated in Figure 2. The main difference between the approaches concerns the starting point of the relationship. In the financial accelerator and portfolio adjustment approaches, the starting point is monetary expansion and an increase in credit supply; in the life-cycle approach, it is an increase in house prices.

[INSERT FIGURE 2]

5. Methodology

In this study, which focuses on the dynamic relationship between private credit and house prices, the 14 chosen developed countries of the EU[14] are investigated for the period 1999–2017, based on quarterly data[15] Private credit covers those loans in an economy that deposit money banks and other financial institutions lend to households and companies (BIS, n.d.). The present analysis, at both cross-country and individual-country levels, is based on certain assumptions, namely: there is a two-way interaction between private credit and house prices in the EU and its sub-groups; the size and direction of this interaction may vary depending on the monetary policy being implemented; the magnitude and direction of the interaction between credit and house prices may differ from one country group to another even if they belong to in the same group of developed countries and are subject to the same monetary policy strategy; the same can apply in the country to country analysis.

Two methods are used to examine the relationship between credit and house prices, two methods are used: the vector autoregressive (VAR) model with both panel data and with

[14] See footnote 6.

[15]While deciding whether the countries in the sample are in the same group with regard to economic development, the United Nations (UN) and the International Monetary Fund (IMF) classifications are used. Although their classification criteria differ, in the case of the sample countries see them all as developed economies according to both classification. The UN divides the world's 193 countries into three groups - developed economies, developing economies and transition economies- according to their gross national per capita income using the World Bank Atlas method. In this approach, countries with incomes over $12,615 as of 2017 are counted as developed economies (or high-income countries) The IMF with 189 member countries considers the relative size of the economies (gross domestic product [GDP] based on purchasing power parity, population and total exports. Like the UN, its classification also comprises three groups: developed, emerging and developing economies. Countries with incomes over $12,235 as of 2017 are counted as developed economies (or high-income countries) (see. UN, 2018; IMF , 2018).

individual countries, and the simultaneous equations model. The second model is applied for a robustness check.

The panel VAR model has the same logic and structure as the VAR model. In the panel VAR model, a cross-sectional dimension is added to the VAR model, that is, the panel VAR mode holds accross different agents as well as over time. Such a model increases the sample size and this approach also allows for unobserved individual heterogeneity. It is argued that the VAR model is a powerful tool in terms of revealing dependencies between sectors, markets and input-output links in an economy to capture the structural time variation in the dissemination of impacts of the shocks or the connections between regions or countries in today's increasingly globalised world (Canova and Ciccarelli, 2013).

The VAR model captures the linear interdependencies among many time series and allows consideration of more than one evolving variable. In this model, all variables enter the model in the same way and it is assummed that all model variables are treated as endogenous and independent. In VAR modeling, the equation for each endogenous variable derived from its lagged value, the lagged values of the other endogenous variables, and possibly some other exogenous control variables.

The approach of Arrigo and Love (2016) is followed in the panel VAR model and the restriction is applied. The underlying structure is the same for each cross-sectional unit. The ensuing problem of individual heterogeneity in the levels of the variables can be overcome by introducing fixed effects in the model. In addition, the generalised method of moments (GMM) technique is applied to alleviate the 'endogeneity' problem that exists in the model due to the lagged variables. This technique is appropriate when the shape of data distribution is not known. It is also suitable when there is a loss of large degrees of freedom due to an increasing number of lags as instrumental variables; hence, the approach of Holtz-Eakin et al (1988) is followed to replace missing observations with zeros in order to ensure efficiency of the GMM. In addition, a reduced form of VAR is also estimated (Brooks, 2018).

The panel VAR model with panel -specific fixed effects consists of a two equation system in which private credit and house prices are specified as endogenous variables: a private credit equation and a house price equation.

The empirical analysis comprises four stages. In the first stage, In the first stage, our model is tested for the whole sample using the panel VAR method to test the first hypothesis - that is, whether there is a dynamic relationship between credit and house prices. It represents the benchmark model of the analysis.

The second stage investigates whether the interaction between credit and house prices changes due to monetary policy implementation, i.e., the second hypothesis. The monetary policy (i.e. whether 'easy' or 'tight'), determines the amount of money in the economy by affecting both money supply and the cost of financing (i.e. the market interest rates) of both the lenders and borrowers. Since in the EU, two different monetary policies are operated, the countries are divided into two groups: Eurozone and non-Eurozone. The Eurozone is the EU's area of monetary union, in which countries accept the euro is their common currency and recognize the euro system a their monetary authority. These countries are therefore subject to the monetary policy set by the European Central Bank (ECB) and are not free to implement their own. Non-Eurozone countries are able to implement their own national monetary policies (Baldwin, 2012; ECB, 2011).

In the context, the relationship between credit and house prices, the reason for such a classification is that in an economy, the credit channel of the monetary policy has an important role in the distribution of funds and the size of credit supply in financial markets, . It can be argued that the credit channel plays a highly effective role in achieving monetary policy targets, especially considering the banking sector's domination the financial markets in the majority of EU countries (Bijlsma and Zwart, 2013).

In the period in which easy monetary policy is implemented, banks can lend more and extend the maturity of loans since the credit channel of monetary policy transmission affects the credit supply and credit allocation in the banking sector. 'Tight' monetary policy is the opposite. In the sample, 11 countries are in the Eurozone (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands) while Portugal and Spain and three are non-Eurozone (Denmark, Sweden and the UK). The Eurozone economy is significant for the EU with regard to its stability and economic integration: at the end of 2017, it accounted for more than %70 of the EU's total output (i.e. 15.3 trillion (PPP) and had 66.3% of the total population (i.e.337, 143 million) of the total EU population.

The third stage examines the relationship between credit and house prices by grouping some of the Eurozone countries and hence undertakes an analysis at both cross country and country level (Figure 3). The grouping are based on whether the countries have experienced a sovereign debt crisis (i.e. the GIIPS group), whether these crisis countries are simultaneously facing both credit boom and house price boom (i.e. the GIIS group); and whether or not the main reason for their crisis is a house price boom-bust (i.e. the IS). This stage therefore consists of four steps: in the first three steps, the benchmark model is estimated for these sub-

groups. In the last step, this relationship is estimated for the individual countries in the GIIPS group.

[INSERT FIGURE 3]

The GIIPS includes five countries: Greece, Ireland, Italy, Portugal and Spain. The reason examining them separately is that they were the main actors in triggering and spreading the sovereign debt crises, which was the first crisis in the EU after the establishment of the monetary and economic union area (i.e. the Eurozone). This has led to their being labelled as the crisis countries of the EU. When the crisis began to spread, GIIPS countries were responsible 1/3 of total production in Eurozone. Before the crisis hit, they shared numerous economic problems: high current account deficits, high labour costs, high public debt, high external debt and gradually decreasing debt payment capacity. In addition, they figured higher than the EU average with respect to such indicators -budget deficits, external debt, higher labour cost and so on. The estimation of the model for GIIPS allows the crisis countries to be compared to the Eurozone more widely (Wyplosz, 2012; Mody and Damiano, 2012).

In the second step, the benchmark model is run again but this time excluding Portugal from the GIIPS group (i.e. now the GIIS). The GIIS countries -Greece, Ireland, Italy, and Spain, unlike Portugal, experienced large increases in both credit supply and house prices in the pre-crisis period as seen Figure 4.[16] Also, in these countries, a credit boom and a house price boom occurred simultaneously (e.g. Hoffmaister et al., 2008; Buzaglo, 2011; Mody and Damiano, 2012). In this way, it is possible to draw a comparison between the Eurozone and its sub-groups in terms of the size and direction of interaction.

[INSERT FIGURE 4]

In the third step, our model is estimated by considering only Ireland and Spain (i.e. IS) It has been suggested that the main reason for these countries' deep crisis was the bust following their house price boom. (IMF (a), 2011; IMF (b), 2011). Following this estimation, any differences between IS and other sub- groups in terms of this dynamic relationship might be identified.

[16] Increase in real house prices between 2000-2007, real house prices increased about 50 % in Greece and Italy, 60% in Ireland, and 95% in Spain. The change in real credit volume in the period 2000-2007 was 175.46% in Greece, 182.7% in Ireland, 103.65% in Italy and 163.51% in Spain (BIS nd).

The fourth phase of the analysis is to examine the EU's crisis countries (i.e. GIIPS) individually. This makes it possible to test the last hypothesis and discover whether there are differences between individual countries with the same monetary policy and belonging to the same development group as a part of advanced economic integration, both in terms of the size and direction of this relationship and the effects of monetary policy.

The contribution of this study is to examine the relationship between credit supply and house prices at cross country and country level in the EU and reveal the direction and the size of this relationship; to consider the effect of different monetary policy on this relationhip and to compare the sub-groups of the Eurozone as well as individual countries; to identify the diffrences between them; to reveal the importance of the direction of casuality between credit and house prices for governing this relationship in order to implement more efficient micro and macro policies in the economy.

5.1. Model Specification

A reduced form of the panel VAR model comprises two equations; a private credit equation and a house price equation. To identify the model, two control variables (i.e. exogenous variab*les)* are included.

In the private credit equation (Equation 1), the control variables are economic activity (*gdp*) and short term interest rates (*sint*). The choice of the control variables was based on the standard credit model as used as previous studies studies (e.g. Bernanke and Gertler, 1998; Hofmann, 2004*).* In the literature, it is assumed that credit supply is mostly determined by demand (e.g. Calza et al, 2001). In the standard model, private credit supply positively depends on lenders' financing cost and on economic activity. Since economic activity influences total investment and consumption, there is a positive relationship between credit and economic activity.[17] Financing cost is reflected in market interest rates. Credit lending is expected to be negatively related to financing cost because an increase in financing cost causes an increase in interest rates. This means that an increased cost of financing makes the cost of borrowing more expensive for households and firms and thus we should expect to see a decrease in credit demand.

[17] In fact, it is also suggested that economic activity has a negative impact on credit demand. Because if economic growth is not expected to be temporary, the private sector (i.e. households and companies) may choose to make savings instead of investing or consuming. Again, in case of the improvement of the cash-flow position in the economic expansion period of the companies, they may give up to borrow the loan with the aim for investment. Yet, empirical studies show that credit supply is positively affected by economic activity)(e.g. Helbling, et al., 2011; Gertler and Kiyotaki, 2015).

In the house price equation (Equation 2), the control variables are selected according to the traditional approach (i.e. supply-demand approach) commonly used in empirical studies. This approach suggests that house prices are determined by house supply and demand. Existing literature shows as long as the main determinants of housing supply are house building costs, housing stock and credit availability for housing builders, housing demand is determined by household income, house price, availability of credit to home buyers, interest rates and demographic factors (see. Meen, 2001; Ball et al. 2010; Arestis and Gonzales-Martinez, 2016; Bahmani-Oskooee and Ghodsi, 2018).

For the second equation in the VAR model, income and interest rate are selected as the control variables from among those variables that are most likely to affect house prices s under the assumption that supply factors do not significantly affect s in the long run.[18] In a departure from previous studies (e.g. Oikarinen, 2009; Gimeno and Martinez-Carascal, 2010), we have used term spreads in the housing price equation equation (see below for definition) rather than long term interest rates, in order to avoid a multicollinearity problem. Because of this, private credit used as a measure of credit lending, is divided by the GDP as Oikarinen (2009).[19]

As such, both the private credit and the housing price equations cover two control variables. The first equation includes economic activity (*gdp*))and short term interest rates (*sint*) while the second one covers the total income (*gdp*))and term spread (*dfin*t). [20]

[18] A supply variable is not added in most of previous studies that examine the dynamic relationship between credit and house prices (e.g. Oikarinen, 2009; Gimeno and Martinez-Carasscal, 2010). Because they generally assumed that supply factors do not significantly affect house prices in the long run. One of the reasons for this is that it is difficult to include factors affecting housing supply, such as regional policies, in empirical studies. Another reason is the difficulty of finding supply data in quarterly terms and limited number of "exogenous variable" that we can add to our model in order to make effective estimations.

[19] However, there is no any supply variable in this equation as most of previous studies that examine the dynamic relationship between credit and house prices (e.g. Oikarinen, 2009; Gimeno and Martinez-Carasscal, 2010). In fact, in empirical studies, it is generally assumed that supply factors do not significantly affect house prices in the long run. One of the reasons for this is that it is difficult to include factors affecting housing supply, such as regional policies, in empirical studies. (e.g. Oikarinen (2009) ve Gimeno and Martinez-Carasscal (2010).

[20] In our model is, the number exogenous variables (i.e. regressors) are equal to the number of instruments, i.e. our panel VAR model is just identified.

Thus, in testing the relationship between between credit and house prices , the analysis is based on a panel VAR with fixed effects given by:

$$credit_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i}\, credit_{t-p} + \sum_{i=1}^{P} \beta_{2i} hprice_{t-p} + \sum_{i=1}^{P} \beta_3 control\ variables_t + U_1 \quad (1)$$

$$hprice_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i}\, hprice_{t-p} + \sum_{i=1}^{P} \beta_{2i} credit_{t-p} + \sum_{i=1}^{P} \beta_3\, controlvariables_t + U_2 \quad (2)$$

i= 1, 2,3, ….,N ; t= 1, 2, 3,…,T

Where *credi*t is the quarterly private credit to households and companies in country *i* at time t; *hprice* is the quarterly house prices in e country *i* at time t; *p* is the lag length and U_1 and U_2 are the error terms. All variables are used first-differenced in real terms. In addition, their natural logs are used, except for short term interest rates and term spread.

Following cross-country and country level analyses, the expectation is that private credit has a positive relationship with house prices ; that both credit and house prices also have a positive relationship with economic activity and total income respectively while short interest rates and term spread will have a negative effect on credit and house prices

6. Data Description

In this study, the sample consists of 14 developed countries of the EU: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom, over the period 1990q1 to 2017Qq3.[21] The data set consists of six variables, which are: private credit (*credit*), house prices (*hprice*), economic activity (*gdp*), consumer price index (*cpi*), term spread (interest rate spread) (*dfint*) and short-term interest rates (*sint*).

