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The Impact of Unconventional Monetary Policies on Lending Rates: An Evidence of the European Central Bank's Large Scale Asset Purchases

Mário Jorge Correia Fernandes

Dissertation submitted as partial requirement for the conferral of
Master in Monetary and Financial Economics

Supervisor:
PhD, Sérgio Miguel Chilra Lagoa, Professor Auxiliar
Department of Political Economy

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ACKONWLEDEGEMENTS

I would like to thank my parents (Maria Alexandrina Fernandes and António da Fonseca Fernandes) and Joana Caria Silva for their constant encouragement and unconditional support during this MSc program.

I take this opportunity to warmly thank Professors Sérgio Lagoa, PhD and Rui Menezes, PhD for their full availability and support. It has been a privilege working with both.

I would also like to thank António Quintino, PhD and my Master José Paulo Oliveira for their support in my professional and academic career.

Finally, the financial support provided by the Academic Excellence Awards by ISCTE – Institute University of Lisbon is gratefully acknowledged.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

List of Acronyms

ABS – Asset-Backed Securities

ABSPP – Asset-Backed Securities Purchase Programme

ADF – Augmented Dickey–Fuller

AIC – Akaike Information Criteria

APP – Asset Purchase Programme

BoE – Bank of England

BoJ – Bank of Japan

BVAR – Bayesian Vector AutoRegression

CBPP1 – First Covered Bond Purchase Programme

CBPP2 – Second Covered Bond Purchase Programme

CBPP3 – Third Covered Bond Purchase Programme

CE – Credit Easing

CSPP – Corporate Sector Purchase Programme

d.f. – degrees of freedom

DSGE – Dynamic Stochastic General Equilibrium

DSP – Difference-Stationary Process

ECB – European Central Bank

FED – Federal Reserve System

FPE – Final Prediction Error

GDP – Gross Domestic Product

HQ – Hannan–Quinn

IRF – Impulse Response Function

LR – Likelihood Ratio

MFI – Monetary and Financial Institutions

MRO – Marginal Refinancing Operations

NFC – Non-Financial Corporations

PP – Phillips-Perron

PSPP – Public Sector Purchase Programme

QE – Quantitative Easing

SBC – Schwarz Bayesian Criterion

TLTRO – Targeted Longer Term Refinancing Operations

TSP – Trend-Stationary Process

SMP – Securities Markets Programme

VAR – Vector AutoRegression

ZLB – Zero Lower Bound

ZNLB – Zero Nominal Lower Bound

Abstract

Over the last few years, the largest central banks used different approaches due to financial and debt sovereign crises. The present dissertation introduces a review of unconventional monetary policies (Quantitative Easing and Credit Easing) and assesses the main transmission mechanisms of unconventional monetary policies and the conditions under which they may, or may not, impact the economic agents through the bank funding channel. Furthermore, this dissertation evaluates the impact of the European Central Bank's (ECB) unconventional monetary policies on the lending rates. The statistical distribution analysis is based on the credit to non-financial corporations and for house purchases. The analysis is subsequently extended to a Vector Auto-Regressive (VAR) model, where the main goals are to analyse the Impulse Response Functions (IRF) of the Large Scale Asset Purchases (LSAP) and the fixed interest rate for the Main Refinancing Operations (MRO) on the lending rates for non-financial corporations and house purchases and study the causality between these variables and the decrease on the lending rates. The results show that (i) changes on the ECB's LSAP Granger causes changes on both lending rates as well as the changes on the policy rate, (ii) these variables have significant effects from the IRF and (iii) the Bayesian Vector AutoRegression (BVAR) approach confirm the standard models.

KEY WORDS: Large Scale Asset Purchases, Monetary Policy, Quantitative Easing, Unconventional Monetary Policy, Vector Auto-Regressive Models.

JEL Classification System: C51, C52, C54, E52, E58.

Resumo

Ao longo dos últimos anos, os principais bancos centrais utilizaram diferentes abordagens para fazer face à crise financeira internacional e à crise da dívida soberana. Esta dissertação introduz uma revisão das políticas monetárias não convencionais (*Quantitative Easing* e *Credit Easing*) e aborda, também, os principais mecanismos de transmissão da política monetária não convencional, bem como as condições sobre as quais (ou não) impactam os demais agentes económicos, através do canal do financiamento do sistema bancário. Além disso, esta dissertação avalia o impacto das políticas monetárias não convencionais do Banco Central Europeu nas taxas de juro para empréstimos aos agentes económicos. A análise das distribuições estatísticas é estendida para as taxas de juro para empréstimos às empresas não-financeiras, bem como para finalidade para compra de habitação. Posteriormente, a análise é estendida para o recurso aos modelos vetoriais auto-regressivos (VAR), cujos principais objetivos são as análises das Funções Impulso Resposta das taxas de juro para empresas não-financeiras e para compra de habitação às compras de ativos pelo banco central e à taxa de juro para as principais operações de refinanciamento na área-euro e, também, analisar a causalidade entre as variáveis descritas e o decréscimo das taxas de juro do sistema bancário. O resultados alcançados demonstram que: (i) as variações no programa de compra de ativos pelo Banco Central Europeu, bem como as alterações na taxa de juro para operações de refinanciamento, parecem causar à *Granger* as alterações nas taxas de juro praticadas no sector bancário, (ii) que tais variáveis têm efeito significativo ao nível das Funções Impulso Resposta e (iii) que o VAR *Bayesiano* (BVAR) confirma os resultados dos tradicionais modelos VAR.

Palavras-Chave: Compra de Ativos em Larga Escala, Política Monetária, Política Monetária Não Convencional, *Quantitative Easing*, Modelos VAR.

JEL Classification System: C51, C52, C54, E52, E58.

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I. Introduction

Over recent years, in almost all advanced economies the market interest rates have fallen to a significant low-level as a consequence of the last financial crisis. This fall in the market interest rates was affected by domestic and global factors. This research presents a brief narrative of the conduct of European Central Bank (ECB) monetary policy during the last years, explores the main transmission channels of non-standard policies and offers an empirical evidence on the relevance of these policies on the lending rates in the euro area.

The timeline of the monetary policies of the ECB shows that this central bank decided to broke through the Zero Lower Bound (ZLB) of their nominal interest rates on 11th June 2014, using the deposit facility rate. However, in the same month, in order to give marginal monetary accommodation to the credit market, to restore the economic activity and to secure the path of the inflation into the target on the euro area, the ECB's Governing Council decided to introduce a pack of additional measures. Firstly, the European monetary authority cut the main nominal interest rates – the marginal refining rate, the main refinancing rate and the deposit facility rate. As documented by Ullersma (2002) this type of events (negative nominal interest rates) had been exceptionally rare in the history of the monetary policy. For example, the goal of decreasing the deposit facility rate is clear: decrease the marginal incentive for the banking system to save their liquidity in deposits in the ECB. The second step of the ECB's decision makers was the continuing strategy to conduct its Main Refinancing Operations (MRO) at a fixed rate with full allotment for the sufficient and necessary time in order to create more certainty regarding to the large availability of bank refinancing. Additionally, the ECB introduced several Targeted Longer Term Refinancing Operations (TLTRO) with the aim of creating marginal incentives to lending for the economic agents. Third, the ECB introduced their Asset Purchase Program (APP). Combining with the TLTRO, it allowed a significant balance sheet expansion. This APP included the Covered Bond Purchase Program (CBPP) – to ensure easier bank funding – and other programmes, such as the Asset-Backed Securities Purchase Programme (ABSPP). Finally, a unanimous decision of the ECB's Governing Council decided to use other additional non-standard instruments to overcome the risk of a too long period of low-inflation in the euro area. This pack of unconventional instruments included purchases in the secondary market of government bonds.

As previously mentioned, these non-standard monetary policies also affected the lending and credit markets. Lending conditions are relevant for the welfare of societies, to the level of economic activity and for monetary policy. As mentioned by Hristov et al. (2014), this fact is especially significant in the euro area, where around 50% of external funds in the balance sheet of small and large non-financial corporations (NFC) are bank loans (in the U.S. economy bank loans only represent 25% considering the same typology of firms, for example). For the monetary policy, the effectiveness of the pass-through of policy rate conditions affects the role of central banks since it controls the dynamics of the price stability and aggregate demand. However, in periods of uncertainty and additional financial stress, some economic constraints might modify the effectiveness of the conventional monetary policy. In fact, recent research argues that there is relevant fall in the pass-through of the policy rate, comparing it with the period before the crisis (Hristov et al., 2014; Holton and Rodriguez d'Acri, 2015). Thus, these patterns beg relevant questions: can unconventional monetary policies impact cost of borrowing indicators? Have these non-standard policies the same dynamic behaviour for NFC loans and for house's purchase loans? Is there causality between conventional and unconventional monetary shocks and changes in the cost of borrowing indicators?

This dissertation contributes for the literature by quantifying the effects of changes on non-standard monetary policies (from the total assets purchased by the ECB) and from changes on the policy rate (MRO at fixed rate) on the changes of cost-of-borrowing indicators for both NFC and households for house purchase using a standard macroeconomic model. We found that in lending rates for house purchases, changes on the unconventional monetary policies (CE and QE) Granger cause changes in these lending rates, although changes on the policy rate do not Granger cause changes in the lending rates for this purpose. In the model of differences in the NFC loans, changes on the unconventional and conventional policies Granger cause changes in these lending rates. The findings on the models for the lending rates for house purchases are consistent with the ZLB problem and with the findings of Hristov et al. (2014) and Holton and Rodriguez d'Acri (2015) about the inefficiency of the conventional policy over the last years. As a robustness check, we also show that the Bayesian VAR (BVAR) provided similar results in the responses of changes in the cost-of-borrowing indicators from the impulses on the conventional and unconventional monetary policies.

The remainder of this research is organized as follows. Chapter 2 presents a brief survey of literature. Data and methodology are presented in Chapter 3. In chapter 4 we estimate and analyse the VAR model, including the impact of the ECB's Large Scale Asset Purchases (as measure of unconventional monetary policy) and the fixed interest rate for the MRO on the lending rates for NFC and house purchase. Chapter 5 presents some final remarks and proposals for future research in these areas.

II. A brief survey of literature

In the conventional monetary policy, an effective pass-through of policy rate changes facilitates for central bank decision makers to control the specific dynamics of aggregate demand. In the period between 2000 to the end of 2007 the monetary policy of the European Central Bank (ECB) was characterized by homogeneity across economies (Ciccarelli et al., 2013) and the pass-through of interest rates of the ECB to lending rates in the commercial banks is almost complete in the long-run (Hristov et al., 2014). However, with the consequences of the financial and sovereign debt crises the conventional monetary policy changed. Appendix 1 shows the policy rate of the ECB for the marginal lending facility, main refinancing operations (fixed rate) and deposit facility in the data set for the period 2000-2017.

The literature and empirical researches analyzing and exploring the transmission mechanisms of the conventional and unconventional monetary policy is quite extensive. Prior to the introduction of the unconventional monetary policy, the conventional monetary policy in developed economies was based on the manipulation of the short-term interest rate. This manipulation of the interest rate in the short-run affects investment and consumption decisions. Usually, in the literature we find three traditional transmission mechanisms: (i) the interest rate channel, (ii) the expectation channel and (iii) the credit mechanism (Russell (1992), Bernanke and Gertler (1995) and Mishkin (1996)).

Since the unconventional monetary policy represents a non-standard framework of the central bank decision makers, other transmission mechanisms may matter. In this new theoretical framework for the central banks, we will focus on the most significant non-standard policies: (i) the Credit Easing (CE) and the (ii) Quantitative Easing (QE). In order to present the most relevant differences between CE and QE, we will begin with the CE. In the situations where the interest rate channel cannot be efficient – Zero Lower Bound (ZLB) or Zero Nominal Lower Bound (ZNLB) – and there is a weak inflation dynamic in the economy, CE can be used to support private sector credit flows. Consequently, CE policies affects the composition and the size of the total assets in the balance sheet of the central bank. On the other hand, even though QE also combats deflationary risks by easing private sector borrowing conditions, there exist some differences. Comparing with the CE, QE involve a program (or programmes) to expand the central bank balance sheet by the liabilities side. Secondly, there are no explicit references to the assets the central bank holds.

Despite being different measures of the unconventional monetary policy, the transmission mechanisms are quite similar. One relevant channel is the cost relief channel, which unconventional monetary policies should improve commercial banks' refinancing conditions. This channel can be used for CE and QE. In the first scenario, it allows banks to replace market funding conditions by the central bank conditions. Consequently, it reduce the supply of bank bonds, decreasing the yields. This phenomenon should contribute for lower lending conditions (or lower lending rates) for the real economy (NFC or for house purchase, for example). In the case of the QE, the transmission mechanism also works, since bank bonds could be close substitutes for the assets purchased by the central bank.