Definitions of the quarterly panel data set and their sources are included in Appendix 1. Private credit and house prices are the endogenous variables that are examined with regard to their interactions with each other. The private credit variable covers the total credit that deposit money banks and other financial institutions lend to the non-financial sector (households and non-financial corporations) excluding general government. The nominal housing price index – which is a measure of changes in house prices – is used as the house price variable.

[21] A lack of data, especially on private credit and interest rates as a long time-series, restricts the number of the EU countries included in our empirical analysis.

Other variables are exogenous, with the exception of the consumer price index. The consumer price index (2010 = 100) is used to convert all variables from nominal values to real values. These variables are also converted into logarithms of themselves except for short-term interest rates and term spreads. Short-term interest rates represent lenders' financing costs and include the interest rates under which short-term borrowings (i.e. overnight, or between one and twelve months) between financial institutions are realised in the market, or the rates through which short-term government securities are issued or traded on the financial markets. Term spread (or interest rate spread) measures the difference between long-term and short-term interest rates. It is a predictor of changes in future interest rates. If the time spread is positive, inflation rises over time.

The volume of total output is used for the variable of economic activity and total income in the economy.[22] In the analysis, quarterly GDP (current prices in US dollars) is taken as the indicator of the total output. It is defined as the monetary value of all the final goods and services produced in a country in a period of time (often annually or quarterly).

Initial Assessment

The descriptive statistics are provided in Appendix 2. Before testing the VAR model, in order to make better estimation there is a check for multicollinearity between repressors and a check to see whether the variables are stationary. In controlling the multicollinearity of the VAR model, the correlation matrix, variance inflation factors (VIF) and the multicollinearity (or collinearity) diagnostic are examined. Then, multicollinearity is tested using the VIF and the multicollinearity diagnostic. If a VIF is greater than 5 and the tolerance statistics below 0.1, this indicates that there is a multicollinearity problem (Heigberger and Holland, 2015). The results of these tests indicated no multicollinearity problem among the regressors of the VAR model (see Appendices 3 and 4). In addition, the correlation matrix was checked. A correlation matrix indicates the presence or absence of a relationship between sets of variables. In the correlation matrix, correlation values typically cited as evidence of multicollinearity are in the range 0.6 and above (Wooldridge, 2016). Appendices 5 and 6 present correlations between the variables of the 14 countries and show that the highest correlation between any of the

[22] Due to the lack of data on household income as a long time-series, we use the same measure for both economic activity and total income in an economy.

independent variables in the quarterly data set.is 0.3319. This proves that there is no multicollinearity between the variables.

Unit Root Tests

Before the VAR model is estimated, unit root tests are carried out to ensure that all of the variables are stable. Unit root tests are a common method of testing the stationarity of the variables.

The most important assumption in regression analysis, including time-series data, is that the time-series is stationary. In stationary time-series, the mean and variance are fixed over time; the covariance value depends on the distance between the two periods and is not related to the actual period in which this covariance is calculated. If the condition is not fulfilled, the causal relationship may vary depending on time (Brooks, 2008). In this study, a series of unit root tests are applied to the data to check whether our variables are stationary: these are the Levin-Lin-Chu test, the Im-Pearson-Shin W statistic test, the Augmented Dickey-Fuller test and the Phillips-Perron test,[23] while the Augmented Dickey-Fuller test is used for the data of the individual

As illustrated in Tables 1 and 2, the results of the unit root tests show that all variables in levels are non-stationary at cross-country and country level. However, once they have been first-differenced, all are stationary. Because of this, in order to remove a unit root in all the included variables, they are used in the VAR model as first-differenced at cross-country and individual-country level.

[INSERT TABLE 1]

[INSERT TABLE 2]

7. Empirical Analysis and Findings

This section presents the results of further empirical analysis at cross-country and individual-country level. In the first three stages, the interaction between private credit and house prices is examined in the period between 1999q1 and 2017q3 by using the VAR model with panel data. In the first stage, the panel VAR model is estimated for the whole sample by investigating the interaction between private credit and house prices. This is the main model for the analysis. In the second stage, the interaction is re-estimated for Eurozone and non-

[23] In the Levin-Lin-Chu test, null: unit root (assumes common unit root process). In the other three tests, null: unit root (assumes individual unit root process). In the Augmented Dickey-Fuller and Phillips-Perron tests, the probabilities for Fisher tests were computed using an asymptotic Chi-square distribution. All the other tests assume asymptotic normality.

Eurozone countries. The third phase comprises estimations of the panel VAR model looking at the Eurozone crisis countries and their sub-groups. In the fourth stage, the interaction between credit and house prices is estimated for individual countries in the crisis countries group.

Before estimation of the VAR model begins, the lag length needs to be selected to identify the VAR structure. The aim here is to incorporate the error term into the model to eliminate autocorrelation. Determining an appropriate lag is of critical importance. An implication of an increasing number of lags as instrumental variables is the loss of large degrees of freedom.

One approach to choosing the appropriate lag length is use of information criteria. With such criteria, a normality assumption, which is related to error terms distribution, is not required (Fabio, 2007; Brooks, 2008). It is preferable that the number of lags selected is the same in each equation. The chosen lag number is the number that minimises the value of the information criteria considered.

In this study, to select the number of lag orders, up to five lags are tested for validity and the lag length is decided according to the lowest value of the Bayesian information criterion (BIC) (or Schwarz information criterion) which is based on the estimated standard errors. BIC is one of the most widely used information criteria, and it is accepted that this is the most accurate criterion for quarterly VAR models with realistic sample sizes (Ventsizlav and Killian, 2005; Brooks, 2008).

As such, first, the lag length is chosen for whole sample according to the BIC criterion. Table 3 shows that the first lag order is the one that should be considered for the whole sample because the BIC criterion here has the lowest value. Then, by using the same information criterion, the number of lags is decided for all sub-samples of the analysis (i.e. Eurozone, non-Eurozone, GIIPS, GIIS, IS and individual countries) (see Tables 3 and 4). The results show that the first order should be selected for all samples.

[INSERT TABLE 3]

[INSERT TABLE 4]

Having determined the VAR structure, the model is estimated and then, the four tools associated with VAR models are in order to better understand the interaction between credit and house prices. These tools are the Granger causality test, the eigenvalue stability test, forecasting error variance decomposition, and impulse response functions.

7.1. Estimation Results

Table 5 and Table 6 present the estimation results of VAR model with the first order at the cross-country and the individual country level respectively.

Estimation results at cross-country level

Table 5 includes the estimation results for all panel samples in three phases covering the results for the whole sample as well as the sub-samples while investigating whether there is a dynamic relationship between endogenous variables (i.e. credit and house prices). Both **e**ndogenous variables with their lagged values are present in the analysis. In addition, all variables are included with their first difference values in real terms. Natural logs of all the variables are also used except for short term interest rates and term spread.

[INSERT TABLE 5]

In Table 5, Panels A and B show the private credit and house price equations. Model 1 covers the estimation results of the panel VAR model with fixed effect for the whole sample, while Models 2 and 3 present the results for Eurozone and non-Eurozone countries. The last three columns of the table (i.e. Models 4, 5 and 6) give the test results for three sub-samples of the Eurozone (i.e. GIIPS, GIIS and IS).

The estimation results for the whole sample (i.e. Model 1) confirm the hypothesis being tested and demonstrate an the relationship between credit and house prices. In both the credit equation (Panel A) and the house price equation (Panel B), the signs of the estimated coefficients of the endogenous variables (*dlnrcredit and dlnrhprice*) indicate that there is a positive relationship between credit and house price variables. Panel A shows that changes in house prices have caused credit to change in the same direction. The same can be seen in the relationship between both endogenous variables in Panel B. A 1% increase in house prices in Panel A increases credit by 0.08687%, while a 1% increase in credit size in Panel B positively affects house prices by 0.02194%. The estimated coefficients of both the credit and house price variables are statistically significant in Panels A and B. These results also indicate that the effect on credit supply of a change in house prices is stronger than the effect on house prices of a change in credit supply.

Similarly, the signs of estimated coefficients of the exogenous variables (i.e. economic activity, total income, short-term interest rates and term spread) are as expected in both Panels A and B. The economic activity and total income affect credit and house prices in the same direction, and the estimation results are also statistically meaningful.

A change in interest rates adversely affects both endogenous variables as expected. In Panel A, a 1% increase in short-term interest rates (*drsint*) and term spread (*dfint*) reduces credit supply by 0.53745% and 0.27585% respectively. However, their coefficients are statistically insignificant. Economic activity accounts for most of the variance in credit supply. In Panel B, a 1% increase in short-term interest rates and in term spread also has a depressing effect on housing demand, and thus house prices, by 0.45190% and 0.27211% respectively. The coefficient of short term interest rates is not significant statistically, but that of term spread is significant statistically.

Moreover, Panel B in Model 1 shows that house prices, and hence housing demand are the most sensitive to a change in interest rates, more so than a change in either credit or total income. In fact, the impact of a 1% change in short-term interest rates is almost 22 times stronger for house prices than the impact of a change in income. This is the strongest predictor of house prices. This may be taken as an indication that affordability of credit is a more important factor than income in households' borrowing decisions. In this case, it might be suggested that potential house buyers give the affordability of mortgages greater weight than their income in making decisions. In addition, this may be an indication why housing credit has a much longer maturity than other types of credit (e.g. consumer credit). Given that for the vast majority of households who want to own their own home, this will be the most expensive asset they will ever buy, and given that households mostly require financing to do so, it could be argued that affordability of credit is more important for households than the actual amount borrowed.

The second stage of the analysis relates the second hypothesis and examines whether monetary policy affects the relationship between private credit and house prices. To achieve this, the whole sample is divided into two groups: Eurozone and non-Eurozone countries, according to their monetary policy, and the main model is re-estimated. In Table 5, Model 2 comprises the estimation results for the Eurozone, where has a common monetary policy determined by the ECB, and Model 3 comprises the estimation results for the group of the countries that determines their own monetary policy (i.e. non-Eurozone).

The results in the two models are consistent with the results of the whole sample (Model 1). The signs of the estimated coefficients of all the variables in Models 2 and 3 are as expected and similar to those of Model 1. In both models, a 1% change in house prices in Panel A causes a 0.08240% change in credit supply in Model 2 and a 0.11715% change in Model 3. In the non-Eurozone group, the impact of a change in house prices on credit is higher than it is in the Eurozone group. However, the estimated coefficient of the house price variable is statistically

significant in the Eurozone group but not in the non-Eurozone. In Panel B, a 1% change in credit supply alters house prices in Models 2 and 3 by 0.01168% and 0.05590% respectively; in Panel A the coefficients are statistically significant for non-Eurozone but not for Eurozone countries. Although the relationship between credit and house prices has a positive sign, it can be observed that the size of the relationship in the two zones is different. In addition, this relationship is stronger in the non- Eurozone than in the Eurozone. Thus, it can be argued that a differentiation in monetary policy strategy affects the magnitude of the relationship between credit supply and house prices.

At a whole-sample level, in both the Eurozone and non-Eurozone, there is an inverse relationship between credit supply and the short-term interest rates as well as term spread, and this is also the case with respect to the relationship of house prices with term spread and the short term interest rates). Nonetheless, their coefficients are insignificant in both regions. Again, economic activity is the most important determinant of credit supply in both Eurozone and non-Eurozone (Panel A) and short-term interest rates represent the main determiner of house prices in the whole sample (Panel B).

Models 4, 5 and 6 in Table 5 show the results of the test of the panel VAR model in the Eurozone countries in the context of three different groupings. Model 4 has the GIIPS group and Models 5 and 6 include the results for the GIIPS sub-groups (i.e. the GIIS and IS). As mentioned above, the GIIS comprises four countries in the GIIPS that experienced simultaneous sharp increases in both credit supply and house prices (i.e. a credit boom and a house price boom) before sovereign debt crisis (Figure 4); it omits Portugal, which did not experience house price increases during that period. IS covers only Ireland and Spain; it is accepted that one of the main reasons for these countries' sovereign debt crises was the house price boom turning into a bust. The results for these three Eurozone sub-groups are also consistent with the results from Models 1, 2 and 3, as are the signs of the estimated coefficients. These results indicate differences between the sub-groups with regard to the magnitude of the relationship between credit and house prices.

Among all sample groups, the impact on credit of a change in house price is strongest in the IS group (0.20129) and weakest in the Eurozone group (0.08240) in Panel A. The estimated coefficients of the housing variable are also statistically significant in both groups. The strongest impact on house prices of a change in credit is in the non-Eurozone (0.05590), while the weakest is in the GIIPS group (0.00077), but in both groups, the estimated coefficient is not statistically significant.

When the panel VAR model is tested for these different samples, the estimation results share some common features: first, although the sample size is different, the lag order of the panel VAR model for all is the same and is equal to one; second, the signs of the estimated coefficients are the similar and also as expected; third, the relationship between credit and house prices is positive, yet the impact on credit of a change in house prices is stronger than the impact on house prices of a change in credit; fourth, in the credit equation the main determinant of credit supply is economic activity; finally, interest rates are the main explanatory variable for house prices for all samples. This result may be taken as an indicator that house buyers pay much more attention to the affordability of credit than they do to either their income or their level of borrowing.

In conclusion, in the first three phases of the analysis, all results, including both the full sample and the sub-samples, confirm the accuracy of this study's three hypotheses. Credit and house prices are mutually reinforcing, and monetary policy can change the size of the relationship between credit and house prices in the Eurozone and non-Eurozone. However, this is also the case in the Eurozone sub-groups, even though they belong to the same group of countries with regard to economic development and are subject to the same monetary policy. From the findings, other factors can also be observed to play a role in the relationship between house prices and credit, besides monetary policy (e.g. economic structure, the features of the housing finance system and institutional features).

Estimation results at country level

In the fourth phase of the analysis, the relationship between credit supply and house prices is examined for each of the countries in the GIIPS group of the Eurozone. That is, this relationship is explored for Greece, Ireland, Italy, Portugal and Spain. As mentioned above, to achieve this, we re-estimate the VAR model at country level. As the VAR model with panel data, the model at country level has the first order for each of the individual countries according to the BIC criterion as displayed.

Table 6 exhibits the estimation results of our model with the first order at an individual country level. In this table, again Panel A and Panel B indicates the private credit equation and the housing price equation.

[INSERT TABLE 6]

The results for the five countries in Panels A and B are similar to those of the sample groups: the signs of the credit and housing price variable coefficients are as expected and there

is a positive relationship between credit and house prices. In Panel A, a 1% change in house prices affects credit supply in Greece by 0.25233%, in Ireland by 0.08074%, in Italy by 0.18496%, in Portugal by 0.37687 and in Spain by 0.47746%. The estimated coefficients of the house price variable are statistically significant in all countries. In Panel B, a change in credit supply has a lower impact on house prices than that of house prices on credit in all the individual countries. A 1% change in credit supply affects house prices in Greece by 0.06002%, in Ireland by 0.01501%, in Italy by 0.00922%, in Portugal by 0.06738% and in Spain by 0.02174%. The estimated coefficients of the credit variable are statistically significant for all except for Italy and Portugal.

Among the countries in the GIIPS group, the effect of the change in house prices on credit is strongest in Spain and weakest in Ireland. Conversely, the strongest impact of a change in credit on house prices is in Portugal while the weakest is in Italy.

7.2. Further Tests

Stability Condition

Having tested the VAR model at cross-country and individual-country level, a check is carried out of whether the models estimated for each of the whole sample, its sub-groups and the GIIPS countries fulfil the stability condition. If our model is stable, the variables in the VAR model will be stationary. Table 7 and Table 8 illustrate the results in relation to the stability conditions of all estimated models at cross country and country level. They show that all meet the stability condition.

[INSERT TABLE 7]

[INSERT TABLE 8]

In practice, the VAR model estimates are rarely interpreted alone but are evaluated together with Granger causality tests, forecast-error variance decompositions and impulse response functions (Vanavo, 2007; Brooks, 2008; Wooldridge, 2016).

Granger causality test

An examination of causality in the VAR model helps identify whether an endogenous variable in the model has a statistically significant effect on the future values of each of the other endogenous variables in the system. In other words, the Granger causality tests show only an association between the current value of one of the endogenous variables and the past values

of other(s) (Brooks, 2008; Wooldridge, 2016). Thus, the causality test results show whether a change in one of the endogenous variables gives rise to a change in the other. In addition, they point out whether one of the endogenous variables has a unidirectional, a bidirectional or no relationship with other endogenous variable(s).

When the Granger causality tests are applied in the VAR model of the present study, it will be possible to see whether there is a causal relationship between credit supply and house prices – or vice versa – for the 14 EU countries and hence to determine the direction of the causality. Table 9 presents the results for the whole sample and the sub-groups (i.e. Eurozone, non-Eurozone, GIIPS, GIIS and IS), and Table 10 presents the results for the individual countries.

Results at cross-country level

The results for the whole sample show a two-way causal relationship between credit (*dlnrcredit*) and house prices (*dlnrhprice*) in lag order one (Table 9). This means that changes in house prices cause changes in credit supply and the same is true for credit: changes in credit cause changes in house prices; and the causality from credit to house prices is stronger than from house prices to credit.

[INSERT TABLE 9]

However, the Granger causality test results for the sub-groups of the EU (i.e. Eurozone, non-Eurozone, GIIPS, GIIS and IS) are different from the whole sample in lag order one: there is a one-way relationship in all cases except for the GIIPS and the GIIS groups. In addition, the direction of the causality varies between certain groups. The Eurozone and non-Eurozone have a one-way relationship between credit and house prices. However, in the Eurozone, which is implemented a common monetary policy, the direction of the causality is from house prices to credit; in the non-Eurozone the direction is from credit to house prices. The strength of causality also differs in the two zones, being weaker in the Eurozone than in the non-Eurozone. In this case, it can be concluded that monetary policy affects the direction and strength of causality between house prices and credit as well as direction.

In the IS, Eurozone sub-sample, there is a one-way causality in the lag order one, with its direction being from house prices to credit, as in the Eurozone. Yet there is no causal relationship between credit and house prices in the GIIPS and GIIS samples in the same time period despite their having a common monetary policy as members of the Eurozone and also being in the same category in terms of economic development. In these two groups, credit and house prices move independently in the lagged one quarter.

In conclusion, the results at cross-country level show a causal relationship between credit and house prices for all samples in lag order one, except for the GIIPS and GIIS groups. However, the direction of the causality and its strength differ among them as seen in the Eurozone and non-Eurozone groups. In the non-Eurozone, the causality is from credit to house prices, but the reverse in the Eurozone. In addition, in the non-Eurozone, the causality is stronger than in the Eurozone. This is evidence for how the two different monetary policies within the EU affect the relationship between credit supply and house prices in different ways. Nonetheless, this is also valid in lag order one in the Eurozone sub-samples, which share the same monetary policy. There is a causal relationship between credit and house prices in the IS group, but none in the GIIPS and GIIS groups. It might be suggested that monetary policy can have an effect whenever a causality is present, and can also alter the size of the relationship from one sample to another. It can also be argued that this case indicates that monetary policy is not the only determining factor: other factors, such as the characteristics of individual countries, may also affect the relationship between credit supply and house prices.

Results at country level

Finally, the Granger causality test is applied separately to the GIIPS (the Eurozone's sovereign debt countries). These findings are consistent with results achieved at cross-country level. The presence or absence of causality and its direction in the relationship between credit supply and house prices can vary among these countries in one lagged quarter. As shown in Table 10, causality between credit and house prices can be observed only in Italy and Spain in one lagged quarter with no causality in the other GIIPS countries (i.e. Greece, Ireland and Portugal) in the same period. There is a one-way causality in Spain and its direction is from house prices to credit; in Italy, there is a two-way causality and the direction from house prices to credit is stronger than from credit to house prices; Italy also has a stronger causality than Spain. Thus, the causality results at country level show differences between these countries with regard to the direction of the causality and its size. While a causal relationship in Italy and Spain is evident in one lagged quarter, none is observable in Greece, Ireland and Portugal in the same period, and credit and house prices move independently in these three countries.

[INSERT TABLE 10]

However, a causality between credit and house prices does occur in these three GIIPS countries (Greece, Ireland and Portugal) but only over a longer time period than in Italy and

Spain. It is not observable over lag order one, but arises over lag order three or later. As shown in Appendix 6, a causality arises in three lagged quarters in Greece, four lagged quarters in Ireland and seven lagged quarters in Portugal. In addition, as in Spain, both Greece and Ireland demonstrate a one-way causality and its direction is from house prices to credit. Portugal has a two-way relationship, like Italy, but differs in that, in the former, the direction of causality between credit and house prices is stronger than from credit to house prices.

In summary, the causality test results in lag order one at cross-country and individual-country level are quite similar to each other. They show a causal relationship between credit and house prices for most of samples of the analysis, but with some differences, such as size of relationship and its direction. Monetary policy affects the direction of the causality of the relationship between credit supply and house prices as well as its strength. However, a differentiation also exists with regard to the presence/absence and direction of the causality between credit and house prices, even where there is a common monetary policy, as seen in the Eurozone. This differentiation cannot be explained by difference in monetary policy alone, so it is necessary to consider other factors, such as countries' economic structure and their institutional environment etc. Furthermore, the direction of the causality can be important in managing and/or controlling the relationship between credit supply and house prices and hence in setting more efficient policies.

Heretofore, the Granger causality tests have been applied in the VAR model, allowing us to observe how changes in one endogenous variable (e.g. credit) alters the future value of another endogenous variable (e.g. house prices) for the whole sample and its sub-samples, as well as in individual countries. However, the complete story about the relationship between endogenous variables cannot be told in full by the Granger-causality test.

It is also necessary to understand whether changes in the value of the endogenous variable being considered have a positive or negative effect on the other endogenous variables in the equations system of the VAR and, if so, how long it takes (Brooks, 2008).

For this purpose, other tools of the VAR model – error variance decompositions and impulse response functions – are applied. Impulse response technique is used in order to observe the effects of the impulses of shocks to the responses of our endogenous variables in the VAR model. The variance decomposition tool reveals the proportion of movements in the endogenous variables attributable to their own shocks received, in relation to shocks to the others.

Variance Decomposition

In examining the dynamics of the VAR model in error variance decompositions, a slightly different method is followed. Variance decompositions determine the extent to which the forecast of error variance in every variable can be explained by external shocks to other variables, and show how much each endogenous variable contributes to other variables.

The results from variance decomposition are displayed in Tables 11 and 12. Table 11 shows the contribution of the previous lags of each of two endogenous variables (i.e. credit and house price) to their error variance in the whole sample as well as in the sub-groups. Table 12 presents the results of variance decomposition in individual countries.

Results at cross-country level

In Table 11, house price (*dlnrhprice*) explains 2.692% of the error variance of credit (*lnrcredit*) in the case of the whole sample, while credit explains 0.025% of error variance of house price. The contribution of house prices in forecasting the error variance of credit is higher than the contribution of credit in forecasting the error variance of house prices. In other words, at 2.692%, the contribution of house prices in explaining the error variance of the credit variable is higher than that of credit.

[INSERT TABLE 11]

The findings from variance decomposition for all the sub-groups are similar to the results for the whole sample. That is, the contribution of house prices in forecasting the error variance of credit is higher than that of credit. The results indicate that, in the Eurozone, house price explains 3.412% of the error variance of private credit but 2.299% in the non-Eurozone. Credit explains 0.042% and 0.107% of the error variance of house price in the Eurozone and non-Eurozone respectively.

In addition, in the Eurozone sub-samples (i.e. GIIPS, GIIS and IS), the contribution of house price in forecasting the error variance of credit is much higher than the whole sample, as well as both the Eurozone and non-Eurozone. At 8.045%, the contribution of house price in explaining the error variance of credit is higher than that of credit among all the sample groups of the analysis. It is lowest in the non-Eurozone (2.299%). Again, while the contribution of credit in explaining the error variance of house price is higher in the whole sample (0.250%), considered at sub-sample level the lowest one is the GIIPS group (0.0001%).

In the panel VAR model, a common feature of the samples is the higher contribution of house price in forecasting the error variance of credit because house prices are more likely to explain the error variance of credit than credit explains the error variance of house prices.

Thus, these cross-country results show that the size of the contribution of house price to the explanation of the error variance of credit changes from one sample to another. The reverse is also true.

Results at country level

When the five GIIPS countries are taken individually, the results are similar to the results of the sample groups, with the exception of Portugal, yet the proportion of the contribution of one of the endogenous variables to the explanation of the error variance of the other is different from country to country, as shown in Table 12.

In other words, even if the explanation rates of the variables' variance differ for Greece, Ireland, Italy and Spain, the results are similar to the cross-country ones. The house price variable goes most of the way to explain the error variance of private credit in these countries. However, the opposite obtains in Portugal, where the credit variable serves to explain the error variance of the house price variable more than the other way around.

[INSERT TABLE 12]

At 8.38%, the contribution of house price in explaining the error variance of the credit variable in Greece is the highest among the five GIIPS countries in the ten-year period but lowest in Portugal (0.99%). Again, while the contribution of credit in forecasting the error variance of house price is highest in Portugal (8.39%), among these countries, it is lowest in Spain (0.16%).

As a result, in all the samples of the analysis at both cross-country and individual-country level, with the exception of Portugal, house prices are more likely to explain the error variance of credit than credit is to explain the error variance of house prices. However, the size of the contribution in forecasting the error variance varies from one sample to another. One interpretation is that a relationship between credit supply and house prices exists in all cases, but the direction of causality may differ, even if they share the same monetary policy. Another interpretation is that these findings may be seen as an indicator that the integration of the two markets has not taken place at an advanced level among EU member countries, or perhaps as an indicator of the existence of integration but at varying rates between countries.

Impulse responses function

Impulse response functions are used to track impulses of the system's shocks to responses of system variables. They allow us to keep track of how the other variables react to a shock that occurs in one of the endogenous variables in the model. In the impulse response function, a unit of shock is applied for each endogenous variable in each equation, and its effect on the VAR system is observed within a certain time period. As such, an impulse response graph shows how a variable is affected after a unit of shock on one of the other endogenous variables. The shock within the model is also expected to disappear gradually in a stable system (Brooks, 2009; Wooldridge, 2016).

In order to observe the effects of impulses of shocks vis-à-vis the responses of the endogenous variables (i.e. credit and house prices) in our VAR model, first a unit of shock is applied to the model by taking the whole sample, then the sub-samples, as well as each country in the GIIPS group.

Figure 5 displays the impulse responses for the whole sample in a 95% confidence band, while Figure 6 and 7 present the impulse response figures for the Eurozone and non-Eurozone. For the GIIPS, GIIS and IS, the impulse responses figures are shown in Figures 8–10. Figures 11–12 present the impulse responses for each of the individual countries (i.e. Greece, Ireland, Italy, Portugal and Spain). All figures display the effects on present and future values of the endogenous variables for one standard deviation shock (or a unit of shock) in one of the variables. Thus, in the model equations, it is possible to go beyond the average estimations illustrated in Tables 5 and 6.

Results at cross-country level

In whole sample, when a positive shock is delivered to credit (*dlnrcredit*) to housing prices (*dlnrhprice*), the first effect for one step is significantly positive, but thereafter it is insignificant (Figure 5). The effect of the shock on house prices is significantly positive for one step and then insignificant. When a unit of shock on house prices to credit is applied, the effects are initially positive in the first two periods, but then negative and insignificant.