Another relevant transmission channel is the portfolio rebalancing channel. In this channel, the QE has a significant role in the monetary policy of the central bank. The Large Scale Asset Purchase Programs (LSAP) of the central banks change the supply of marketable assets as well as their yields. This is especially relevant if there are differences in the liquidity that the private sector receives and the liquidity in the assets sold. This transmission mechanism is also known as portfolio rebalancing channel because sellers of assets should rebalance their asset portfolios in order to buy assets with similar characteristics to those sold to the central bank. It implies that price bonds should increase, lowering the yields of these assets – government bonds, corporate bonds and Asset-Backed Securities (ABS) – and make lending activities more attractive than other investments. Under this transmission channel, CE should also produce equivalent effects. The additional amount of bank liquidity from the CE can be used to purchase eligible assets included in the asset purchase program. Notice that one of the most relevant goals of the CE is to decrease the commercial banks' cost for targeted lending operations and where the banks replace market funding by funding in the central bank. Therefore, this marginal liquidity can be used by the commercial banks to purchase debt securities with similar features as the securities purchased by the central bank (see Altavilla et al.,2016). Empirical evidence with the Federal Reserve (FED), Bank of England (BoE) and ECB experience using unconventional monetary policies can be find on Krishnamurthy and Vissing-Jorgensen (2011), Joyce et al. (2011) and Altavilla et al. (2015).

Lastly, unconventional monetary policies are also relevant for the central banks to signal to economic agents in order to the path of future monetary policy and interest rates as well. This mechanism channel is known as the signalling channel. The main idea of this transmission channel is quite similar to the signalling games in the contract theory since central banks has a credible and strong commitment to keep a low policy rate in the medium-term. Note that if the central bank change the rate policy, i.e., increasing the reference interest rate (the Main Refinancing Operations interest rate for the euro area, for example), economic agents will obtain losses from the LSAP since the central bank signaled the planned path of future policy rates and the banking system may have assets that are in the programme (Eggertsson and Woodford, 2003). Exploring this transmission mechanism, this commitment of the central bank with the markets has two implications. The first implication may work as a downward update on the expectations for future short-term rates. On the other hand, this channel may work as re-anchoring the inflation expectations. Since central bank has a commitment with the market providing information about the future short-term interest rates, it affects the expectations about future inflation. On other words, this signalling channel affect the yield curve. However, the magnitude of the effect also depends on the maturity of the assets involved in the LSAP. In the researches of Krishnamurthy and Vissing-Jorgensen (2011), Altavilla et al. (2015), and Bauer and Rudebusch (2014) this transmission channel has been deeply studied.

2.1. The Portfolio Substitution and the Bank Funding Channel

As previously mentioned, in a response to the last financial crisis, central banks found themselves limited in the use of conventional monetary policy and in the aftermath of this fact, standard policies are looking increasingly less efficient. Two potential reasons emerged as the potential justifications: (i) the ZLB on interest rates and (ii) the spread between official nominal interest rates and the market interest rates practices. Thus, with a large program of purchasing financial assets, monetary authorities can expand the balance sheet of their central banks. By purchasing assets and expanding their balance sheets the monetary authorities can influence explicitly the quantities, in opposite to manipulate the short-term nominal interest rates. In this type of APP, the design can be different depending on the desired magnitude. These programs may include public sector securities (Treasury Bonds or Treasury Bills) as well as assets related to the private sector (such as corporate bonds and other securities). The expansion of the central bank's balance sheet is not the unique impact of the non-standard monetary policies. As a consequence of the LSAP, the unconventional monetary policies influences the composition of assets in the portfolio held by the agents, since private agents hold more securities on the central bank and fewer of the securities the central bank has purchased. Contrasting with the handling of the short-term nominal interest rate (or target for a policy rate), the APP are expressly about quantities. In terms of the central bank's balance sheet: (i) the liabilities rise in accordance with the reserves held by the banking system and (ii) assets rise in the same proportion.

Several key questions about the efficacy of these programs are made in the research agenda of the unconventional monetary policy. These key questions can be summarized in: (i) why does the non-standard monetary policy affect the real economy and the economic agents and how it stimulates the aggregate demand?; (ii) which are the mechanisms that affect the nominal and the real cost of credit available to private sector?; (iii) is the design of the LSAP really important to achieve the goals of the unconventional monetary policy? and (iv) which are the main differences between a CE program and a QE program in terms of real effect on the economy? However, under specific conditions, CE and QE approaches are ineffective regardless of the typology of financial assets purchased (private sector or government securities). It will be a useful key point to analyse the assumptions needed to achieve effectiveness results in non-standard monetary policies.

In accordance with Eggertsson and Woodford (2003) if we assume a single private rational agent with infinite lifetime with no credit restrictions the financial assets held by the central bank are indistinguishable from their own assets. This argument also goes back to Wallace's (1981) central idea. Thus, any swap between the private agents and the central bank is ineffective. This scenario is consistent with the Ricardian Equivalence proposition. Andre´s et al. (2004) used a Dynamic Stochastic General Equilibrium (DSGE) model with limited access in the financial markets and differentiation of preferences for government securities. In the model developed by Andre´s et al. (2004) programs such as LSAP are relevant. Curdia and Woodford (2011) concluded that a specific financial assets included in the APP of the central bank can affect the aggregate demand and the output gap. The authors also consider the impact of imperfections in the credit market and the heterogeneity and their results show that the impact only holds for CE (lendings to the private agents, given by the central bank). In the Curdia and Woodford (2011) model, the QE is ineffective. The central idea of the authors is that government bonds pay an identical safe rate to the bank reserves (associated to the rate set by the central banks). In this situation, reserves and government bonds are perfect substitutes and the QE becomes ineffective. The inefficiency is related to the fact of government securities included in the APP being short-run assets with similar features to bank reserves.

Therefore, to achieve positive impacts of QE it is necessary a portfolio switch and that is not indifferent to investors in the financial markets. Otherwise, QE does not generate a positive impact. Several researches have viewed the efficiency of the QE as a 'portfolio balance' channel. Tobin (1961, 1963, 1969) and Brunner and Meltzer (1973) exhibit significant developments on how central banks can influence the pattern of yields on several financial assets based on different sources of financing with specific characteristics of maturity and liquidity. According to the authors, central banks are mainly concerned about the imperfect asset substitutability. Such implies that the ability of the central bank in influencing the quantities could also affect the price of financial assets and thus influence aggregate demand (investment decisions, e.g.). In this case, the influence on the quantities by the central bank can be exemplified with government securities held by the private economic agents. Kiyotaki and Moore (2012) suggests a monetary model with entrepreneurs, who have specific needs of funding their investments with their own equity. In this model financial assets have different features of liquidity and shocks of liquidity are the heart of the model. Thus, the central bank can influence the poor liquidity of the shares by buying this type of assets (equities). The Kiyotaki and Moore (2012) model was an important contribute to explain the failure of the neutrality result suggested by Eggertsson and Woodford (2003) based on the arguments of (i) the credit markets imperfections and (ii) the problem of limited participation. The developments of Bernanke and Gertler (1989), Kiyotaki and Moore (1997) and Holmstrom and Tirole (1998) support the framework of the Kiyotaki and Moore (2012) monetary model.

The overview of credit imperfections models and portfolio balance models are essential for understanding the mechanisms of the QE and their efficiency. Miles (2011, 2012) suggests two important channels that explain the effects of the LSAP in the economy: (i) the portfolio substitution channel and (ii) the bank funding channel. The framework of the author was developed taking into account the specific case of the Bank of England (BoE), however it is possible to systematize this transmission channels of QE to any other central bank. In terms of the portfolio substitution channel it (i) reduces the free float of long-term fixed income debt while it (ii) increases the central bank reserves held by second order banks (commercial banks, for example). In the case of many central banks operations, most debt securities were purchased from non-banks. Note that the sale of these financial assets (debt securities) would probably be converted to bank deposits. In a scenario where the central bank's interest rates are close to zero and assuming that debt securities and deposits are perfect substitutes, there may be inefficiency in the implementation of this strategy by the central banks. In this situation the economy would be a Keynesian trap (liquidity trap) and the marginal supplies of money (in the case of standard monetary policies) by the central bank or LSAP (in the case of non-standard monetary policies) would not lead to an increase in the price of government bonds (yields decreasing). This scenario is a swap between the sale of debt securities to banking deposits and the final outcome would be the banks to increase their reserves in the central bank. However, note that usually bank deposits and government bonds are not perfect substitutes. There are basically two reasons for this: (i) the first is related to perfect habitats and (ii) another one is related to the asset pricing of duration risk. To understand this effect we assume that some investor have in their portfolio several assets, including government bonds. If we introduce the assumption where the maturity of government bonds is greater than one year (Treasury Bills, e.g.), then after the sale of these Treasury

Bills due to the intervention of the central bank (with unconventional measures) investors would exchange their long-term assets (Treasury Bills) for short-term assets (bank deposits).

Monetary authorities expect therefore that the proceeds from the sale of assets (public securities) to the central bank may also serve to buy long-term assets, such as corporate bonds. If investors buy another assets (corporate bonds), they restore the duration of their portfolio. With these LSAP programs the central bank reduces the stock of long-term assets (and the stock of privately held). Since in general the duration risk decreases (agents sell securities to the central bank, investor exchange a long-term assets, i.e. debt securities, for a short-term assets, deposits in the banking system), private agents should require a lower risk premium. This leads to the decrease of the risk premium of several long-term assets, i.e., the prices of the long-term risky assets are likely to increase. In other words, the purchases of the central bank reduces the stock of long-term assets and some investors need to restore the duration (to match the duration between assets and liabilities, e.g.). In order to purchase assets to restore de duration, investors must pay a higher value for the securities (with a lower yield) which contributes to lowering the risk premium of long-term risky assets. The final impact is called CE: rising asset prices and decreasing yields of the remaining assets which will allow many companies to see eased its funding conditions and obtain access to credit. On the other hand, households that own these risky assets will obtain capital gains. *Ceteris paribus*, their wealth will increase. Thus, if (i) households consume part of the obtained capital gains and (ii) companies/firms apply the new funds in the capital markets, aggregate demand will be expanded and positively affect the Real Gross Domestic Product (GDP). This is the portfolio substitution channel.

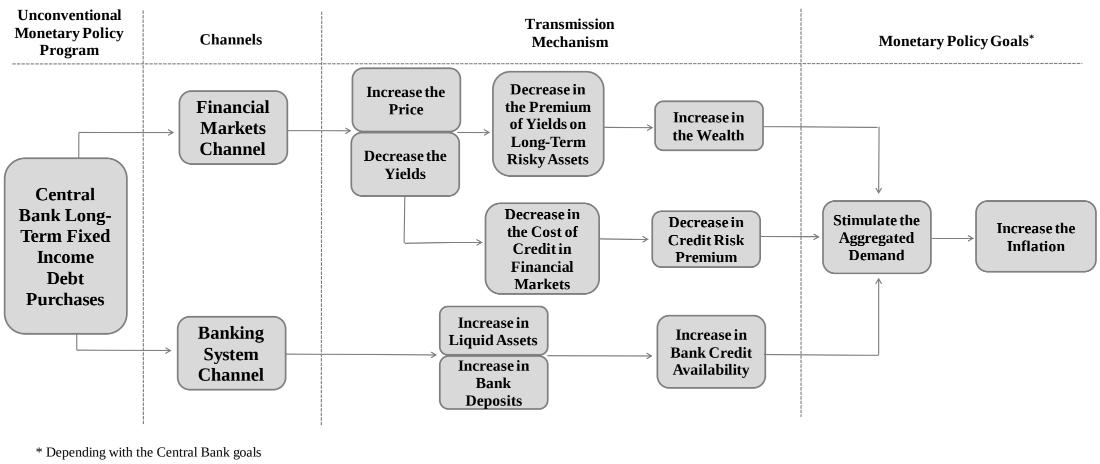


Figure 1: Channels for the impact of the central banks' APP on Aggregated Domestic Demand and Inflation.
Source: Adapted from Joyce et al. (2011)

The transmission mechanism presented on the Figure 1 is consistent with the research developed by Modigliani and Sutch (1966) where the preferred-habitat theory emerged, in which investors have a specific preference for a particular segment of the yield curve. In the literature on non-standard monetary policies there are several references to the channels of transmission of QE and the LSAP programs effect on bond prices. The research developed by Vayanos and Vila (2009) included a model where the effects of non-standard monetary policy influence the supply of bonds and their yields, including arbitrageurs in the financial markets. Greenwood and Vayanos (2010) studied these effects based on the United States macroeconomics data. Gagnon et al. (2011), for example, emphasized the duration channel as a special case of the model developed by Vayanos and Vila (2009). The study of Gagnon et al. (2011) implies that the long-term asset purchases (which includes medium and long-term government bonds) by the central bank will reduce the average duration of the portfolio of economic agents (banks, institutional investors – insurance companies or pension funds – and other investors). This would imply a decrease of the premium required to hold duration risk or, alternatively, increase the price of these securities.