[INSERT FIGURE 5]

Looking at both the Eurozone and non-Eurozone, when one standard deviation shock on credit is applied, the responses of house prices differ. In the Eurozone, the effect of the shock is insignificant, but significant in the non-Eurozone. In the non-Eurozone, the effect of

the shock on house prices exhibits a similar trend to the whole sample and is significantly positive for one step and then insignificant (Figure 5). When a unit of shock on house prices to credit is applied, the response of credit is the opposite. In the Eurozone, a similar trend to the whole sample is observable, whereas in the non-Eurozone the effect of the shock on credit is not significant.

In the case of the GIIPS, the effects on house prices of shocks to credit are similar among constituent countries, as well as to the Eurozone, and insignificant (Figure 6). On the other hand, applying a positive shock to house prices elicits a response from credit displaying an almost similar trend to the Eurozone for the GIIPS and GIIS groups but not for the IS group. That is, the effect on credit of a shock to house prices is positive in the first two periods, but thereafter the responses of credit are negative and insignificant in the GIIPS and GIIS groups (Figure 6). However, the effect is not significant in the IS (Figure 6).

[INSERT FIGURE 6]

Results at country level

Figures 7-11 show the impulses and responses of both endogenous variables for the five countries in the GIIPS. In Greece, when a positive shock on credit to house price occurs, the response of house prices is significant for two steps, in which prices increase; thereafter it is insignificant (see Figure 7). In Portugal, the effect of one unit shock to credit is the similar to Greece. But, in Portugal, the response is significantly negative and occurs in a shorter time (one period) (see Figure 8).

On the other hand, the impacts on house prices of a shock to credit are not significant in the rest of the GIIPS countries (i.e. Ireland, Italy and Spain). In applying a positive shock to house prices, the response of credit is almost similar in three of the GIIPS countries (Greece, Italy and Portugal) but not significant (Figure 7, Figure 9 and Figure 10). In Ireland, the impact of this shock is significant for the first step and then disappears (Figure 8), while in Spain this effect continues for longer (about five periods) than in Ireland until it disappears (Figure 11).

[INSERT FIGURE 7]

[INSERT FIGURE 8]

[INSERT FIGURE 9]

[INSERT FIGURE 10]

[INSERT FIGURE 11]

8. Robustness Check

The robustness of the estimation results of the panel VAR is tested using an alternative method. For this purpose, the simultaneous equations model is estimated using the three-stage least squares (3SLS) technique[24] (Chan and Chang, 1995).

However, there are some differences between these two methods.[25] In considering the reduced form of these models, the VAR model covers the actual lagged values of endogenous variables as well as the lagged values of other endogenous variables, while in the simultaneous equations model current values of other endogenous and exogenous variables are expressed.

Unlike the VAR, the simultaneous equations model does not cover equations for all variables if they are the exogenous variables. In addition, in contrast to the VAR model, in the simultaneous equations model there is a distinction between endogenous and exogenous variables. Another difference is that the specification of the simultaneous equations model means that it needs more information about the variables than the VAR model. In the case of the VAR model, only a list of variables that will intertemporally affect each other can be hypothesised.

In simultaneous equations model, the main assumption is that there is a relationship between the error term and one or more exogenous variables. In the VAR model, the error term is correlated with all variables, not just exogenous variables. Moreover, unlike in the simultaneous equations model, the VAR model may explain how the model's shocks (i.e. the effect of a shock to one of the endogenous variables on another variable) are transferred to other variables.

In conclusion, the main differences between these two models relate to the determination of the variables in the model, the determination of restrictions, the separation of the variables as endogenous or exogenous, the distribution of lags, the serial correlation features of the errors, and the information needed in the factors affecting a variable.

In checking the robustness of the results, as with the panel VAR, the simultaneous equations model consists of two equations: a private credit equation and a house price equation.

The equations include the same variables. That is, the variables in simultaneous equations model are private credit (*credit*), house prices (*hprice*), economic activity (*gdp*), term spread

[24] It is accepted that the 3SLS yields an efficient estimation in a simultaneous equations model (Brooks, 2014; Kennedy, 2008).

[25] For the comparison of two models to each other, we benefited from the following sources: Wickens, 2007; Brooks, 2008; Wooldridge, 2016.

(*dfint*), short-term interest rates (*sint*) and total income (*gd*p). Different from the panel VAR model, the endogenous variables' own lags are not included in the simultaneous equations model. Like the panel VAR model, all variables are taken with their first differences in real terms. They are also expressed as their natural logs except in the case of the two interest rates (i.e. short-term interest rates and term spread).

The estimation results of the simultaneous equations model cover the whole sample (i.e. the 14 EU countries) and its sub-groups (i.e. Eurozone, non-Eurozone, GIIPS, GIIS and IS). The results of the robustness check are presented in Table 13. In this table, Panels A and B show the private credit equation and the house price equation respectively. Model 1 gives the estimation results for whole sample; Models 2 and 3 give the results for the Eurozone and non-Eurozone respectively; and Models 4, 5 and 6 give the findings for the Eurozone sub-samples (i.e. GIIPS, GIIS and IS).

[INSERT TABLE 13]

The estimation results of the simultaneous equations model for the whole sample are consistent with the results for the panel VAR model. A change in one of the endogenous variables leads to a change in the other. That is, a change in house prices causes a change in credit in the same direction, even though the size of the impact changes. In Panel A, a 1% change in house prices causes a change in credit by 0.152% in a positive way.

The same is true for the effect on house prices of a change in the credit variable. A 1% change in credit supply positively affects house prices by 0.052%. In addition, similar to the panel VAR model, the impact on credit supply of a change in house prices is greater than the effect on house prices of a change in credit. In addition, the relationship exogenous variables have with both credit and house prices are as expected and overlap that of the panel VAR model.

The estimation results for all of the sub-samples confirm those of the panel VAR. Among all the samples, the strongest change in credit is in the IS, showing a 1% change in house prices, as in the VAR model (5.962%). The same is true for the credit variable. As a result, the test results of the simultaneous equations model confirm the robustness of the results of the panel VAR model. The results show a relationship between credit supply and house prices, although the size of the relationship may vary among the different sub-samples of the EU.

9. Conclusion

The aim of this study is to investigate a causal relationship between credit supply and house prices and to examine the size and direction of this relationship at cross-country and individual-country level. The empirical analysis comprised four stages, in which two alternative methods were used: the VAR model and the simultaneous equations model. The second was used to check robustness.

The cross-country results show differences in terms of both the size and direction of this relationship, as well as the presence/absence of causality in lag order one. The results indicate a relationship between credit supply and house prices for all cross-country samples, but with different magnitudes. Among the samples, house price is very influential on credit supply in the IS (Ireland and Spain) group. In addition, there is a causal relationship between credit supply and house prices in all groups in one lag quarter, with the exception of the two sub-groups GIIPS and GIIS),[26], but there are differences among the samples with regard to the direction of the relationship. The whole sample shows a two-way causal relationship, while both the Eurozone and non-Eurozone show a one-way causality. However, the direction of causality in the Eurozone is from house price to credit, whereas in the non-Eurozone the reverse is true. Thus, it can be concluded that monetary policy affects the size and direction of the relationship between credit supply and house prices.

Among the sub-groups of the Eurozone having a common monetary policy, there are also differences in both the size of the relationship and the causality. For example, in the Eurozone the IS group shows a one-way causality between credit supply and house prices in lag order one, while there is no causality in the GIIPS and GIIS groups over the same period: that is, in these groups credit supply and house prices move independently.

The direction of causality can be taken as an indication of the strength with which credit supply affects house prices, or vice versa. Given the direction of the one-way causality in the Eurozone group, it can be concluded that the housing markets, not the credit markets, are decisive in this relationship. In this case, contrary to expectations, monetary policy alone in attempting to govern this relationship may have a weak impact on house prices. Consequently, it might be suggested that in the Eurozone it is important to consider credit policies alongside housing market policies[27] in pursuit of financial and economic stability.

[26] The GIIPS group consists of Greece, Ireland, Italy, Portugal and Spain. The GIIS group cover the same countries except for Portugal.

[27] Housing polices include: investment in social housing, rent controls and support for alternative types of rental housing (such as co-ops).

The non-Eurozone group, in which causality sees credit acting on house prices, is in the opposite situation. The unilateral relationship shows that the credit market is more important than the housing market in the relationship between credit supply and house prices. Thus, it can be argued that in non-Eurozone countries monetary policy could mitigate financial as well as economic instability more effectively than in the Eurozone group.

The results at country level are similar to the cross-country results. In the five Eurozone (i.e. Greece, Ireland, Italy, Portugal and Spain), the trend for developments in the relationship between credit supply and house prices was similar to group results, with house prices influencing credit supply in a positive way. But the size and direction of the relationship between house prices and credit, as well as the outputs, changes from country to country in lag order one. The effect on credit of a change in house prices is largest in Italy among these individual countries, followed by Spain. In addition, in Italy there is a two-way causality between credit and house prices, a one-way causality in Spain, but no causality in Greece or Ireland in the same period. Whereas in Spain, causality starts in lag order one, in Greece and Ireland it starts in lag orders three and four respectively. This shows that, although these Eurozone countries share a common monetary policy, among them not only the size and direction of the relationship but also the length of time of interaction varies.

These results therefore confirm the hypotheses of this essay: that there is a causal relationship between credit supply and house prices in the EU; that monetary policy affects the relationship; and that the relationship between credit and house prices is different at cross-country and individual-country level, even under the same monetary policy.

The findings of the whole sample concur, to some extent, with those of a previous cross-country study (e.g. Goodhart and Hofmann, 2008),[28] that shows that there is two-way causality between credit and house prices. However, since the literature review revealed no study comparing Eurozone and non-Eurozone, or focusing on the GIIPS countries or its sub-groups, it was not possible to compare results further.

In comparing the findings of previous studies at individual-country level, it can be seen that there is some overlap. For example, in lag order three, the results are similar to those of Brissimis and Vlassopoulos (2009), which focuses on Greece, and which shows a causality from house prices to credit. However, in contrast, Gimeno and Martínez-Carrascal (2010) show

[28] Goodhart and Hofmann (2008) considered 17 industrialized countries of the OECD, so their sample is slightly different from ours. However, the majority of their sample consists of the EU countries in our sample, except for Austria, Greece and Portugal. Due to this, it can be asserted that the findings for the whole sample of this study are consistent with their findings.

that in Spain the causality is from credit to housing price, the reverse of the result from this study. An overall similarity with all the reviewed studies at country level is the existence of a relationship between credit and house prices. Differences arise over whether there is a causality and what its direction is: that is, whether the causality is unilateral or bilateral and/or whether the direction is o from credit to housing price or the reverse). These differences may be greatly affected by the time period covered, the scope of the variables and the data introduced into the analysis.

Following on from these findings, it can be suggested that, besides monetary policy, other factors, such as the presence/absence of causality and its direction, economic structure, type of housing finance system and institutional features, can all play a role in the relationship between credit and house prices and hence account for differences between the countries.

These results have policy implications at both country and EU level. First, consideration of the direction of causality can contribute to more efficient macro and micro policies on credit and housing markets. This is particularly important in the Eurozone, where credit markets are governed by policy from a supranational authority (the ECB) but housing markets are governed by national policy. This implies a need for close coordination between the ECB and the national authorities. In contrast, each non-Eurozone country has autonomy over both markets. Second, in determining policies to manage the relationship between credit and house prices, policy-makers should also pay attention to differences between countries attributable to other factors (e.g. economic structure, institutional environment) alongside consideration of monetary policy. Finally, policy-makers ought to take into account the interaction between credit and house prices not only at country level but also at EU level (and its sub-groups), in order to achieve deeper integration of the EU mortgage markets.

The main limitations of this research stem from two aspects of the data availability. It is difficult to find sufficient length of data for all the EU countries and different variables. Firstly, lack of data has prevented exploration of the relationship between credit supply and housing prices for all members of the EU. Secondly, because of data limitation, different classifications for example, it was not possible to compare the EU new members with old ones.[29]

[29] These countries joined on 1 May 2004 and later. They are Bulgaria, Croatia, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.

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FIGURES

Figure 1. Sub-markets of Financial Markets

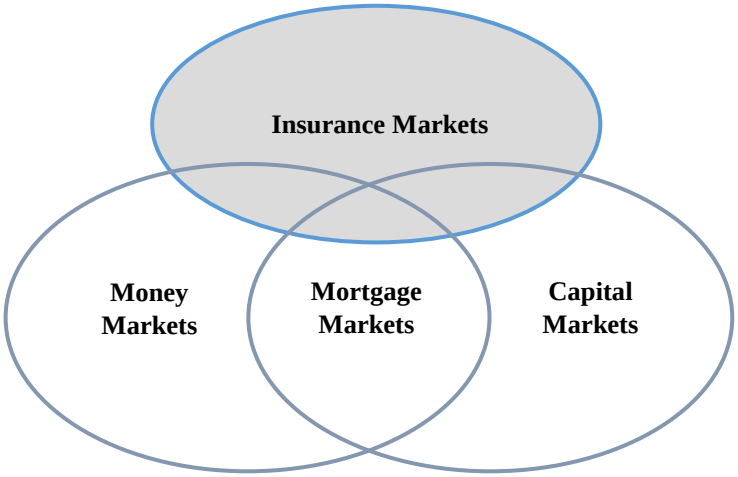


Figure 2. Interaction between Credit and house prices

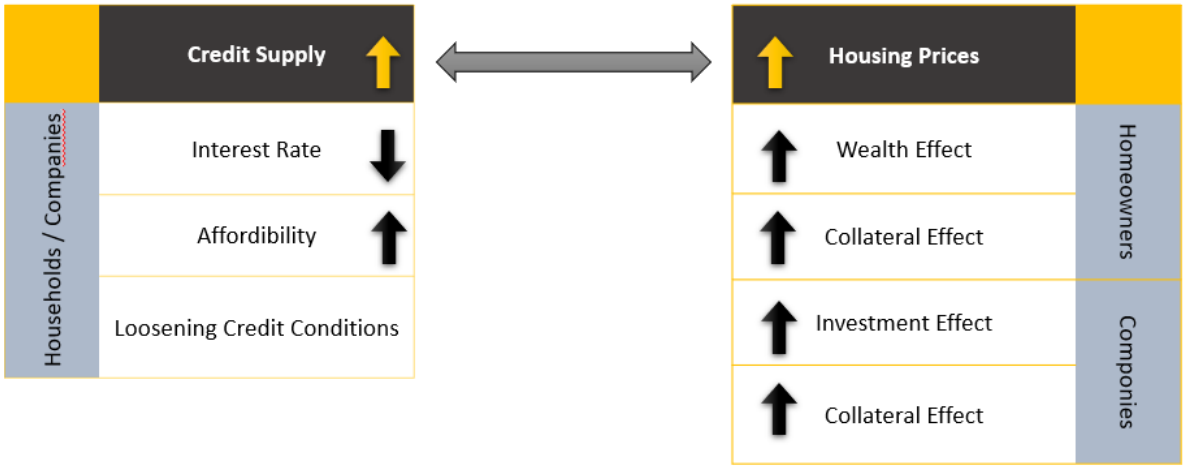
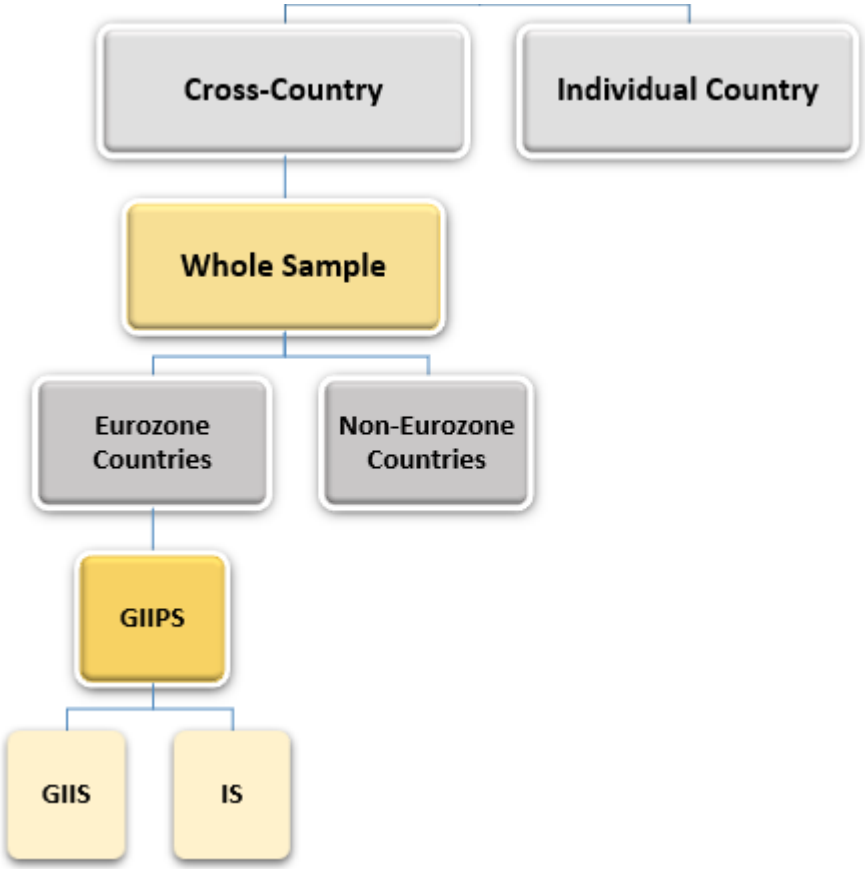


Figure 3. Samples of the Empirical Analysis

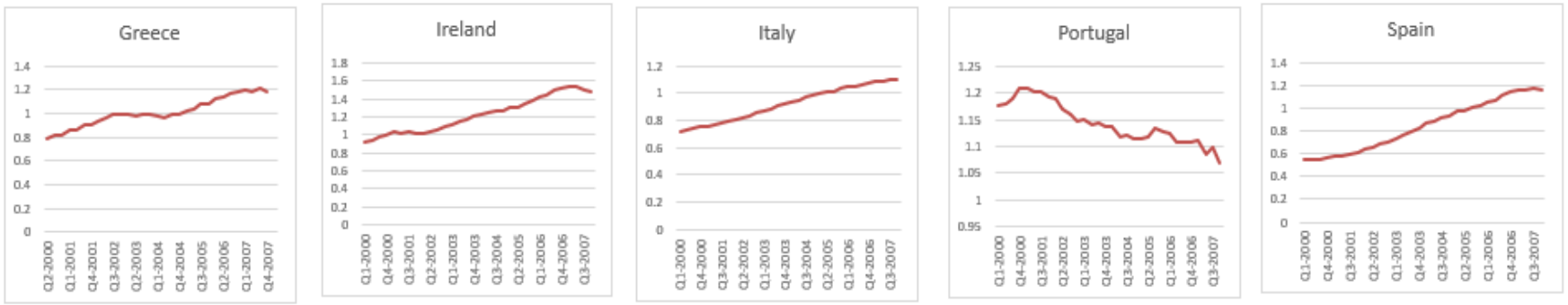


The whole sample covers the 14 EU countries; The Eurozone is the countries in the monetary and economic union are of the EU. Non-Eurozone includes ones in outside area from the Eurozone. The GIIPS consists of Greece, Ireland, Italy, Portugal and Spain; the GIIS covers Greece, Ireland, Italy and Spain, except for Portugal and the IS includes Ireland and Spain; Individual countries cover the

Figure 4. Real Private Credit vs. Real house prices (2000-2007)

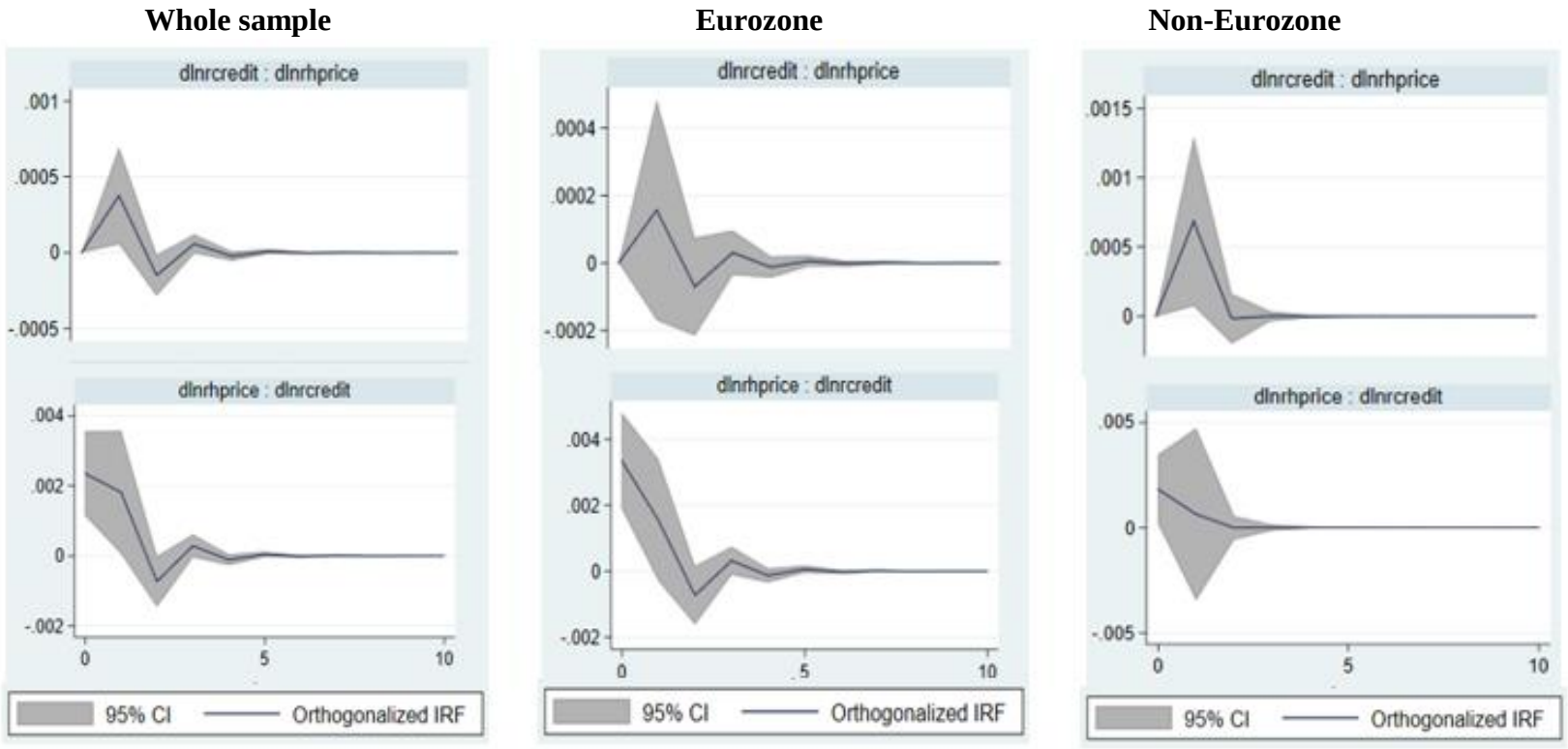
Real Private Credit (1)

Real house prices (2)



Source: BIS and IMF.
(1) Real private credit (billions of US dollar)
(2) Real housing price index (2010=100)

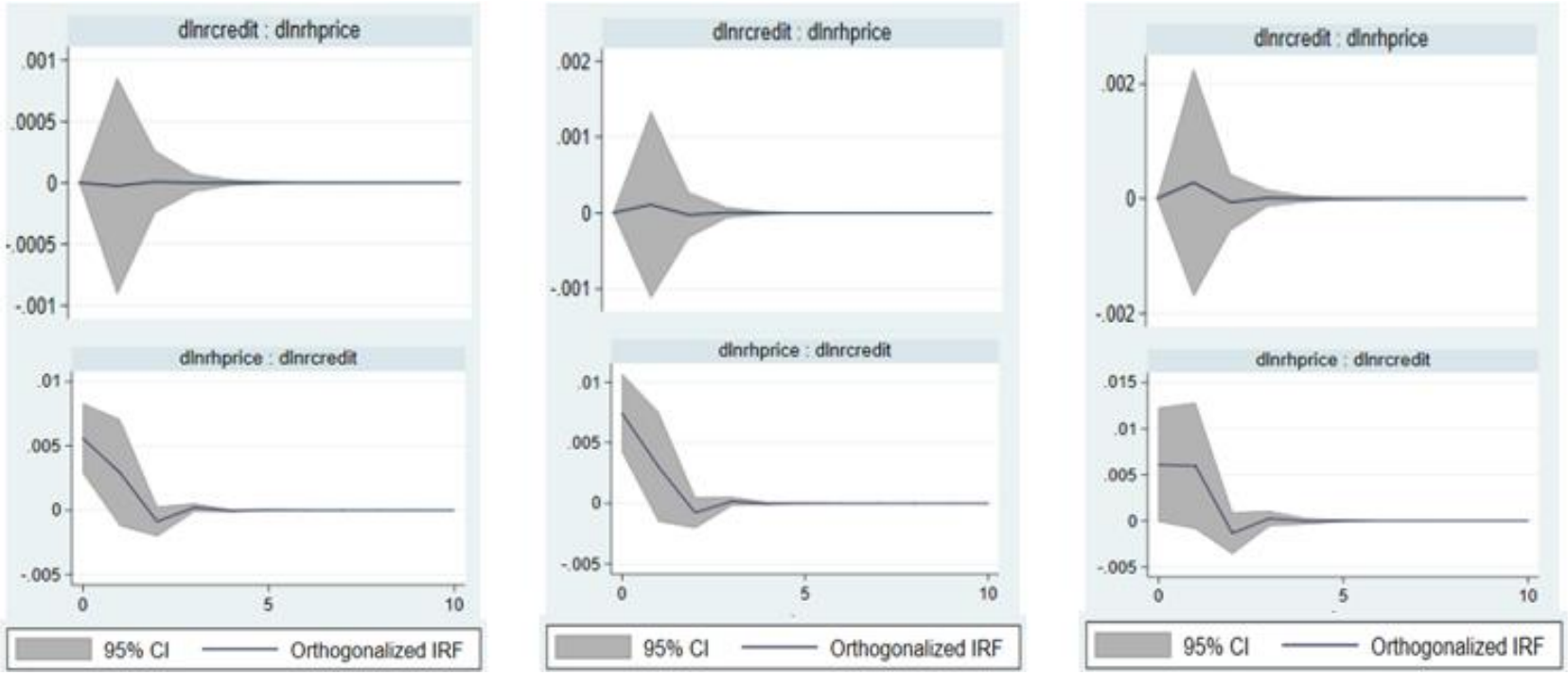
Figure 5. Impulse Response Functions



Note that: *dlnrcredit:* private credit/GDP and *dlnrhprice*: housing price.