So far we only analysed the portfolio substitution channel. Figure 1 also illustrates the banking system channel (or bank funding channel). The banking system channel might help the central bank to increase the availability of banking credit. This channel can be also used to prevent a decrease in the availability of lending activities. Generally, when a central bank use a LSAP for assets owned by non-banks (NFC or households, e.g.), second order banks' deposits increases as well as reserve balances at the central bank. In other words, the main goal of this transmission channel is to flood second order banks with deposits so they can then increase the availability of banking credit. However, this channel might have some relevant weaknesses. The main reason for the possible weakness of this transmission channel is the expectation about the maturity of the additional deposits. When the marginal funds generated by the LSAP come to commercial banks as short-term deposits (by NFC and households), they do not feel that marginal funds in their balance sheet is enough to increase lendings.

III. Data and Methodology

3.1. Data Set

This dissertation examines the conventional and unconventional monetary policies pass-through to lending rates in the euro area during 2003(3) to 2017(2) using a monthly disaggregated data set with 170 observations covering the lending rates for house purchase and for Non-Financial Corporations (NFC). In this dissertation we employ euro area data from APPs included in the total assets of the ECB. The variables used in our benchmark VAR's are defined as follows:

- *House*: This measure is used to accurately assess borrowing costs to households for house purchase, per cent per month. The cost of borrowing indicators are based on the Monetary Financial Institutions (MFI) statistics of the euro area (see Appendix 4 and Appendix 5).

- *NFCorporations*: This measure is used to accurately assess borrowing costs for non-financial corporations, per cent per month. The cost of borrowing indicators are based on the MFI statistics of the euro area (see Appendix 4 and Appendix 6).

- *ECBinterest*: The interest rate on the Main Refining Operations (MRO) is the rate that provide the bulk of liquidity for the baking system in the euro area, per cent per month. MRO (also known as the minimum bid rate) is the interest rate which banking system in the euro area do have to pay when borrow money from the ECB. Usually, baking system do so when they are short on liquidity.

- *BalanceSheet*: The total assets of the ECB's balance sheet, which include the Asset Purchase Program (APP) includes all purchase programs of the ECB [1] under which public sector securities and private sector securities are purchased in order to avoid the risk of low inflation rate in the euro area, in euro million, at month end. The APP of the ECB is the sum of the terminated APP and ongoing APP: (i)

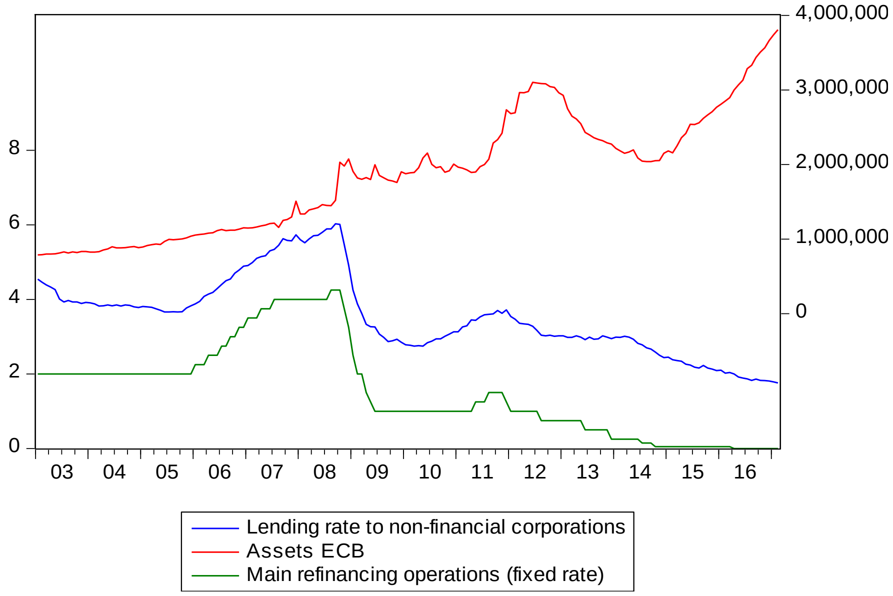
[1] This variable represents all asset purchase programmes (including the terminated programmes and credit easings) in the total assets of the ECB: https://www.ecb.europa.eu/mopo/implement/omt/html/index.en.html

Securities Market Program (SMP), (ii) first Covered Bond Purchase Programme (CBPP1), (iii) second Covered Bond Purchase Programme (CBPP2), (iv) third Covered Bond Purchase Programme (CBPP3), (v) Asset-Backed Securities Purchase Programme (ABSPP), (vi) Public Sector Purchase Programme (PSPP) and the (vi) Corporate Sector Purchase Programme (CSPP).

In the case of the PSPP, the securities covered by this programme include (i) bonds issued by some agencies, local and regional governments, international organizations and multilateral development banks in the euro zone and (ii) nominal and inflation-linked central government bonds. The target of the ECB for these assets is 90% allocated in government bonds and 10% to securities issued by multilateral development banks and international organizations. The inclusion of the ABSPP help the banking system to fulfil the goal of providing credit to firms and households. On other words, securitizing loans and selling them can increase the necessary funds to provide new lendings for firms and households as one possible transmission mechanism of the unconventional monetary policy.

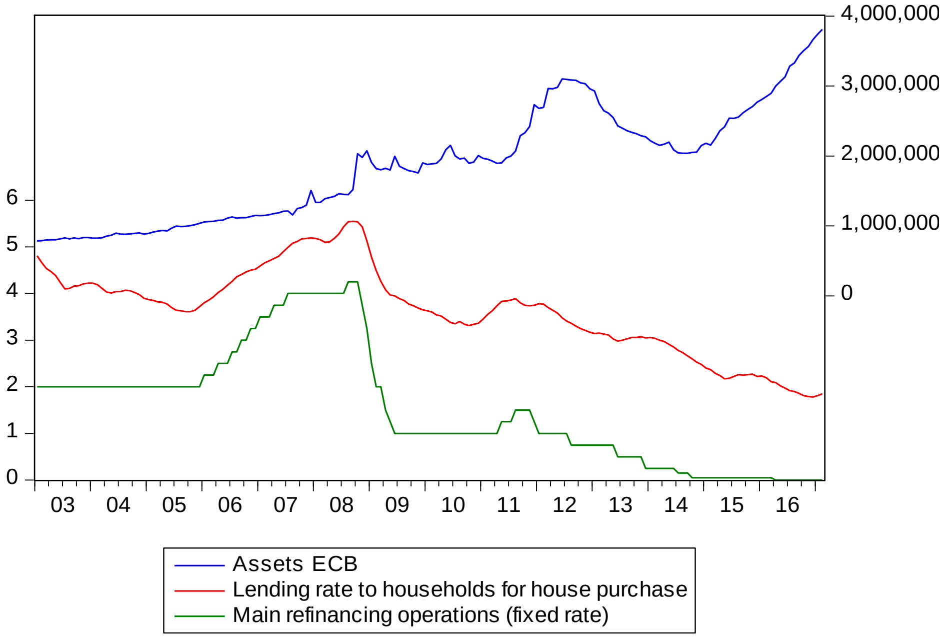
In a similar function, the CBPP1, CBP2 and the CBPP3 also supports financing conditions in the euro zone through the facilitation of the credit provision for firms and households given by the positive spillovers to the markets. Lastly, the CBPP was also included in order to further strengthen the pass-through of ECB's LSAP to funding conditions for the agents in the euro area (see Appendix 2 for more details comparing with other central banks). As mentioned on the previous chapter, both APP largely expanded the Balance Sheet of the ECB (see Appendix 3). The historical evolution of both variables used in this empirical research are available in the Figure 2 and Figure 3.

Figure 2: Historical evolution of the lending rates in the euro area for NFC (in %), total assets of the European Central Bank (in millions of €) and the fixed rate of the Main Refinancing Operations (in %).



Source: European Central Bank, data warehouse (2017).

Figure 3: Historical evolution of the lending rates in the euro area for house purchase (in %), total assets of the European Central Bank (in millions of €) and the fixed rate of the Main Refinancing Operations (in %).



Source: European Central Bank, data warehouse (2017).

3.2. The econometric methodology

In order to address the questions of interest in our research we use a Vector Autoregressive (VAR) methodology. VAR models are largely used in empirical research and analysis of monetary policy studies. In fact, increasing attention to monetary policies shocks identification issues has been devoted in the last decades VAR literature. We can find several researches applying VAR models to the conventional monetary policy, such as the impact of the monetary policy over the dynamics of bank reserves market (Gordon and Leeper, 1994; Strongin 1995; Bernanke and Mihov, 1995; Christiano, Eichenbaum and Evans, 1992; Leeper, Sims and Zha, 1996).

The main purpose of this dissertation is to assess the role of the conventional and non-standard monetary policies on the lending rates in the euro area in the recent years using VAR models. We also use Bayesian statistics to estimate a Bayesian VAR (BVAR).

IV. An Evidence of Unconventional Monetary Policies in Euro Zone

Our results deserve discussion on, at least, six issues: (i) unit root tests for study the stationarity of the series, (ii) causality between the MRO and APP on the composite cost of borrowing indicators through the Granger causality test, (iii) co-integration analysis, (iv) estimation of the VAR and subsequent analysis, (v) defining the Impulse Response Functions (IRF) from the APP and MRO and the variance decomposition analysis with Cholesky ordering, and, finally, (vi) using the BVAR approach for the NFC model as well as the model for house purchase.

4.1. Unit Root Tests

Since the research of Nelson and Plosser (1982), numerous papers attempting about the presence of a unit root in macroeconomic time series. Most researches studying the presence of a unit root have in macroeconomic time series used Bayesian methods or non-Bayesian methods. The most generally used unit root test used to testing the stationarity of time series studied in macroeconomics and macro-econometric literature is the Augmented Dickey Fuller test (Fuller, 1976; hereafter ADF). In order to testing the procedure for the ADF test, the following model must be applied:

$$\Delta y_t = \alpha y_{t-1} + x_t'\delta + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \ldots + \beta_p \Delta y_{t-p} + v_t \qquad (1)$$

where α, β and ρ are respectively the constant, the coefficient on a time trend and the lag order of the autoregressive process. However, some researches in this theme have concluded that there are several macroeconomic time series where we can find a structural break from their trend. One potential reason for this phenomenon mostly due to relevant policy ruptures. This policy changes can be motivated by economic crises or financial crises. As a result, it affects the analysis of the models and also on the forecasting process. Based on these facts, in the unit root tests there is some evidence against the ADF test since it is biased towards null of random walk when there is a structural changes in some macroeconomic time series.

In our data set, we can find some significant changes in the monetary policy and in the policy rate as well. The main interest rates of the ECB might configure an example of this structural breaks (see Appendix 1 once again). The Phillips-Perron (hereafter PP) test is an alternative to the ADF test. Similarly to the ADF test, the PP test the null hypothesis that a time series is integrated of order one (Phillips and Perron, 1988). The main difference between these two alternatives address to the fact that in the ADF test we introducing lags of Δy_t as regressors in the previous equation (test equation). In the PP test, it makes a non-parametric correction to the t-test statistic. However, the PP test exhibits some limitations. Since the PP test is based on asymptotic theory, it works correctly only in large samples. On the other hand, the PP test share one limitation with the ADF test: it shows sensitivity to structural breaks. For our empirical research, we used both tests: (i) ADF test and the (ii) PP test, since these are most often used in macro-econometrics applications. Appendix 7 provides the summary of unit root tests for both variables.

In the variable *House* (in levels), the first ADF test show that there is no evidence to reject the null hypothesis, under which the series is a Difference-Stationary Process (DSP). In a second ADF test, introducing constant and trend, there is also no evidence to reject the null hypothesis, under which the variable is DSP (the alternative hypothesis address to a Trend-Stationary Process, hereafter TSP). So, based on the ADF test, the variable *House* in levels is DSP with 95% of confidence. Based on the PP test for *House* in levels, the first test (with constant) reveals that the variable is DSP since we cannot reject the null hypothesis with 5% of significance. Based on the second test, with constant and trend, the same conclusion is obtain: *House* in in fact DSP.

The same conclusion is also true for *NFC loans*, the *Interest rate of ECB* and the APP in the *Balance Sheet* of the ECB since both variables in levels seems DSP, with 95% of confidence using the ADF test and the PP test (see Appendix 7). This conclusion is consistent with the graphical analysis for the studied variables and is also consistent with the literature about macroeconomic variables (Nelson and Plosser, 1982). From the ADF and PP test we can conclude the variables are not stationary in levels because they exhibit a DSP phenomenon.

For this macroeconomic time series, usually taking the first differences is enough to obtain stationary processes. Repeating the ADF and the PP test for the variables individually in first differences (see Appendix 8), now they exhibit stationarity in both tests. For each one, in the ADF test, there is evidence to reject the null hypothesis and believe in the stationarity. Thus, with the rejection of the null hypothesis in both tests, the variables in the first differences does not exhibit DSP and TSP phenomenon. Since all variables need the method of the first differences (also known as I(1) variables) we should use a VAR in differences or a Cointegrated VAR. For this purpose we need to test the cointegration.