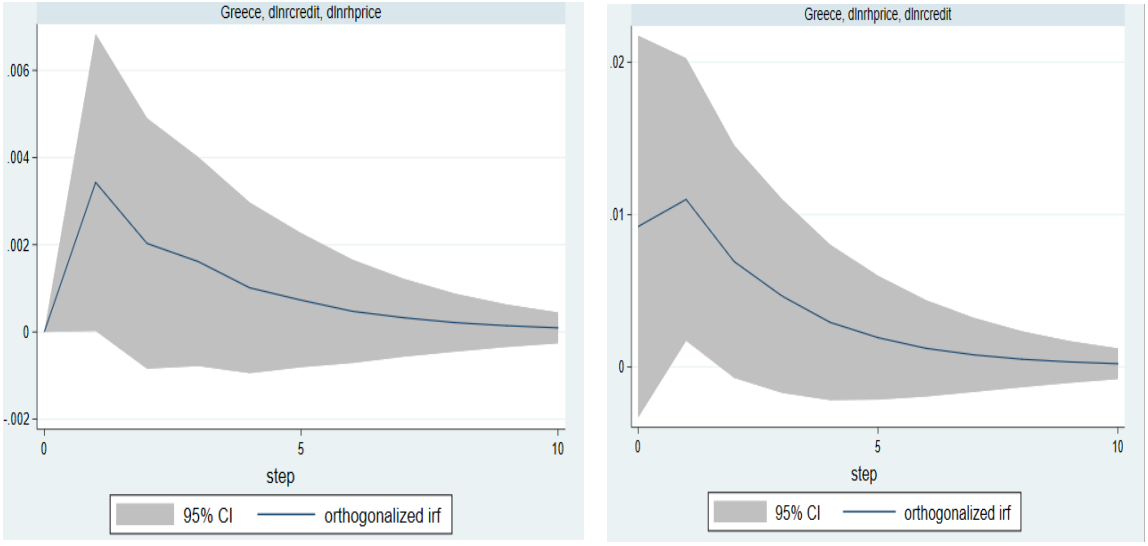
Figure 6. Impulse Response Functions for the Eurozone Sub-Groups

GIIPS **GIIS** **IS**



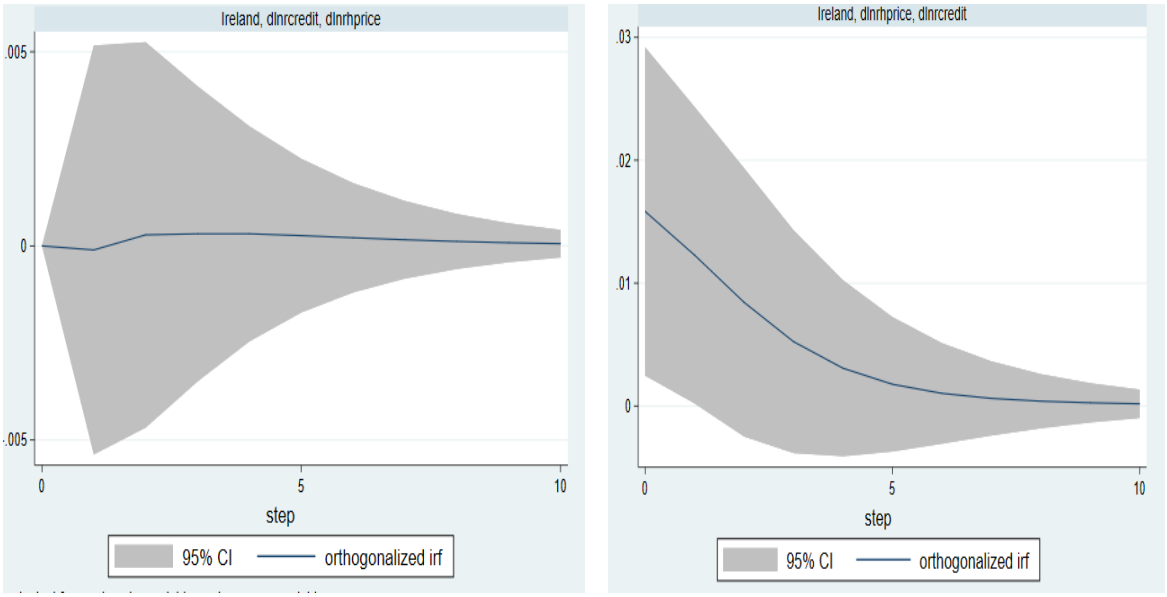
Note that: *dlnrcredit:* private credit/GDP and *dlnrhprice*: housing price

Figure 7. Impulse response Functions for Greece



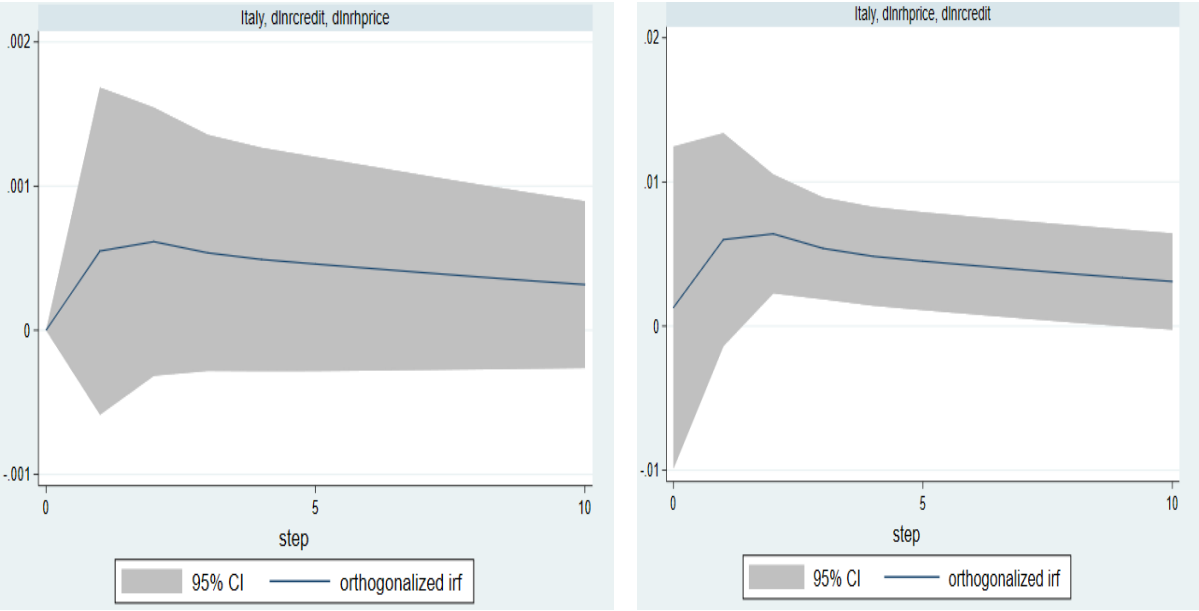
Note that: *dlnrcredit:* private credit /GDP and *dlnrhprice*: housing price.

Figure 8. Impulse response Functions for Ireland



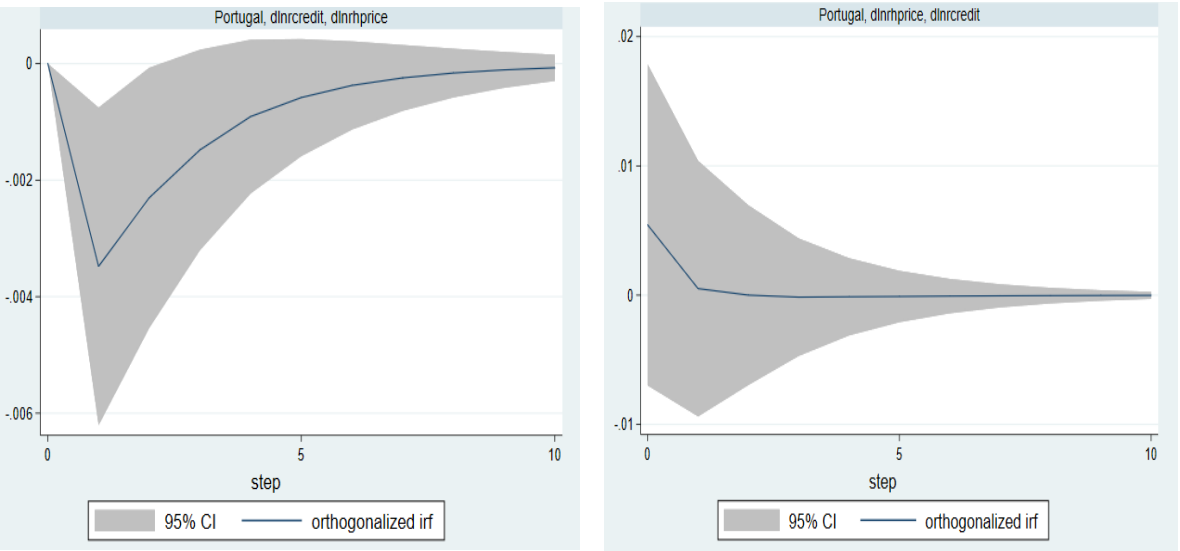
Note that: *dlnrcredit:* private credit /GDP and *dlnrhprice*: housing price.

Figure 9. Impulse response Functions for Italy



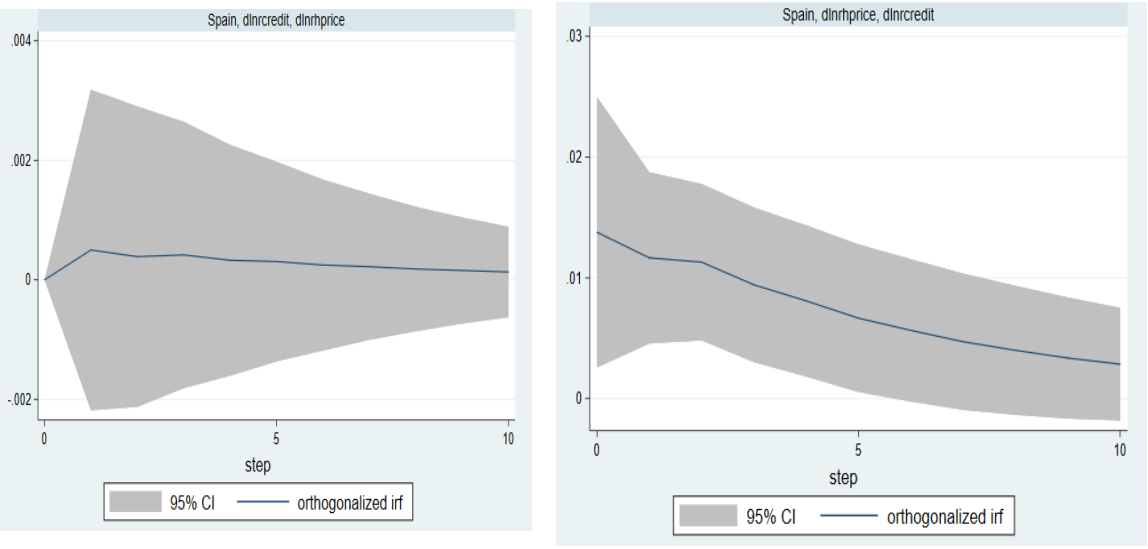
Note that: *dlnrcredit:* private credit /GDP and *dlnrhprice*: housing price.

Figure 10. Impulse response Functions for Portugal



Note that: *dlnrcredit:* private credit /GDP and *dlnrhprice*: housing price.

Figure 11. Impulse response Functions for Spain



Note that: *dlnrcredit:* private credit /GDP and *dlnrhprice*: housing price.

TABLES

Table 1. Unit Root Tests for Panel Data

	Levin-Lin-Chu		Im-Pearson-Shin W Statistic		Augmented Dickey-Fuller		Phillips-Perron	
	Level	First difference	Level	First difference	Level	First difference	Level	First difference
hprice	-1.9887**	-2.9385***	3.1792	-67.172***	26.3312	-84.9064***	26.0758	143.556***
credit	-3.82317	-9.07089***	0.3363	-11.4573***	26.4691	215.204***	26.9751	301.918***
dflint	2.52176	-21.4604***	3.34471	-21.0552***	12.6909	379.105***	8.37161	365.679***
gdp	-1.77235	-27.4057***	0.68574	-26.2216***	15.2388	443.489***	15.5779	442.871***
sint	-0.76448	-14.8665***	-0.28292	-13.8172***	21.6691	233.495***	16.9438	240.221***

Note that: The table presents Im-Pearson -Shin (IPS) test statistics for the null hypothesis of a unit root. In Levin-Lin-Chu method, Null: unit root (assumes common unit root process). In the other three tests, Null: unit root (assumes individual unit root process). In Augmented Dickey-Fuller and Phillips-Perron, probabilities for Fisher tests are asymptotic normality. (***), (**) and (*) indicate statistical significance at the levels of 1, 5 and 10 percent respectively. (***), (**) and (*) indicate that null hypothesis is rejected at the statistical significance levels of 1, 5 and 10 percent respectively.

Table 2. Unit Root Tests for Individual Countries (Augmented Dickey-Fuller (ADF) Test)

	Private Credit		house prices		Economic Activity		Short-term interest rates		Term spread	
	Level	First difference	Level	First difference	Level	First difference	Level	First difference	Level	First difference
Greece	-0.1704	-4.3196***	-0.0802	-1.6187*	0.2108	-4.8397***	1.1047	-3.4362***	1.9042	-4.4876 ***
Ireland	0.2635	-3.6369***	-0.2045	0.3605	1.1544	-4.5252***	1.1047	-3.1564***	0.9366	-3.2316***
Italy	-0.1318	-5.0052 ***	-3.2935	0.2591	-0.0701	-5.2382***	1.1047	-3.1564***	0.9366	-4.2187***
Portugal	-4.8997	-4.8997***	-3.4517***	1.9622**	0.0184	-5.0233 ***	1.1047	-3.1564***	1.9042	-3.1564***
Spain	-4.2464	-4.2464***	-3.4517***	-0.4871	0.0184	-5.0233 ***	1.1047	-3.1564***	1.9042	-2.8640**

Note that: The table presents Augmented Dickey-Fuller (ADF) test statistics for the null hypothesis of a unit root. In ADF, probabilities for Fisher tests are asymptotic normality. (***), (**) and (*) indicate that null hypothesis is rejected at the statistical significance levels of 1, 5 and 10 percent respectively.