4.2. Cointegration Tests

4.2.1. Engle and Granger Cointegration Test

One traditional contribution to the literature in macro-econometrics providing a way of determining whether there is a long-run relationship between the variables that contain unit roots is the Engle and Granger cointegration test. The hypothetical existence of a long-run relationship between the lending rates for house purchase and non-financial corporations lending rates in the euro area and the policy rate of the ECB and other unconventional monetary policies can be tested by estimating an regression using the ordinary least squares (OLS) method and exploring the stationarity of the residuals resulting from this regression.

As developed in the research of Engle and Granger (1987), this approach using a regression will suffice to yield consistent estimates of the long-run coefficients. Thus, the aim of this test is to determine whether a long-run relation exists between lending rates and conventional and unconventional monetary policies in the euro area in recent years. As previously mentioned in the previous unit root tests, these time series are, by definition and nature, non-stationary stochastic processes, and so testing the cointegration with this approach (Engle and Granger, 1987) is particularly apposite.

From the previous sub-chapter, the obtained results for our empirical research suggest that we cannot reject the null hypothesis of a unit root at the 95% confidence level for the levels of the variables. Consequently, we take the results to indicate that the levels of the variables are integrated in the first order, I(1). As dependent variable in our regressions we introduce individually the lending rates for house purchase, *House*, and the lending rates for non-financial corporation loans, *NFC loans*. In the independent variables we used the MRO fixed rate in the euro area (as measure of the conventional monetary policy) and the amount of euros in APP (in the *Balance Sheet* variable). In the first model, without constant in the estimation, the variables are individually significant with 5% of confidence (see Appendix 9). The residuals from the regression was used in the ADF test. The ADF test statistic is -1.58 and with the appropriated table we can conclude that we cannot reject the null hypothesis of non-cointegration, probably because the residuals follows a DSP. The same procedure was repeated for the *NFC loans* model, and the ADF test for the residuals shows that once again we cannot reject the null hypothesis of non-cointegration (see Appendix 10).

4.2.2. Johansen Test for Cointegration

In order to testing the cointegration, this research also introduce and use the methodology developed by Johansen (1988). In fact, the Johansen approach is now the most used and unfailing test for cointegration and provides better small sample properties than most other approaches. The introduction of the Johansen method (1988) occurs due to the well-known limitations with the cointegration tests, such as the ADF test recommended by Engle and Granger (1987). For a further understanding of the limitations of the solely Engle and Granger test when testing the cointegration, we can find it on Kremers et al. (1992).

For a further understanding on the Johansen test for cointegration, let's consider the following VAR of order *p*, VAR(*p*):

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + B x_t + \epsilon_t \qquad (2)$$

where y_t represents a *k*-vector of non-stationary variables, x_t represents a *d*-vector of deterministic variables in the model and, finally, ε_t represents a vector of innovations as usual. We may rewrite this VAR(*p*) model as:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + B x_t + \epsilon_t \qquad (3)$$

and where the matrix Π is given by:

$$\Pi = \sum_{i=1}^{p} A_i - I, \qquad \Gamma_i = -\sum_{j=i+1}^{p} A_j \tag{4}$$

Based on the Granger's representation theorem states if the coefficient matrix Π has a reduced rank (where $k > r$), then it implies there are k x r matrices α and β where each matrix with rank r such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is stationary process, I(0). Notice that r is the number of cointegrating relations (also known as cointegrating rank). The cointegration vector is each column β. On the other hand, the adjustment parameters in the Vector Error Correction (VEC) model are the elements of α. To understand the Johansen's approach, it consists in the estimation of the Π matrix from the unrestricted VAR previously estimated and test whether we can reject the restrictions implied by the reduced rank of Π.

As usual in macro-econometrics and time series, in our data set the series have non-zero means and they are non-stationary (they have deterministic trends or/and stochastic trends). On the other hand, the cointegrating equations may have deterministic trends as well as intercepts. Notice that the asymptotic distribution of the Likelihood Ratio (LR) test statistic for the cointegration phenomenon needs some assumptions w.r.t. deterministic trends. Thus, to perform the Johansen cointegration test, it summarizes five deterministic trend cases (Johansen,1995): (i) the level data y_t with no deterministic trends and the cointegrating equations do not have intercepts; (ii) the level data y_t with no deterministic trends and the cointegrating equations have intercepts; (iii) the level data y_t with linear trends but the cointegrating equations have only intercepts; (iv) the level data y_t and the cointegrating equations with linear trends and, finally, (v) the level data y_t have quadratic trends and the cointegrating equations with linear trends.

Applying the Johansen test for cointegration, we will consider two test statistics for the number of cointegrating vectors: (i) the trace test and (ii) the maximum eigenvalue statistic. In the application of the trace test, the number of cointegrating vectors is less than or equal to r consists in the null hypothesis. This test consider that in each case the null hypothesis is tested against a general alternative. The alternative approach is the maximum eigenvalue. The maximum eigenvalue is a similar test excluding the fact that alternative hypothesis is explicit. Thus, if the null hypothesis address to no cointegration in the series (where r assumes null value, $r = 0$), it is tested against the alternative that $r = 1$, $r = 0$ against the alternative $r = 2$, etc. One limitation of the Johansen cointegration test is about the impossibility in the determination of the standard errors for the long-term coefficients.

In order to provide additional support the inexistence of a long-term relation between the variables, Appendix 11 and Appendix 12 presents the empirical results from the Johansen cointegration test for both models (*House* and *NFC loans*) and for the five trend assumptions. For both models, the Johansen test shows that both the trace test and maximum eigenvalue statistic does not reject the null hypothesis of $r = 0$ at the 95% confidence level. These results from the Johansen cointegration test suggest that there is no cointegrating vector. Note that this result from this procedure appears to support those from the Engle-Granger approach since the conclusion is the same. One plausible reason for the inexistence of cointegration in the variables and no long-term relation as well between the variables is the nature of the unconventional monetary policies. Since these non-standard policies are usually used to prevent weak inflation and temporaries (despite the duration of the APP are unknown) it can explain the inexistence of cointegration.

4.3. Estimating the VAR Model

In order to explore the main aim of this research we will apply an unrestricted VAR. The unrestricted VAR approach was developed by Sims (1980). The VAR was developed to deal with problems with transfer function analysis and intervention. Our suggested model provides a multivariate empirical framework where changes in the lendings rates in the euro are – for house purchase and for NFC loans – are related to changes in its own lags and to changes in the policy rate of the ECB (measuring the conventional monetary policy) and changes in the APP (as measure of the non-standard monetary policies). Note this methodology treats the variable as endogenous jointly. As we have seen on the previous sub-chapter, in the context of the VAR we need to obtain information about whether or not we should use levels or (first) differences in our VAR. Since we tested the existence of unit roots and no cointegration phenomenon we applied an unrestricted VAR in first differences for both models, with lending rates for house purchase and for NFC loans.

The next step in the VAR methodology is to determine the appropriate number of lag length for our unrestricted VAR model. In order to achieve this goal, the traditional Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC) are used in the test. To give more robustness in the optimal lag decision, we also employed additional criteria: (i) the Final Prediction Error (FPE), (ii) the sequential modified LR test statistic and (iii) Hannan-Quinn information criterion (HQ). This information criterion are used in the context of the VAR Lag Order Selection Criteria. As presented in the Appendix 13, the results for our unrestricted VAR for the house purchase model with first differences in the variables shows the optimum lag is 1 (considering the SBC and the HQ) and 3 lags (based on the AIC, FPE and LR). To avoid possible relevant lags exclusions, we considered and unrestricted VAR (3) in differences for the lending rates for house purchase.

The same process was repeated for the NFC loans (see Appendix 14 and Appendix 16), where we concluded to use an unrestricted VAR (8) in differences, since we also use the AIC and the LR test statistic (each test at 5% level). Based on the HQ and SBC, we could use an unrestricted VAR (1) in differences but there is also the risk of exclusion significant lags in our suggested model. The estimation of both unrestricted VAR's in differences are available in Appendix 15 and 16. The residuals of both unrestricted VAR models exhibits absence of autocorrelation and heteroskedasticity (Appendix 32). Based on the Jarque-Bera normality test, the residuals from the models are slightly asymmetric and also present excess of kurtosis.

4.4. Impulse Response Functions and Variance Decomposition

The VAR methodology often center on the determination of the IRF and variance decomposition. The IRF and the variance decomposition track the evolution of shocks through the system. In the case of IRF, based on VAR models, plays a significant role in empirical monetary policy and macroeconomics as well (see Pesaran and Smith 1998; Christiano, Eichenbaum and Evans 1999). In our empirical research for the euro area, we apply the IRF and the variance decomposition for both models, the VAR (3) in differences for the lending rates for house purchase and the VAR (8) in differences for the differences for the lending rates for NFC loans. The decomposition method for both functions is based on the Cholesky decomposition. In order to impose an ordering of the variables in the VAR models, we assume the degrees of freedom (d.f.) adjustment, which considers a small sample d.f. as mechanism correction in the estimation of the residual covariance matrix to derive the Cholesky factor. The responses standard errors are from an analytical/asymptotic basis.

The order in Cholesky decomposition considers the most exogenous to the most endogenous variables. Credit rates are fixed by banks and it is well known that the pass-through from the policy rate to the credit rates takes some time. Thus credit rates are the most exogenous. The second in the order is the ECB policy rate, whiles the balance sheet expansion is the third as the assets purchases (and balance sheet expansion) are on a daily basis and Governing Council (the main decision-making body of the ECB which impacts the policy rate), usually meets every two weeks.

The IRF for the VAR (3) is available in Appendix 17. The most significant responses to Cholesky with one standard deviation innovation of differences in lending rates for house purchase are to the impulses from differences in the policy rate of the ECB and from differences in the APP of the central bank in the euro area. Both functions considers two standard errors to obtain a lower and an upper band with 95% of confidence level. Analysing the IRF for the first VAR, the responses of the changes in the lending rates for house purchases to impulses in the policy rate of the ECB cannot be significant different from zero, since the lower limit and the upper limit contains the response function. This result is also valid for the 10 periods the IRF run. However, the sign of the IRF is consistent with the initial expectation because the function assumes positive values until the 7th period. It is consistent since the policy rate of the central bank affects positively the interest rates used in the banking system.

In the opposite way, the responses of the changes in the lending rates seems statistically different from zero from the 3rd period due to impulses from the differences in the non-standard monetary policies (QE and CE). The sign of the function is also consistent. As previously mentioned in the chapter 1, for largest central banks, the literature on the transmission channels of the unconventional monetary policy on the last decade is obvious: non-standard policies from the central banks affects the lending rates negatively. Despite the IRF provides a relevant role in the VAR methodology, it is important confirm this results in the Granger causality test. Appendix 18 also present the IRF in an accumulated basis. The variance decomposition (see Appendix 21) show the variance in the changes in the lending rates is mostly explained by itself. However, from the 3rd period, the variance decreases, particularly due to differences in the unconventional monetary policies of the ECB.

The VAR model for the NFC in differences also provide significant results. The IRF from this model shows the responses of differences in lending rates for *NFC loans* seems significant different from zero until the 3rd period from impulses occurred in the policy rates (in this case, in differences in the MRO fixed rate of the ECB), as we can see on Appendix 19. The responses of differences in the lending rates for NFC loans from impulses on the differences in non-standard monetary policies are statistically significant until the 6th period, which is aligned with VAR(3) for the lending rates for house purchase. The accumulated responses are also available in Appendix 20. From this VAR in differences, the variance decomposition (see Appendix 22) show the variance in the differences in the lending rates decrease exponentially until almost 50% in the 10th period. Most of these variance is due to the differences in non-standard policies of the central bank, which also occurred in the previous VAR (3). Finally, one additional note. Since the HQ information criteria and the SC reported the lag 1 as optimal, we also estimated a VAR (1) in differences from the NFC loans model. In this parsimonious VAR model, both IRF tend to zero in the last period and most of times are significant from zero for the impulses on the differences of the policy rate and unconventional monetary policies (see Appendix 23 and Appendix 24). As previously mentioned, in order to obtain robust conclusions on this field, these results must be consistent with the results from the Granger causality test.

4.5. Granger Causality

In this sub-chapter we introduce the Granger causality test. In any meaningful sense of the word, correlation between variables does not necessarily means causation. Several empirical researches in macroeconomics are full of significant correlations which are spurious or without meaning. Granger (1969) developed an approach to the question of whether x_t causes y_t is to see how much of the present values of y_t can be explained by past values of y_t and then to see whether adding lagged values of x_t can improve the explanation. So, y_t is said to be Granger-caused by x_t if and only if (i) x_t contribute in the explanation and prediction of y_t or (ii) in an equivalent way, if the coefficients on the lagged x_t's are statistically significant. Notice that two-way causation is usually the case and thus x_t Granger causes y_t and y_t Granger causes x_t. One additional note may be introduce: the statement "x_t Granger causes y_t" does not imply that y_t is the result of x_t.