Table 3. Lag order Selection for Panel VAR

Whole Sample						
LAG	CD	J	J pvalue	SBIC	AIC	HQIC
1	0.6426164	275.634	2.38E-18	-409.8015	75.63397	-109.3429
2	0.6753727	168.39	3.93E-09	-345.6866	18.38997	-120.3427
3	0.7723646	109.9376	-2.33E+02	-344.5823	18.37847	-82.55083
4	0.8130356	79.74592	1.25E-07	-91.61295	29.74592	-16.49829
Eurozone						
LAG	CD	J	J pvalue	SBIC	AIC	HQIC
1	0.3756601	237.5695	3.30E-13	-423.6346	37.56949	-140.209
2	0.5904205	173.0438	3.06E-08	-3.23E+02	23.04381	-110.2901
3	0.6906436	106.112	6.45E-06	-224.4901	6.111974	-82.77726
4	0.7499692	81.13025	7.58E-08	-84.17077	31.13025	-13.31437
Non-Eurozone						
LAG	CD	J	J pvalue	SBIC	AIC	HQIC
1	0.7870708	127.8996	3.14E-02	-403.9124	-72.10044	-206.3244
2	0.9649697	88.30912	1.40E-01	-310.5499	-61.69088	-162.3589
3	0.9810885	63.46267	9.56E-02	-202.4433	-36.53733	-103.6493
4	0.9861237	39.18845	3.53E-02	-93.76455	-10.81155	-44.36754
GIIPS						
LAG	CD	J	J pvalue	SBIC	AIC	HQIC
1	-1.16356	141.9117	3.75E-03	-440.9829	-58.08833	-210.6556
2	-0.4552748	105.1537	1.24E-02	-332.0172	-44.84629	-159.2717
3	-0.1439652	68.82327	3.99E-02	-222.624	-11.01432	-107.4603
4	0.1437795	43.04937	1.38E-02	-102.6743	-6.950632	-45.09244
GIIS						
LAG	CD	J	J pvalue	SBIC	AIC	HQIC
1	-2.122041	127.3449	3.38E-02	-433.2353	-72.65508	-217.4155
2	-1.22193	97.99243	3.86E-02	-322.4427	-52.00757	-160.5779
3	-0.6830876	62.20223	1.15E-01	-218.0879	-37.79777	-110.178
4	-0.1682503	35.52977	7.90E-02	-104.6153	-14.47023	-50.66033
IS						
LAG	CD	J	J pvalue	SBIC	AIC	HQIC
1	-0.8424443	104.7997	3.52E-01	-386.465	-95.20029	-213.5632
2	-3.413228	98.05565	3.82E-02	-270.3935	-51.94435	-140.7165
3	0.1222264	48.14353	5.48E-01	-96.24214	-51.85647	-111.0379
4	0.6041483	26.57423	3.77E-01	-96.24214	-23.42577	-53.01649

Note that: *CD*: over-all coefficient determination; *J statistic*:statistics of over identifying restrictions in the model (i.e. the Sargan–Hansen test*); J pvalue*: p-values for Hansen`s J statistics; *SBIC:* Bayesian information criteria (or Schwarz information criterion); *AIC*: Akaike information criteria; *HQIC*: Hannan-Quinn information criteria. The whole sample covers the 14 EU countries; The Eurozone is the countries in the monetary and economic union are of the EU. Non-Eurozone includes ones in outside area from the Eurozone. The GIIPS consists of Greece, Ireland, Italy, Portugal and Spain; the GIIS covers Greece, Ireland, Italy and Spain, except for Portugal and the IS includes Ireland and Spain; Individual countries cover the GIIPS countries.

Table 4. Lag order Selection for Individual Countries

Greece								
LAG	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	633.997				1.40E-13	-18.2608	-18.2694	-18.1313
1	680.216	53.242	16	0.000	5.70E-14	-19.1367	-18.8798	-18.4891
2	706.837	109.9376	16	0.000	4.20E-14	-19.4445	-18.9821	-18.2789
3	714.59	15.506	16	0.488	5.50E-14	-19.2055	-18.5375	-17.5218
4	724.104	19.028	16	0.267	6.70E-14	-19.0175	-18.144	-16.8158
5	740.723	33.238	16	0.007	6.90E-14	-19.0354	-17.9564	-16.3157
Ireland								
LAG	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	665.368				5.60E-14	-19.1701	-19.1187	-19.0406
1	718.361	105.99	16	0.000	1.90E-14	-20.2423	-19.9854	-19.5948
2	730.117	23.513	16	0.101	2.20E-14	-20.1193	-19.6569	-18.9537
3	742.263	24.292	16	0.083	2.40E-14	-20.0076	-19.3397	-18.324
4	755.872	27.217	16	0.039	2.70E-14	-19.9383	-19.0648	-17.7366
5	762.211	12.679	16	0.696	3.70E-14	-19.6583	-18.5793	-16.9385
Italy								
LAG	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	848.841				2.70E-16	-24.4881	-24.4368	-24.3586
1	949.936	202.19	16	0.000	2.30E-17	-26.9547	-26.6977	-26.3071
2	975.008	50.144	16	0.000	1.80E-17	-27.2176	-26.7552	-26.052
3	985.13	20.245	16	0.209	2.10E-17	-27.0473	-26.3793	-25.3636
4	1003.18	36.099	16	0.003	2.10E-17	-27.1067	-26.2332	-24.9049
5	1008.76	11.169	16	0.799	2.90E-17	-26.8048	-25.7257	-24.085
Portugal								
LAG	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	801.395				1.10E-15	-23.1129	-23.0615	-22.9834
1	839.988	77.186	16	0.000	5.60E-16	-23.7678	-23.5108	-23.12
2	856.856	33.737	16	0.006	5.50E-16	-23.7929	-23.3305	-22.6273
3	867.444	21.177	16	0.172	6.50E-16	-23.6361	-22.9681	-21.9524
4	881.259	27.629	16	0.035	7.10E-16	-23.5727	-22.6992	-21.371
5	892.994	23.47	16	0.102	8.30E-16	-23.4491	-22.3701	-20.7293
Spain								
LAG	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	764.718				3.10E-15	-22.0498	-21.9984	-21.9203
1	850.391	171.35	16	0.000	4.10E-16	-23.7745	-23.8124	-23.4217
2	875.461	50.14	16	0.000	3.20E-16	-24.3322	-23.8698	-23.1666
3	887.654	24.387	16	0.081	3.60E-16	-24.2219 -	23.5539	-22.5382
4	906.285	37.261	16	0.002	3.40E-16	-24.2981	-23.4246	-22.0964
5	919.049	25.527	16	0.061	3.90E-16	-24.2043	-23.1253	-21.4845

Note that: The number of observations is 69 for each of the countries. *LL*: Likelihood; *LR*: Likelihood ratio; *df:* degree of freedom; *p:* p-value; *FPE*: Final prediction error; *AIC*: Akaike information criteria; *HQIC*: Hannan-Quinn information criteria; *SBIC:* Bayesian information criteria (or Schwarz information criterion).

Table 5. Estimation Results of the Panel VAR

		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
		Whole Sample	Eurozone	Non-Eurozone	GIIPS	GIIS	IS
Panel A: Private Credit	$dlncredit_{t-1}$	-.01124	-.02258*	.02389***	-.06231**	-.07064**	-.05122
		(0.343)	(0.063)	(0.000)	(0.015)	(0.053)	(0.107)
	$dlnrhprice_{t-1}$	.08687**	.08240**	.11715	.14600	.17736	.20129**
		(0.043)	(0.038)	(0.341)	(0.135)	(0.151)	(0.062)
	dlnrgdp	.98727***	.98065***	1.00698 ***	.97418***	.96517***	.97923***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
	drsint	-.53745	-.10937	-1.36291	-.95047	.96517	-2.16510
		(0.359)	(0.861)	(0.130)	(0.419)	(0.147)	(0.111)
	drdfint	-.27588	-.17572	-.36955	-.97356	-1.59030	-.92987
		(0.532)	(0.675)	(0.516)	(0.250)	(0.168)	(0.223)
Panel B: Housing Price	$dlnrhprice_{t-1}$	-.35897***	-.39778***	-.03011	-.17164**	-.12859	-.11663
		(0.000)	(0.000)	(0.576)	(0.040)	(0.176)	(0.250)
	$dlncredit_{t-1}$	.02194***	.01168	.05590***	.00077	.00500	.01651
		(0.005)	(0.232)	(0.008)	(0.968)	(0.840)	(0.595)
	dlnrgdp	.02670***	.02140**	.05721***	.01926	.01191	.04067***
		(0.001)	(0.038)	(0.002)	(0.325)	(0.621)	(0.353)
	drsint	-.45190	-.44354	-.87341	-1.5921*	-1.98101**	-3.21479***
		(0.158)	(0.363)	(0.212)	(0.095)	(0.068)	(0.010)
	drdfint	-.27211*	-.36511	-.01563	-.967285	-1.28197*	-1.11021
		(0.077)	(0.298)	(0,975)	(0.122)	(0.091)	(0.178)

Note that: p-values are provided in parentheses. (***), (**) and (*) indicate statistical significance at the levels of 1, 5 and 10 percent respectively. The variables are transformed in logarithms except for short term interest rates and term spread. Also, all variables with their first difference at real terms. The lag order is one for all samples. *dlnrlhprice*: house prices , *dlncredit*: private credit, *dlnrgdp*: economic activity (and total income); *dlrsint*: short-term interest rates; *drdfint*: term spread

Table 6. Estimation Results of Individual Countries

		Greece	Ireland	Italy	Portugal	Spain
Panel A: Credit Market	$dlnrealhp_{t-1}$	.25233***	.08074*	.18496**	.37687**	.477761***
		(0.000)	(0.090)	(0.098)	(0.022)	(0.000)
	$dlncredit_{t-1}$	.11031***	.49873***	-.00832	.11977***	.056885*
		(0.003)	(0.000)	(0.716)	(0.002)	(0.099)
	dlnrealgdp	.96696***	1.0403***	1.0020***	1.01241***	.99588***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
	drealsint	-.38433	-1.37691	.13236	-.91179	-.43856*
		(0.110)	(0.102)	(0.137)	(0.154)	(0.077)
	drdifint	.30405	-.96453	-.14378	.41791	1.3735**
		(0.250)	(0.890)	(0.613)	(0.426)	(0.050)
Panel B: Housing Price	$dlnrealhp_{t-1}$	.60085***	.7690***	.9696***	.61047***	.87689***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
	$dlncredit_{t-1}$	.06002**	.01447*	.01270	.03827	.02174*
		(0.048)	(0.093)	(0.125)	(0.109)	(0.096)
	dlnrealgdp	.02445	.10423**	.00473	.01883	.04563*
		(0.365)	(0.070)	(0.672)	(0.398)	(0.065)
	drealsint	-.97019**	-.42392	-.64285**	.09934	-.63592
		(0.012)	(0.799)	(0.014)	(0.800)	(0.255)
	drdifint	-.15534	-.45002	-.40682	-.05680	-.36589
		(0.194)	(0.641)	(0.106)	(0.855)	(0.391)
	Observations	72	72	72	72	72

Note that: p-values are provided in parentheses. (***), (**) and (*) indicate statistical significance at the levels of 1, 5 and 10 percent respectively. The variables are transformed in logarithms except for short term interest rates and term spread. Also, all variables with their first difference at real terms. The lag order is one for all samples. *dlnrlhprice*: house prices , *dlncredit*: private credit, *dlnrgdp*: economic activity (and total income); *dlrsint*: short- term interest rates; *drdfint*: term spread

Table 7. Eigenvalue Stability Tests for the Panel VAR

	Eigenvalue		
	Real	**Imaginary**	**Modulus**
Whole Period	-0.36437	0	-0.36437
	-0.00584	0	-0.00584
Eurozone	-0.40033	0	0.400331
	-0.02004	0	0.020041
Non-Eurozone	-0.08842	0	0.088419
	0.08220	0	0.082203
GIIPS	-0.17267	0	0.172672
	-0.06129	0	0.061288
GIIS	-0.14117	0	0.141171
	-0.05807	0	0.058067
IS	-0.15022	0	0.150225
	-0.01764	0	0.017641

Note that: Stability tests results show that in all periods and all samples, all the eigenvalues lie inside the unit circle.

Table 8. Eigenvalue Stability Tests for the Individual Countries

Countries	Eigenvalues	Modulus
Greece	.748805	.748805
	.5329575 + .06918982i	.53743
	.5329575 - .06918982i	.53743
	.3794247	.379425
	-.150312	.150312
Ireland	.7410679	.741068
	.6457525	.645752
	.4039171 + .03754599i	.405658
	.4039171 - .03754599i	.405658
	-.01541341	.015413
Italy	.9319088	.931909
	.4989682	.498968
	.05734682 + .210065i	.217752
	.05734682 + .210065i	.217752
	.01068878	.010689
Portugal	.8552387	.855239
	.6013157	.601316
	.328584 + .02048467i	.329222
	.328584 - .02048467i	.329222
	-.02711216	.027112
Spain	.8552387	.855239
	.6013157	.601316
	.328584 + .02048467i	.329222
	.328584 - .02048467i	.329222
	-.02711216	.027112

Note that: For all countries, all the eigenvalues lie inside the unit circle. VAR satisfies stability condition

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Table 9. The Results of Granger Causality Test for Panel VAR

	Housing Price Equation		Credit Equation		Relationship	Direction
Excluded	dlnrcredit	All	dlnrhprice	All		
Whole Sample	8.017***	8.017***	4.095**	4.095**	Two way	HP ↔ CRE (1)
Eurozone	1.426	1.426	4.284**	4.284**	One way	HP → CRE
Non-Eurozone	0.908	0.908	7.084***	7.084***	One way	CRE → HP
GIIPS	2.234	2.234	0.002	0.002	No relationship	
GIIS	2.058	2.058	0.041	0.041	No relationship	
IS	3.495**	3.495**	0.001	0.001	One way	HP → CRE

Note that: (***), (**) and (*) indicate statistical significance at the levels of 1, 5 and 10 percent respectively. In all samples, the lag order is one. HP: housing price, CRE: private credit.

(1) The effect of credit on housing price is stronger than that of house prices on credit.