In fact, the central idea of the Granger causality is to measure precedence and information content but does not by itself represents causality between the variables. In order to compute the Granger causality test, this approach runs bivariate regressions in the following form:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \ldots + \alpha_l y_{t-l} + \beta_l x_{t-1} + \ldots + \beta_l x_{-l} + \varepsilon_t$$
$$x_t = \Theta_0 + \Theta_1 x_{t-1} + \ldots + \Theta_l x_{t-l} + \Phi_l y_{t-1} + \ldots + \Phi_l y_{-l} + u_t \quad (5)$$

where *l* represent the reasonable beliefs about the longest time (or lags) over which one of the variables could help to explain or predict the other variable and for all pairs of (x_t, y_t) series in the analysis. Note this Granger causality test needs the *F-statistics* since it reported statistic are the Wald statistics for the joint hypothesis in the test for each equation, such that:

$$\beta_1 = \beta_2 = \ldots = \beta_l = 0 \quad (6)$$

In this test, the null hypothesis is given by the inexistence of Granger causality, where x_t does not Granger-cause y_t (for the first previous regression) and that y_t does not Granger-cause x_t (in the second regression).

Based on our empirical research, the first causality test aim to study the causality between the differences in lending rates for house purchase purposes and the differences in the policy rate of the ECB and the differences in the amounts of the APP. On the reasonable beliefs about the longest time (or lags) we used the same number of lags in our VAR model in differences, VAR (3). As a result of this test, there is statistical evidence to reject the null hypothesis regarding to the differences in the APP, i.e., differences in the APP Granger causes differences in the lending rates for house purchase. However, there is no evidence to reject the null hypothesis, under which differences in the MRO fixed rate of the ECB does not Granger Cause differences in the lending rate for house purchase. Since in the VAR lag order selection criteria indicates the optimal lag also with 1 lag, (based on the SBC and HQ information criteria) we repeated the Granger causality test with 1 lag and we obtained the same result: changes in the interest rate policy of the ECB does not Granger Cause changes in the lending rate for house purchase (Appendix 30).

Interpreting the results, one plausible reason is the fact the interest rate channel of monetary policy of the ECB had weakened considerably over the last years and particularly in the context of zero lower bound interest rates. In fact, this conclusion is consistent with the research of Hristov et al. (2014) and Holton and Rodriguez d'Acri (2015). In their empirical studies, these authors show a relevant decrease in the average pass-through of conventional policies from ECB comparing with the pre-crisis period. On the other hand, the result of the Granger causality test is a strong argument of the role of unconventional monetary policies on the lending rates. Note the results from the Granger causality test are also consistents with the information from the IRF. The graphical representation of the IRF show the response to Cholesky one standard innovation of the changes in the lending rates for house purchase with one impulse from the differences in the policy rate of the ECB can be null considering 2 standard errors. However, for the impulse of changes in the APP even with 2 standard errors the response of differences in lending rates for house purchase are significantly different from zero, what is consistent with information of the *F-statistics* in the Granger causality test.

In the VAR in differences for NFC Loans, we used 8 lags and 1 lag as the optimal lags based on the information criteria. Using the same lags for the Granger causality test, the results show that there is statistical evidence to reject the null hypothesis regarding to the differences in the APP, i.e., changes in the APP Granger causes differences in the lending rates for NFC loans. Currently in this model, differences in the policy rate of the ECB Granger causes differences in the lending rates for NFC loans with 5% of significance level (Appendix 31). It is also consistent with the IRF obtained for the VAR (1) and VAR (8). In fact, in the recent literature there are also some authors that find a modest fall in the pass-through of the standard policies from the european monetary authority. Von Borstel et al. (2015) and Illes et al. (2015) achieved these conclusions, i.e., the transmission mechanism of standard monetary policies to the lending rates in the banking system has not changed with the last financial and sovereign debt crises for both – vulnerable and non-vulnerable countries – once euro area commercial banks' effective cost of funding is taken into account. Notice that Illes et al. (2015) presents some concerns about the comparison between policy rates and the lending rates. These authors argue that commercial banks do not obtain the total of their internal funds at policy rates – defined by the central bank – and in the period following the crisis the effective costs of funding rose significantly in the euro area. Based on their empirical research, they conclude the interest rate pass-through appear to have remained constant and stable.

4.6. Bayesian VAR Model

Lastly, we also estimate a Bayesian VAR (BVAR) for both models, with the changes in the lending rates for house purchase and for NFC Loans. In 1984 (Doan, Litterman, and Sims) and 1986 (Litterman) a new Gaussian prior for the parameters of a VAR model was proposed. Currently, it is also known as the Minnesota prior or the Litterman prior. Based on the initial proposal of the authors, it shrinks the VAR estimates toward a multivariate random walk model, which has been found successful in the forecast process of many persistent macroeconomic variable or time series. The central idea is to specify the prior mean and covariance matrix. In order to achieve this, it is necessary for each equation set the prior mean of the first lag of the dependent variable to 1 and set the prior mean of all other slope coefficients to 0. This step imply that if the prior means were the correct parameter values, then each variable would follow a random walk. In the second strep we need to introduce the prior standard deviation. In this step, we need to set the prior variances of the intercept terms to infinity and the prior variance of the ijth element of A_l, denoted $a_{ij,l}$, to:

$$v_{ij,l} = \begin{cases} (\lambda/l)^2 & \text{if } i = j, \\ (\lambda\theta\sigma_i/l\sigma_j)^2 & \text{if } i \neq j, \end{cases} \qquad (7)$$

where l is the corresponding lag, λ is the is the prior standard deviation of $a_{ii,1}$ (estimator for the parameters a_i of the ith equation), $v_{ij,l}$ represents the prior variance of $a_{ii,1}$ and where θ assume values between 0 and 1. The parameter θ aims to controls the relative tightness of the prior variance in the other lags in a specific equation compared to the own lags. For example, when θ assume smaller values, it increases the relative tightness of the other lags. Finally, σ^2_i is the ith diagonal element of the innovation variance Σ_u. For understanding purposes, let's consider a bivariate VAR with 2 lags, for example. The following pair of equations includes the slope parameters evaluated at their prior mean respectively:

$$\begin{array}{llllll} y_{1t} = & 0 & + 1 \cdot y_{1,t-1} & + 0 \cdot y_{2,t-1} & + 0 \cdot y_{1,t-2} & + 0 \cdot y_{2,t-2} & + u_{1t}, \\ & (\infty) & (\lambda) & (\lambda\theta\sigma_1/\sigma_2) & (\lambda/2) & (\lambda\theta\sigma_1/2\sigma_2) & \\ y_{2t} = & 0 & + 0 \cdot y_{1,t-1} & + 1 \cdot y_{2,t-1} & + 0 \cdot y_{1,t-2} & + 0 \cdot y_{2,t-2} & + u_{2t}. \\ & (\infty) & (\lambda\theta\sigma_2/\sigma_1) & (\lambda) & (\lambda\theta\sigma_2/2\sigma_1) & (\lambda/2) & \end{array} \quad (8)$$

As usual, below the expressions we have the standard deviations in parameters (the prior standard deviations in the case of the BVAR). In accordance with the previous ideas, for the dependent variables each individual equation specifies a random walk prior mean. Since the parameters included in the prior standard deviations are non-negative, it explains the uncertainty in the model. Notice the standard deviations decreases with the ascending lag length. It occurs because more recent lags in each equation are assumed to be more likely to have non-negative values. Regarding to the intercept terms of both equations, the standard deviations are set to infinity in order to capture the uncertainty about the current values of these parameters. In terms of comparative advantages with other class of priors, the main advantage of the Minnesota prior is it shrinks the problematic of specifying a high-dimensional prior distribution to one of selecting two parameters through impose marginal structure on the prior.

In our empirical research we also estimate a BVAR for both models, studying the optimal lag structure and repeating the process to obtain the IRF and the variance decomposition from our BVAR estimated model. In the specification of the Minnesota prior for our BVAR for changes in the lending rate for house purchase and for NFC loans, we choose the hyper-parameters (where λ_1=0.1, λ_2=0.99, λ_3=1and θ=1) with the univariate AR estimate for the initial residual covariance options. Since λ_1 is the overall tightness on the variance (in this case, for the initial lag) and define the relative relevance of sample and prior information, then a smaller value for the λ_1 represents that prior information dominates the sample information. On the other hand, λ_2 measures the relative tightness of the variance of other variables and a null value for λ_2 implies that the VAR will collapse to a vector of univariate models. In order to avoid this scenario, we choose a higher value, λ_2 = 0,99. Finally, λ_3 measures the relative tightness of the variance of lags in the model. In the literature, Koop and Korobilis (2009) set λ_3=2. However, Kadiyala and Karlsson (1997) set λ_3=1, which represents a particular case of linear decay. In our empirical research we choose this linear decay.

The estimation of the BVAR (3) for the differences in lending rates for house purchase and the BVAR (8) for the differences in lending rates for NFC loans is available in Appendix 25 and Appendix 27. The VAR lag order selection criteria for the first model show that the optimal lag is the lag number 3 from the LR test, FPE and AIC. For the model of differences in lending rates for NFC loans we also repeat the VAR lag order selection criteria and this test report the optimal lag occurs for the lag number 8, based on the evidence of the same information criteria of the first model. The IRF for 10 periods is presented in Appendix 26 and Appendix 28 for the BVAR (3) and BVAR (8). In the opposite way from the conventional VAR's, note these impulse response analysis does not include the lower and upper bands with the standard errors (confidence intervals). For the BVAR (3), the IRF show similar conclusions when comparing with the previous estimated VAR (3): the changes in the policy rate of the ECB has positive impact on the differences in the lending rates for house purchase and these responses tend to disappear as long as the last period occur. For the impulse of changes in the APP of the ECB, the conclusion is similar since it has negative impact on the differences in the lending rates for house purchase and the response tend to zero in the last period.

For the changes on the NFC loans, the impulse response analysis resulting from the estimated BVAR (8) is available in the Appendix 28. In the second period for both IRF (responses of changes on the loans for NFC to impulses on the changes on the policy rate and changes on the expansion of the ECB's balance sheet), it reach the highest value in the responses for the differences in the policy rate and differences in the APP of the ECB. In the case of the responses of changes on the loans for NFC to impulses on the changes on the policy rate the function assume positive values and tends to zero from the 2nd period. The behaviour of the responses of changes on the loans for NFC to impulses on the changes on the expansion of the ECB's balance sheet seems symmetric comparing with the previous one once assume non-positive values and tends to zero from the 2nd period. The dynamic of these IRF from the Bayesian approach is similar to the standard VAR (1) for the differences in the lending rates for NFC loans. Comparing numerically the values from the estimated IRF for each model, the IRF from BVAR (8) – responses of the changes on lending rates for NFC to changes in the expansion of the balance sheet – reaches the minimum value in the 2nd period when the response is -0.02. In the IRF from the standard VAR model, the corresponding value in the Y-axis to the minimum in the 2nd period is -0.04 (almost double). For the IRF of changes on the lending rates for the NFC loans due to changes in the policy rate the estimated IRF is similar in both models. The variance decomposition analysis resulting from the BVAR (8) show most of variance in the differences for the lending rates for NFC loans is given by itself. In the 10th period, almost 5% of the variance is due to the differences in the policy rate and 10% from the differences in the APP of the ECB (see Appendix 29).

VI. Concluding Remarks

Advanced economies are more susceptible to face some macroeconomic problems, such as the zero lower bound one (Chung et al, 2012; Williams, 2014). Probably, this macroeconomic problem is correlated with the secular stagnation hypothesis. In accordance with this thesis, advanced economies faced a low economic growth for a long period and low inflation as well. The mentioned lower growth is also complemented by a lower interest rate (and real equilibrium interest rate, *ceteris paribus*) and on the other side, real interest rates depend on many other factors besides trend productivity growth. In standard times, conventional monetary policy has important stabilization mechanisms due to the goals of monetary policy decision makers (e.g. repos or open market operations), however previous findings denote LSAP are relevant.

This dissertation investigated the contribution of the unconventional or non-standard monetary policies on the lending rates of the banking system in the euro area in recent years. This empirical research was built on several potential reasons we can find in recent literature about the failure of the interest rate channel of monetary policy in the euro area over the last 10 years. This research also studied how unconventional measures might have helped to mend the link between economic activity and the monetary policy of the ECB. This dissertation makes use of both the policy rate of the ECB and the LSAP to measure the impact on the recent success in decreasing the lending rates for house purchases and for funding non-financial corporations. Based on the findings of this empirical research, the first expected result is the nature of the non-stationarity of all variables in levels. Both tests show there are clearly unit roots, which are consistent with the nature of macroeconomic variables. The Engle and Granger test and the Johansen test for cointegration show there is no cointegration phenomenon. In the literature it can be explained by the short and medium-term nature of the unconventional monetary policies. We propose an unrestricted VAR for the changes in lending rates for house purchase and NFC loans. In fact, our model allows to derivate the IRF, which show the significance of the impact of changes in APP for the lending rates, particularly in the context where the policy rate cannot affect the lending rates in the banking system. With the variance decomposition we conclude most of variance in both lending rates is largely explained by the variance of itself and in a more reduce way by the variance in the unconventional monetary policy. The contribution of the variance by the policy rate of the ECB is almost residual. Finally, the results from the Granger causality test are consistent with the IRF. Indeed, changes in the unconventional monetary policies of the ECB affect changes in the lending rates in the euro area. The findings also show that the BVAR approach confirms the standard models, i.e., the dynamics of the IRF and the variance decomposition for both models is quite similar. For the changes on the lending rates for NFC, Granger causality tests and the IRF for the changes on the policy rate and non-standard policies of the ECB show both policies seem relevant to the decreasing on these rates. This finding complements the research of von Borstel et al. (2015) and Illes et al. (2015) since they found that the impact of policy rate in the lending rates is also significant. Essentially, the results from our research allow to conclude that the expansions of the ECB's balance sheet also contributed for the decrease of the cost-of-borrowing indicators for both NFC loans and for house purchase loans.

However, apart from the obvious benefits of non-standard monetary policies, this type of programs (LSAP) present some risks and potential costs. Firstly, these programs may deviate price levels above the central bank objectives. This potential risk may not be relevant since monetary policy decision makers have in their control several instruments to mitigate it (as the conventional monetary policy by manipulating the interest rate). Secondly, central banks should consider financial stability risks, stemming from search for yield and higher leverage. Nevertheless monetary policy cannot be inhibited by these risks, given the high-priority goals (convergence of inflation in the euro area for the optimal target). The possibility of losses incurred by the central bank and the exit strategy is also another risk but the upturn in economic activity can minimize this, therefore it does not constitute a true economic and social risk (David Wessel (ed), 2014). The environment of low interest rates (including zero interest rates) and some weakness in the banking system is likely to worsen with this type of policies. However, the growing concern over the issues of banking supervision and macro-prudential policies can mitigate this risk. Finally, there is a potential cost related to the increasing inequalities using LSAP, since there are some concerns that non-standard monetary policies affect mainly the banking system and it could amplify the trend of increase in wealth and income inequality in advanced countries (Claeys and Leandro, 2016). This latter potential cost is mitigated with higher economic growth and lower unemployment levels.

For future researches, we suggest a similar approach based on a panel VAR for all countries in the euro area. It would also be interesting to test the impact of the policy rate and the non-standard policies in the lending rates by the banking system among vulnerable countries and non-vulnerable countries in the euro area. To complement the previous idea, it would be interesting to use the VAR approach including the individual APP (CBPP, ABSPP and PSPP) of the central banks. Another lack in recent literature is the inexistence of robust key performance indicators for this LSAP. Even so, the following years will represent an exponential and exciting growth in theoretical and empirical research in this field.

VI. References

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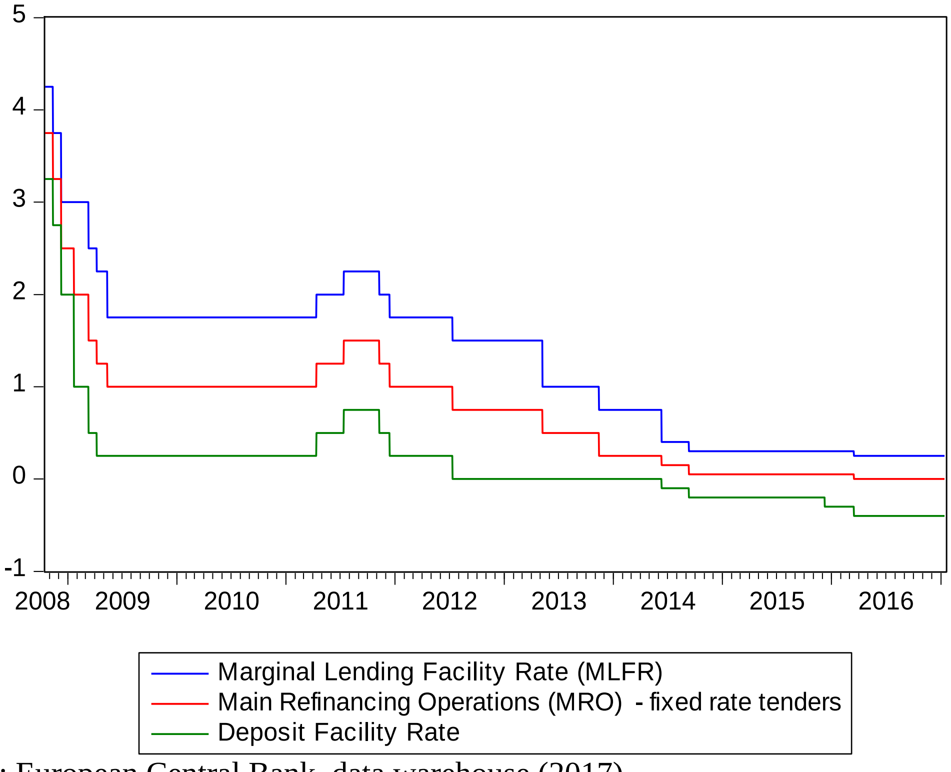
Appendices

Appendices

Appendix 1: Historical evolution of the interests rates in the euro area (in %).



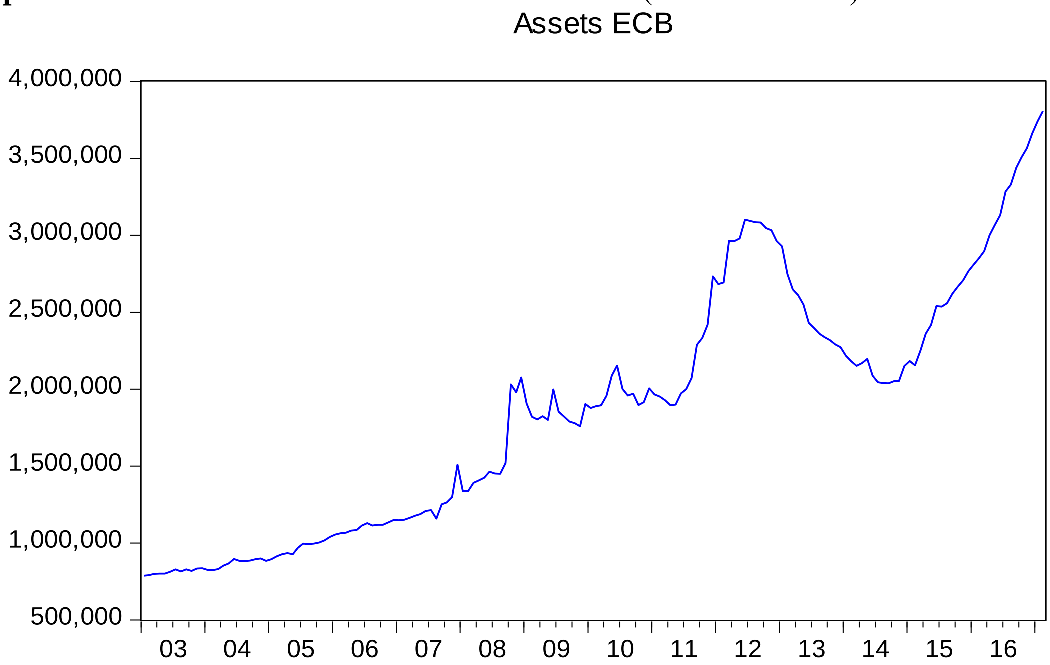
Source: European Central Bank, data warehouse (2017).

Appendix 2: Monetary Policy of the Main Central Banks in the Financial Crisis

European Central Bank	Federal Reserve System	Bank of Japan
2008 - Fixed-rate full allotment	2008 - Term-Auction Facility and Term Securities Lending Facility	2008 - Securities Lending Facility – expansion
2008/2009/2011 - Long-term Refinancing Operations	2008 - Primary Dealer Credit Facility	2008 - Outright purchases JGBs
2009/2011/2014 - Covered Bonds Purchase Programmes	2008 - Asset-Backed CP MMMF Liquidity Facility - AMLF (and MMIFF)	2008 - CP repo operations - expansion; Outright purchases CP
2012 – announcement of Outright Monetary Transactions	2008 - Commercial Paper Funding Facility - CPFF	2008 - Special Funds-Supplying Operations to Facilitate Corp. Financing
2013 - Forward guidance	2009 - Term Asset-Backed Securities Loan Facility (ABS CMBS) – TALF	2009 - Outright purchases Corporate Bonds
2014 - Targeted Long-term Refinancing Operations	2009 - Liquidity to credit markets - consumer, small business CMBS – TALF	2010 - Asset Purchase Programme - APP
2014 - ABS and Covered Bond Purchase Programme	2008/2010/2012 - Large-scale Asset Purchases - QE1, QE2, QE3 – LSAP	2012 - Loan Support Programme
2015 - Expanded Asset Purchase Programme	**2008/2011/2012/2014 - Forward guidance (qualitative and quantitative)**	**2013 - Quantitative and Qualitative Monetary Easing**

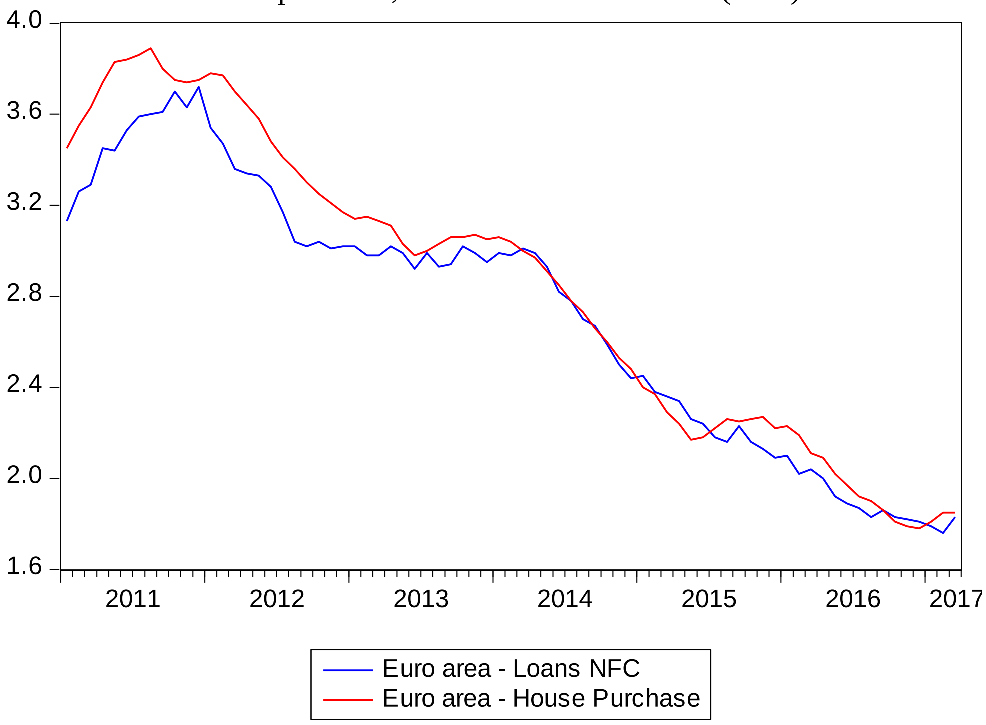
Source: ECB, 2015 US Monetary Policy Forum (adapted)

Appendix 3: Evolution of total assets from the ECB (in millions of €)



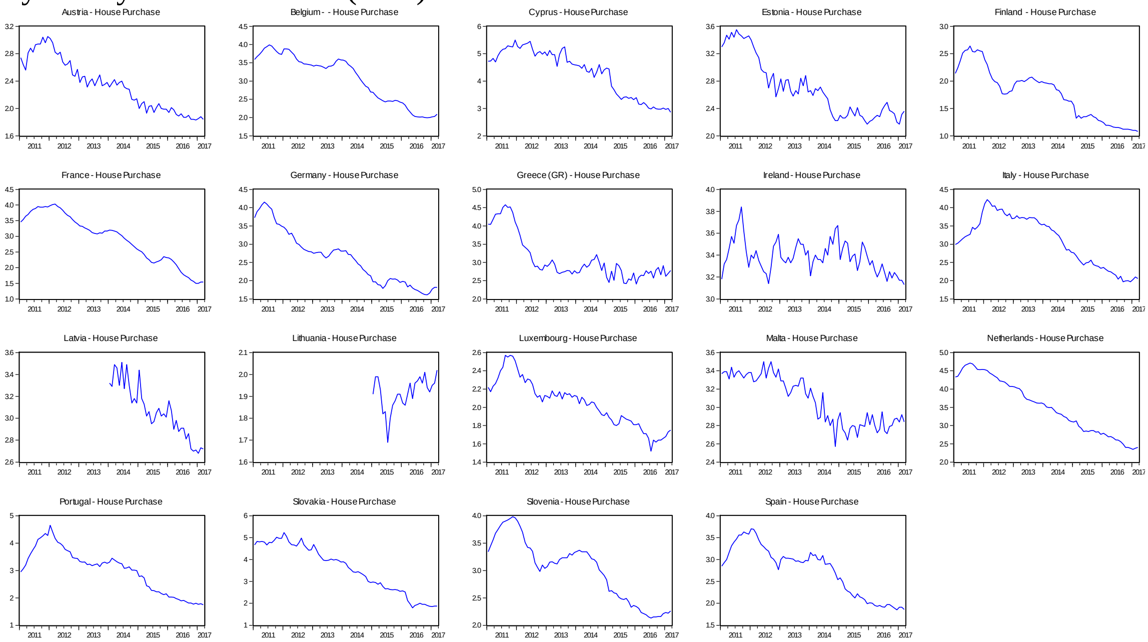
Source: European Central Bank, data warehouse (2017).