Table 10.The Results of Granger Causality Test for Individual Countries

	Credit Equation		Housing Price Equation		Relationship	Direction
Excluded	dlnrhprice	All	dlnrcredit	All		
Greece	1.473	9.2523*	2.213	8.9072*	No relationship	
Ireland	2.412	16.699***	0.049	1.951	No relationship	
Italy	6.432**	16.001***	3.4612*	9.6275**	Two way	HP ↔ CRE (1)
Portugal	1.079	5.646	0.804	7.339	No relationship	
Spain	8.3349 ***	29.602***	0.41434	2.2421	One way	HP → CRE

Note that: p-values are provided in parentheses. (***), (**) and (*) indicate statistical significance at the levels of 1, 5 and 10 percent respectively. In all samples, the lag order is one. HP: housing price, CRE: private credit.
(1) The effect of house prices on credit is stronger than that of credit on housing price.

Table 11. Variance Decomposition for the Panel VAR

Response Variable	Period	Impulse Variable : dlnrcredit					
		Whole Sample	**Eurozone**	**Non-Eurozone**	**GIIPS**	**GIIS**	**IS**
dlnrhprice							
	1	0	0	0	0	0	0
	5	.00025	.0000421	.0010751	.00000107	.0000159	.000069
	10	.0002501	.0000421	.0010751	.00000107	.0000159	.000069

Response Variable	Period	Impulse Variable : dlnrhprice					
		Whole Sample	**Eurozone**	**Non-Eurozone**	**GIIPS**	**GIIS**	**IS**
dlnrcredit							
	1	.0158946	.0270484	.0205548	.0444907	.0695902	.0109482
	5	.0269158	.0341129	.0229954	.0568586	.0804468	.0572295
	10	.0269217	.0341218	.0229954	.0568588	.0804468	.0572296

Note that: *dlnrcredit*: private credit; dlnrhprice: house prices .

Table 12. Variance Decomposition for the Individual Countries

Response Variable	Period	Impulse Variable : dlnrcredit				
		Greece	Ireland	Italy	Portugal	Spain
dlnrhprice						
	1	0	0	0	0	0
	5	.046187	.000251	.000012	.083241	.001411
	10	0.046811	.000381	.014993	.083912	.001603

Response Variable	Period	Impulse Variable : dlnrhprice				
		Greece	Ireland	Italy	Portugal	Spain
dlnrcredit						
	1	.02806	.07129	.000705	.009996	.076637
	5	.082626	.1112	.049249	.009949	.189198
	10	0.083895	.112115	.049249	.009955	.218417

Note that: *dlnrcredit*: private credit; *dlnrhprice*: house prices .

Table 13. Estimation Results for a Robustness Check

		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
		Whole Sample	Eurozone	Non-Eurozone	GIIPS	GIIS	IS
Panel A: Private Credit	$dlnhprice_{t-1}$	.16242***	.17658***	.11774**	.27180***	.31038***	.34407***
		(0.000)	(0.000)	(0.013)	(0.000)	(0.000)	(0.000)
	dlnrgdp	.98707***	.98346***	1.0050***	.98649***	.97777***	.98676***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
	drsint	-.17841	-.04497	-.63843***	-.12471	-.25401	.07426
		(0.216)	(0.795)	(0.005)	(0.680)	(0.468)	(0.917)
	cons	.00245***	.00249***	.00260**	.00362***	.00352**	-0.0024
		(0.000)	(0.001)	(0.012)	(0.008)	(0.030)	(0.385)
	Chi2	7551.56	5143.18	3699.54	1595.79	1162.08	386.49
	R-sq	0.8812	0.8656	0.9441	0.8135	0.7988	0.7231
	P-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Panel B: Housing Price	$dlnrcredit_{t-1}$	.04319***	.03348***	.06627***	.05227***	.07879***	.08565***
		(0.000)	(0.004)	(0.006)	(0.005)	(0.000)	(0.000)
	dlnrgdp	.06798***	.05849***	.08127***	.07183***	.08279***	.12781***
		(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
	drdfint	-.20188***	-.21745***	.36906***	-.24933***	-.25831***	-.69967***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
	cons	.00778***	0.0025***	.00252***	0.00825***	0.00892***	0.01868***
		(0.000)	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)
	Chi2	133.99	120.27	33.34	103.09	105.3	70.13
	R-sq	0.1164	0.1313	0.1325	0.2164	0.2617	0.3077
	P-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
	Observations	1018	799	219	365	292	146

Note that: p-values are provided in parentheses. (***), (**) and (*) indicate statistical significance at the levels of 1, 5 and 10 percent respectively. The variables are transformed in logarithms except for short term interest rates and term spread. Also, all variables with their first difference at real terms. The lag order is one for all samples. *dlnrlhprice*: house prices , *dlncredit*: private credit, *dlnrgdp*: economic activity (and total income); *dlrsint*: short-term interest rates; *drdfint*: term spread.

APPENDICES

Appendix 1. Data Description and Source

CODE	VARIABLES	DATA DECRIPTION AND SOURCE
cip	Consumer price index (2010=100) (%)	Definition: Consumer price index (CPI) is defined as the change in the prices of a basket of goods and services that are typically purchased by specific groups of households. Source: The Organization for Economic Co-operation and Development (OECD)
credit	Private Credit/ GDP (%)	Definition: It shows that total bank lending to private sector is divided by the GDP. Total credit is in terms of billions of US dollar. It covers total credit *to* the non-financial sectors (households and non-fınancial corporations excluding general government lent by deposit money banks and other financial institutions Source: Bank for International Settlements (BIS)
dfint	Term spread (%)	Definition: Term spread is also called interest rate spread. It measures the difference between long term and short term interest rates. It is calculated by author. Source: The Organization for Economic Co-operation and Development (OECD)
gdp	Economic activity and total income (as of current billions of the US dollar)	Definition: Gross domestic product (GDP) is total of all the final goods and services produced as monetary value within the borders of a country in a specific period. GDP shows the size of economic activity as well as of total income earned in an economy in a specific period. Source: Bank for International Settlements (BIS)
hprice	Nominal house price index (%) (2010=100)	Definition: House price index measures the price changes of residential housing. Source: The Organization for Economic Co-operation and Development (OECD)
lint	Long- term interest rates (%)	Definition: Nominal long term interest rates are long term government bond yields and are calculated as monthly averages (non -seasonally adjusted data). They refer to central government bond yields on the secondary market, gross of tax, with a residual maturity of around 10 years. Source: The Organization for Economic Co-operation and Development (OECD)
sint	Short-term interest rates (%)	Definition: Short-term interest rates are rates on money markets for different maturities (overnight, 1–12 months. Source: The Organization for Economic Co-operation and Development (OECD)

Appendix 2. Descriptive Statistics

Code	Sample	Mean	Standard Deviation	Minimum	Maximum
hprice	1050	91.07219	21.13372	38.4	158.8
credit	1050	99.49153	31.96031	35.8	199.5
gdp	1050	946921.1	1004578	88021.75	4030455
dfint	1050	1.781952	2.341615	-4.7	18.71
sint	1050	2.12E+00	1.844475	-0.77	10.8

Note that: *hprice:* house prices , *credit:* private credit/GDP, *dfint*: term spread, *gdp:* economic activity, *sint*: short-term interest rates.

Appendix 3. Multicollinearity and Diagnostic Tests for Private Credit Equation

Appendix 3/A: Coefficients for Private Credit Equation (a)

	Unstandardized coefficients		Standardized Coefficients			95% Confidence interval for Beta		Collinearity Statistics	
	Beta	Standard Error	Beta	t-statistics	P-value	Lower bound	Upper bound	Tolerance	VIF (b)
constant	61.085	4.856		12.58	0.000				
gdp	6.858E-6	3.60E-06	0.216	7.456	0.000	0.000	0.000	0.961	1.040
hprice	0.525	0.047	0.347	11.117	0.000	0.432	0.617	0.825	1.212
sint	-1.235	0.532	0.071	-2.323	0.020	-2.278	-0.192	0.854	1.171

(a) Dependent variable is private credit (i.e. credit).
(b) VIF is variance inflation factors
(c) *credit:* private credit/GDP, *gdp:* economic activity, *hprice:* house prices , *sint*: short-term interest rates.

Appendix 3/A: Collinearity Diagnostics for Private Credit Equation (a)

				Variance Proportions		
Dimension	Eigenvalue	Condition Index	Constant	gdp	hprice	sint
1	3.179	1.000	0.00	0.03	0	0.02
2	0.508	2.502	0.00	0.49	0	0.35
3	0.294	3.288	0.02	0.47	0.04	0.37
4	0.118	4.803	0.06	0.01	0.96	0.26

(a) Dependent variable is private credit (i.e. credit).

Appendix 4. Multicollinearity and Diagnostic Tests for Credit Equation

Appendix 4/A: Coefficients for Credit Equation (a)

	Unstandardized coefficients		Standardized Coefficients			95% Confidence interval for Beta		Collinearity Statistics	
	Beta	Standard Error	Beta	t-statistics	P-value	Lower bound	Upper bound	Tolerance	VIF (b)
constant	77.177	2.215		34.841	0.000	72.831	81.524		
gdp	3.595E-6	0.000	0.171	6.442	0.000	0.000	0.000	0.939	1.064
credit	0.241	0.017	0.364	14.028	0.000	0.207	0.275	0.980	1.021
dfint	-3.494	0.242	-0.380	-14.465	0.000	-3.968	-3.020	0.959	1.043

(a) Dependent variable is housing price (i.e.hprice).
(b) VIF is variance inflation factors.
(c) *hprice:* house prices , *credit:* private credit/GDP, *gdp:* economic activity, dif*int:* term spread.

Appendix 4/B: Collinearity Diagnostics for Housing Price Credit Equation (a)

				Variance Proportions		
Dimension	Eigenvalue	Condition Index	Constant	gdp	credit	lint
1	3.273	1.000	0.01	0.03	0.01	0.02
2	0.510	2.534	0.00	0.71	0.01	0.09
3	0.178	4.289	0.02	0.12	0.18	0.75
4	0.139	5.193	0.07	0.14	0.81	0.14

(b) Dependent variable is housing price (i.e.hprice).

Appendix 5. Correlation Matrix

	hprice	credit	gdp	dfint	sint
hprice	1.0000				
credit	0.3319*	1.0000			
gdp	0.1962*	0.1426*	1.0000		
dfint	-0.0979*	-0.1202*	-0.1456*	1.0000	
sint	-0.3823*	-0.0924*	-0.0685*	-0.3771*	1.0000

Note that: Asterisk denotes statistical significance at the 0.05 level. *hprice:* house prices , *credit:* private credit/GDP, *dfint*: term spread, *gdp:* economic activity, *sint*: short-term interest rates.

Appendix 6. Correlation Matrix

	$dlnrealhp_{t-1}$	$dlnrealcredit_{t-1}$	dlnrealgdp	drdfint	drealsint
$dlnrealhp_{t-1}$	1.0000				
$dlnrealcredit_{t-1}$	0.2331*	1.0000			
dlnrealgdp	0.1903*	0.0334*	1.0000		
drdfint	-0.0678*	0.0072*	-0.0133	1.0000	
drealsint	0.1001*	0.0930*	0.1089*	-0.1468*	1.0000

Note that: Asterisk denotes statistical significance at the 0.05 level. *$dlnhprice_{t-1}$:* first difference real house prices with logarithmic transformation, *$dlnrcredit_{t-1}$:* first difference credit with logarithmic transformation, *drdfint:* first difference term spread, *dlnrgdp:* first difference economic activity with logarithmic transformation.

Appendix 6. The Results of Granger Causality Test for Individual Countries

		Credit Equation		Housing Price Equation		Relationship	Direction
	Excluded	dlnrhprice	All	dlnrcredit	All		
Greece	Lag order: 3	5.1361**	9.2523*	0.158	2.568	One way	HP → CRE
Ireland	Lag order:4	4.1077 **	15.91***	0.201	12.265*	One way	HP → CRE
Portugal	Lag order: 7	3.2937*	6.774	11.189***	14.093***	Two way	HP ↔ CRE (1)

Note that: p-values are provided in parentheses. (***), (**) and (*) indicate statistical significance at the levels of 1, 5 and 10 percent respectively.
HP: housing price, CRE: private credit.
(1) The effect of house prices on credit is stronger than that of credit on housing price.

Appendix 7. The Results of Overidentifying Restriction Tests for Panel VAR

Whole Sample	Hansen's J chi2(16) = 64.908783 (p = 0.000)
Eurozone	Hansen's J chi2(16) = 59.058715 (p = 0.000)
None-Eurozone	Hansen's J chi2(16) = 25.543589 (p = 0.061)
GIIPS	Hansen's J chi2(16) = 28.114278 (p = 0.031)
GIIS	Hansen's J chi2(16) = 28.317259 (p = 0.029)
IS	Hansen's J chi2(16) = 21.048652 (p = 0.017)

Note that: There is no over identification.

Appendix 8. Hausman Endogeneity Test

	Coefficients			
	(b)	(B)	(b-B)	sgrt (diag(V_b - V_B))
	eqn3sls	agncid	Difference	S.E.
dlnrcredit				
$dlnrealhprice_{t-1}$	0.2443295	0.1528494	0.0914801	0.0819607
cons	0.0064162	0.0025019	0.0039143	0.0016672
dlnrhprice				
$dlnrealcredit_{t-1}$	0.1193859	0.0522707	0.0671152	0.0287929
cons	0.004057	0.0039595	0.0000975	0.0001255

b : consistent under H_o and H_a obtained from Reg3

B : inconsistent H_a, efficient under H_o obtained from Reg3

Test: H_o : difference in coefficients not systematic

chi2 (4) : (b-B)` [(V_b - V_B)^ (-1)} (b - B)

: 27.60

Prob >ch2 : 0.0000

(V_b - V_B is not positive definite)

Note that: *dlnrcredit:* private credit; *dlnrhprice*: house prices.