Appendix 4: Monthly evolution of the lending rates in the euro area for non-financial corporations and for house purchase, between 2010 and 2017 (in %).



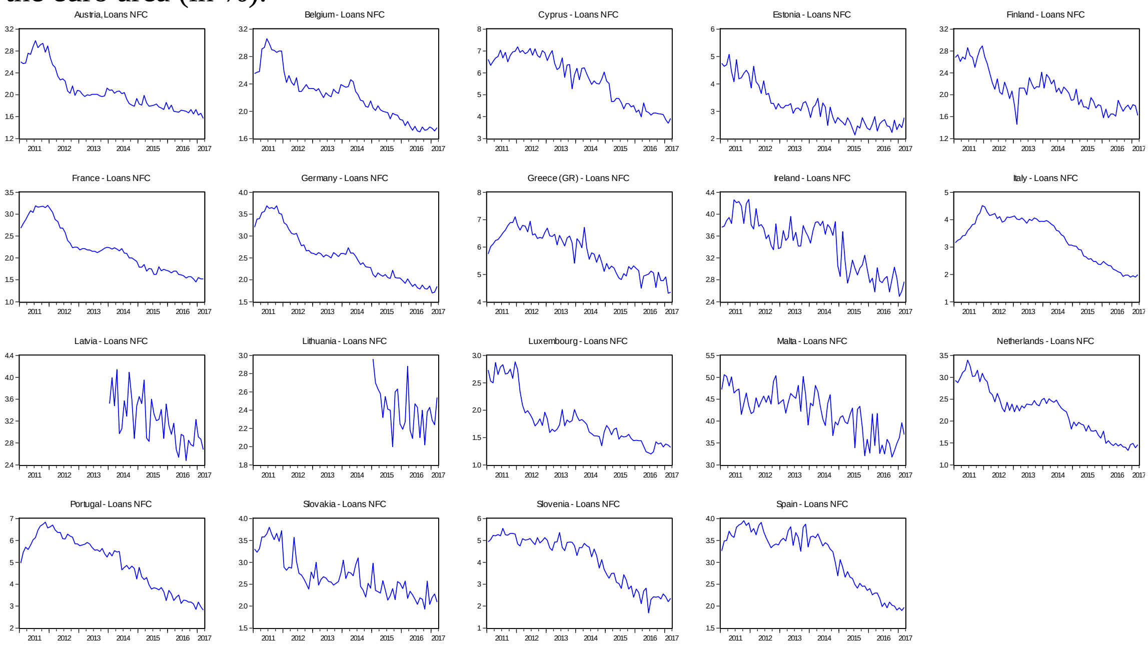
Source: European Central Bank, data warehouse (2017).

Appendix 5: Decrease in the lending rates for house purchase between 2011 and 2017 by county in the euro area (in %).



Source: European Central Bank, data warehouse (2017).

Appendix 6: Decrease in the lending rates for NFC between 2011 and 2017 by county in the euro area (in %).



Source: European Central Bank, data warehouse (2017).

Appendix 7: Unit root tests for variables in levels

Null Hypothesis: HOUSE has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.204030	0.6724
Test critical values:	1% level	-3.469451	
	5% level	-2.878618	
	10% level	-2.575954	

Null Hypothesis: HOUSE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.664074	0.2530
Test critical values:	1% level	-4.013608	
	5% level	-3.436795	
	10% level	-3.142546	

Null Hypothesis: HOUSE has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.937869	0.3091
Test critical values:	1% level	-2.578799	
	5% level	-1.942733	
	10% level	-1.615446	

Null Hypothesis: HOUSE has a unit root
Exogenous: Constant
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.561419	0.8746
Test critical values:	1% level	-3.469214	
	5% level	-2.878515	
	10% level	-2.575899	

Null Hypothesis: HOUSE has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.541801	0.8113
Test critical values:	1% level	-4.013274	
	5% level	-3.436634	
	10% level	-3.142452	

Null Hypothesis: HOUSE has a unit root
Exogenous: None
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.548898	0.1138
Test critical values:	1% level	-2.578717	
	5% level	-1.942722	
	10% level	-1.615453	

Null Hypothesis: ECBINTEREST has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.207398	0.6709
Test critical values:	1% level	-3.469691	
	5% level	-2.878723	
	10% level	-2.576010	

Null Hypothesis: ECBINTEREST has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.293899	0.4345
Test critical values:	1% level	-4.013946	
	5% level	-3.436957	
	10% level	-3.142642	

Null Hypothesis: ECBINTEREST has a unit root
Exogenous: None
Lag Length: 2 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.185828	0.2150
Test critical values:	1% level	-2.578883	
	5% level	-1.942745	
	10% level	-1.615438	

Null Hypothesis: ECBINTEREST has a unit root
Exogenous: Constant
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.923464	0.7789
Test critical values:	1% level	-3.469214	
	5% level	-2.878515	
	10% level	-2.575899	

Null Hypothesis: ECBINTEREST has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.966534	0.6149
Test critical values:	1% level	-4.013274	
	5% level	-3.436634	
	10% level	-3.142452	

Null Hypothesis: ECBINTEREST has a unit root
Exogenous: None
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.095337	0.2472
Test critical values:	1% level	-2.578717	
	5% level	-1.942722	
	10% level	-1.615453	

Null Hypothesis: BALANCESHEET has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.028495	0.9968
Test critical values:	1% level	-3.469214	
	5% level	-2.878515	
	10% level	-2.575899	

Null Hypothesis: BALANCESHEET has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 6 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.121040	0.1049
Test critical values:	1% level	-4.015341	
	5% level	-3.437629	
	10% level	-3.143037	

Null Hypothesis: BALANCESHEET has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		3.155774	0.9996
Test critical values:	1% level	-2.578717	
	5% level	-1.942722	
	10% level	-1.615453	

Null Hypothesis: BALANCESHEET has a unit root
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.331129	0.9793
Test critical values:	1% level	-3.469214	
	5% level	-2.878515	
	10% level	-2.575899	

Null Hypothesis: BALANCESHEET has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.772587	0.7138
Test critical values:	1% level	-4.013274	
	5% level	-3.436634	
	10% level	-3.142452	

Null Hypothesis: BALANCESHEET has a unit root
Exogenous: None
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		2.138643	0.9924
Test critical values:	1% level	-2.578717	
	5% level	-1.942722	
	10% level	-1.615453	

Null Hypothesis: EURO_AREA___LOANS_NFC has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.081922	0.7225
Test critical values:	1% level	-3.469451	
	5% level	-2.878618	
	10% level	-2.575954	

Null Hypothesis: EURO_AREA___LOANS_NFC has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.445891	0.3547
Test critical values:	1% level	-4.013946	
	5% level	-3.436957	
	10% level	-3.142642	

Null Hypothesis: EURO_AREA___LOANS_NFC has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.099594	0.2456
Test critical values:	1% level	-2.578799	
	5% level	-1.942733	
	10% level	-1.615446	

Null Hypothesis: EURO_AREA___LOANS_NFC has a unit root
Exogenous: Constant
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.024535	0.7440
Test critical values:	1% level	-3.469214	
	5% level	-2.878515	
	10% level	-2.575899	

Null Hypothesis: EURO_AREA___LOANS_NFC has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.876345	0.6624
Test critical values:	1% level	-4.013274	
	5% level	-3.436634	
	10% level	-3.142452	

Null Hypothesis: EURO_AREA___LOANS_NFC has a unit root
Exogenous: None
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.202554	0.2093
Test critical values:	1% level	-2.578717	
	5% level	-1.942722	
	10% level	-1.615453	

Appendix 8: Unit root tests for variables in first differences

Null Hypothesis: DHOUSE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.139489	0.0011
Test critical values:	1% level	-3.469451	
	5% level	-2.878618	
	10% level	-2.575954	

Null Hypothesis: DHOUSE has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.316172	0.0006
Test critical values:	1% level	-3.469451	
	5% level	-2.878618	
	10% level	-2.575954	

Null Hypothesis: DECBINTEREST has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.985367	0.0000
Test critical values:	1% level	-3.469691	
	5% level	-2.878723	
	10% level	-2.576010	

Null Hypothesis: DECBINTEREST has a unit root
Exogenous: Constant
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.411651	0.0000
Test critical values:	1% level	-3.469451	
	5% level	-2.878618	
	10% level	-2.575954	

Null Hypothesis: DBALANCESHEET has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.024655	0.0000
Test critical values:	1% level	-3.469933	
	5% level	-2.878829	
	10% level	-2.576067	

Null Hypothesis: DBALANCESHEET has a unit root
Exogenous: Constant
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.10404	0.0000
Test critical values:	1% level	-3.469451	
	5% level	-2.878618	
	10% level	-2.575954	

Null Hypothesis: DLOANSNFC has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.977054	0.0000
Test critical values:	1% level	-3.469451	
	5% level	-2.878618	
	10% level	-2.575954	

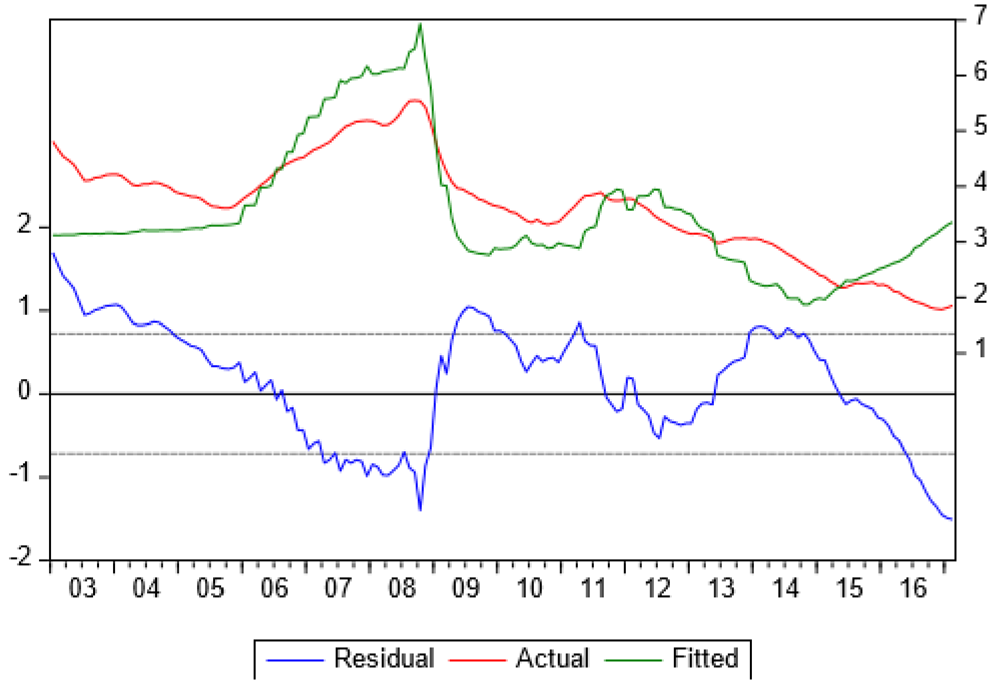
Null Hypothesis: DLOANSNFC has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.026153	0.0000
Test critical values:	1% level	-3.469451	
	5% level	-2.878618	
	10% level	-2.575954	

Appendix 9: Engle and Granger test with the ADF test and graphical representation of the estimation and residuals for house purchase

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECBINTEREST	1.211110	0.033211	36.46691	0.0000
BALANCESHEET	8.82E-07	3.26E-08	27.08411	0.0000

R-squared	0.410962	Mean dependent var	3.642765
Adjusted R-squared	0.407456	S.D. dependent var	0.935608
S.E. of regression	0.720202	Akaike info criterion	2.193124
Sum squared resid	87.14003	Schwarz criterion	2.230016
Log likelihood	-184.4156	Hannan-Quinn criter.	2.208095
Durbin-Watson stat	0.042284		



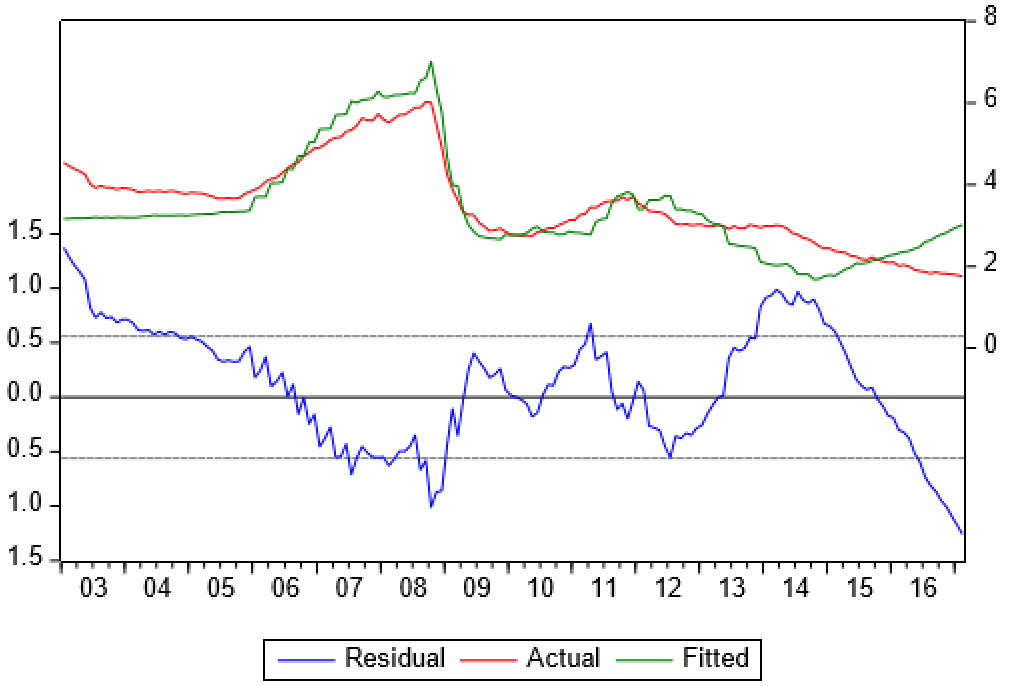
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.580071	0.1072
Test critical values:	1% level	-2.578717	
	5% level	-1.942722	
	10% level	-1.615453	

Appendix 10: Engle and Granger test with the ADF test and graphical representation of the estimation and residuals for NFC loans

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECBINTEREST	1.272227	0.025800	49.31139	0.0000
BALANCESHEET	7.92E-07	2.53E-08	31.32262	0.0000

R-squared	0.724140	Mean dependent var	3.540588
Adjusted R-squared	0.722498	S.D. dependent var	1.062071
S.E. of regression	0.559483	Akaike info criterion	1.688088
Sum squared resid	52.58759	Schwarz criterion	1.724980
Log likelihood	-141.4875	Hannan-Quinn criter.	1.703059
Durbin-Watson stat	0.056601		



Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.740341	0.0776
Test critical values:	1% level	-2.578717	
	5% level	-1.942722	
	10% level	-1.615453	

Appendix 11: Johansen Cointegration Test for lending rates for house purchase

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Information Criteria by Rank and Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or No. of CEs	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
	Log Likelihood by Rank (rows) and Model (columns)				
0	-1593.924	-1593.924	-1591.952	-1591.952	-1590.804
1	-1586.088	-1586.028	-1584.321	-1584.265	-1583.291
2	-1584.252	-1582.617	-1580.970	-1580.605	-1579.729
3	-1584.220	-1580.795	-1580.795	-1577.774	-1577.774
	Akaike Information Criteria by Rank (rows) and Model (columns)				
0	19.98688	19.98688	19.99942	19.99942	20.02200
1	19.96449*	19.97595	19.97952	19.99103	20.00355
2	20.01527	20.01972	20.01183	20.03177	20.03328
3	20.08804	20.08287	20.08287	20.08261	20.08261
	Schwarz Criteria by Rank (rows)				

Appendix 12: Johansen Cointegration Test for lending rates for NFC loans

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0

*Critical values based on MacKinnon-Haug-Michelis (1999)

Information Criteria by Rank and Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or No. of CEs	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
	Log Likelihood by Rank (rows) and Model (columns)				
0	-1711.903	-1711.903	-1709.929	-1709.929	-1709.092
1	-1707.737	-1705.278	-1703.575	-1703.370	-1702.691
2	-1705.762	-1701.438	-1699.797	-1699.040	-1698.594
3	-1705.488	-1699.728	-1699.728	-1696.648	-1696.648
	Akaike Information Criteria by Rank (rows) and Model (columns)				
0	20.95064*	20.95064*	20.96300	20.96300	20.98906
1	20.97274	20.95516	20.95873	20.96832	20.98423
2	21.02123	20.99323	20.98550	21.00049	21.00716
3	21.09022	21.05697	21.05697	21.05600	21.05600
	Schwarz Criteria by Rank (rows) and Model (columns)				
0	21.45680*	21.45680*	21.52541	21.52541	21.60771
1	21.59138	21.59255	21.63362	21.66195	21.71536
2	21.75236	21.76186	21.77287	21.82535	21.85077
3	21.93383	21.95682	21.95682	22.01209	22.01209

Appendix 13: VAR Lag Order Selection Criteria for VAR in Differences for lending rates for house purchase

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1705.822	NA	332359.6	21.22760	21.28502	21.25092
1	-1601.198	204.0500	101328.5	20.03972	20.26939*	20.13298*
2	-1590.942	19.61870	99774.08	20.02413	20.42605	20.18733
3	-1576.935	26.27582*	93785.80*	19.96192*	20.53609	20.19506
4	-1568.101	16.24125	94033.70	19.96398	20.71041	20.26706
5	-1561.357	12.14710	96795.35	19.99201	20.91069	20.36503
6	-1552.499	15.62515	97096.39	19.99378	21.08471	20.43674
7	-1548.609	6.715957	103651.6	20.05726	21.32045	20.57016
8	-1540.127	14.33126	104574.2	20.06369	21.49912	20.64653

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 14: VAR Lag Order Selection Criteria for VAR in Differences for lending rates for NFC loans

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1766.905	NA	709817.9	21.98639	22.04381	22.00971
1	-1675.447	178.3709	254861.3	20.96208	21.19175*	21.05533*
2	-1662.034	25.65975	241298.0*	20.90725	21.30918	21.07045
3	-1654.307	14.49422	245221.4	20.92307	21.49724	21.15621
4	-1646.327	14.67029	248493.3	20.93575	21.68217	21.23883
5	-1639.480	12.33395	255461.8	20.96248	21.88116	21.33551
6	-1629.389	17.79950	252362.3	20.94894	22.03987	21.39190
7	-1619.182	17.62607	249063.2	20.93393	22.19712	21.44684
8	-1608.010	18.87361*	243026.1	20.90696*	22.34239	21.48980

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 15: Estimation of VAR(3) in differences for lending rates for house purchase

	DHOUSE	DECBINTEREST	DBALANCESHEET
DHOUSE(-1)	0.860577 (0.08040) [10.7033]	0.930249 (0.20070) [4.63502]	-54160.88 (152611.) [-0.35489]
DHOUSE(-2)	-0.102452 (0.10555) [-0.97066]	-0.409861 (0.26347) [-1.55563]	40698.79 (200340.) [0.20315]
DHOUSE(-3)	-0.096960 (0.08135) [-1.19194]	-0.016876 (0.20305) [-0.08311]	-69530.83 (154401.) [-0.45033]
DECBINTEREST(-1)	0.011970 (0.03284) [0.36448]	0.107431 (0.08198) [1.31046]	133727.4 (62336.8) [2.14524]
DECBINTEREST(-2)	0.043278 (0.03234) [1.33803]	0.216970 (0.08074) [2.68734]	90325.00 (61392.8) [1.47126]
DECBINTEREST(-3)	0.052111 (0.03237) [1.60985]	0.120850 (0.08080) [1.49562]	-45941.61 (61441.5) [-0.74773]
DBALANCESHEET(-1)	-1.65E-08 (4.1E-08) [-0.40529]	-2.63E-07 (1.0E-07) [-2.57625]	0.022841 (0.07748) [0.29478]
DBALANCESHEET(-2)	-3.81E-08 (4.1E-08) [-0.92344]	-2.07E-07 (1.0E-07) [-2.00681]	0.153256 (0.07828) [1.95780]
DBALANCESHEET(-3)	-1.23E-07 (4.2E-08) [-2.95171]	-9.76E-08 (1.0E-07) [-0.94192]	0.283790 (0.07880) [3.60148]
C	-0.000880 (0.00340) [-0.25910]	0.011034 (0.00848) [1.30085]	11008.53 (6449.82) [1.70680]

Appendix 16: Estimation of VAR(8) in differences for lending rates for NFC loans

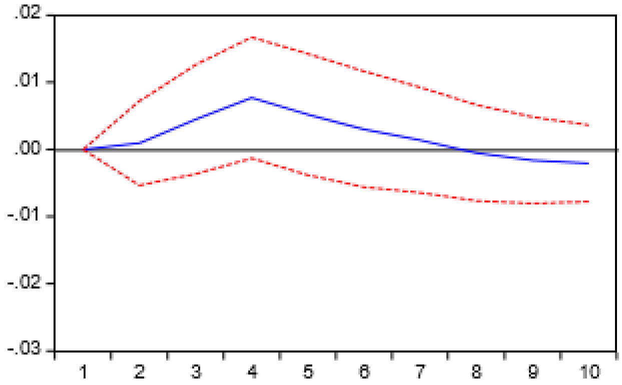
	DLOANSNFC	DECBINTEREST	DBALANCESHEET
DLOANSNFC(-1)	0.433410	0.840314	88339.79
	(0.08747)	(0.11576)	(95806.1)
	[4.95471]	[7.25931]	[0.92207]
DLOANSNFC(-2)	0.047734	0.149481	-149592.2
	(0.10184)	(0.13476)	(111537.)
	[0.46873]	[1.10922]	[-1.34119]
DLOANSNFC(-3)	0.082103	-0.052036	147938.0
	(0.10179)	(0.13469)	(111480.)
	[0.80663]	[-0.38632]	[1.32703]
DLOANSNFC(-4)	0.078930	-0.053196	-171107.7
	(0.09659)	(0.12782)	(105793.)
	[0.81714]	[-0.41617]	[-1.61738]
DLOANSNFC(-5)	-0.188244	0.060167	-115335.3
	(0.09591)	(0.12691)	(105040.)
	[-1.96282]	[0.47408]	[-1.09801]
DLOANSNFC(-6)	-0.047137	0.043704	162235.5
	(0.09568)	(0.12662)	(104794.)
	[-0.49264]	[0.34517]	[1.54813]
DLOANSNFC(-7)	-0.289042	-0.312499	12108.41
	(0.09294)	(0.12299)	(101791.)
	[-3.11001]	[-2.54088]	[0.11895]
DLOANSNFC(-8)	0.190636	-0.071389	30086.56
	(0.09152)	(0.12111)	(100236.)
	[2.08302]	[-0.58946]	[0.30016]
DECBINTEREST(-1)	0.212214	-0.082071	93248.72
	(0.06691)	(0.08855)	(73286.0)
	[3.17150]	[-0.92686]	[1.27239]
DECBINTEREST(-2)	0.232961	0.110823	104305.1
	(0.06757)	(0.08942)	(74005.9)
	[3.44770]	[1.23940]	[1.40942]
DECBINTEREST(-3)	-0.049443	0.033953	44799.12
	(0.06837)	(0.09048)	(74881.7)
	[-0.72317]	[0.37528]	[0.59827]
DECBINTEREST(-4)	-0.093240	-0.113172	56407.21
	(0.06752)	(0.08934)	(73945.9)
	[-1.38102]	[-1.26670]	[0.76282]
DECBINTEREST(-5)	0.053933	0.037047	-112490.2
	(0.06816)	(0.09019)	(74646.9)
	[0.79133]	[0.41076]	[-1.50696]
DECBINTEREST(-6)	0.024128	0.131555	-81817.11
	(0.06791)	(0.08987)	(74382.9)
	[0.35528]	[1.46380]	[-1.09995]

DECBINTEREST(-7)	0.088703	0.153318	74867.71
	(0.06831)	(0.09040)	(74819.5)
	[1.29849]	[1.69600]	[1.00064]
DECBINTEREST(-8)	0.094552	-0.063062	-18846.53
	(0.06293)	(0.08328)	(68928.8)
	[1.50239]	[-0.75720]	[-0.27342]
DBALANCESHEET(-1)	-5.70E-07	-4.40E-07	0.011779
	(8.0E-08)	(1.1E-07)	(0.08768)
	[-7.11711]	[-4.15570]	[0.13434]
DBALANCESHEET(-2)	-1.45E-07	-5.11E-08	0.193626
	(9.3E-08)	(1.2E-07)	(0.10150)
	[-1.57000]	[-0.41670]	[1.90764]
DBALANCESHEET(-3)	-1.78E-08	5.32E-08	0.166193
	(9.2E-08)	(1.2E-07)	(0.10031)
	[-0.19450]	[0.43888]	[1.65672]
DBALANCESHEET(-4)	1.97E-07	1.72E-07	0.142258
	(9.2E-08)	(1.2E-07)	(0.10032)
	[2.15532]	[1.41488]	[1.41802]
DBALANCESHEET(-5)	1.51E-07	1.94E-07	0.009856
	(9.1E-08)	(1.2E-07)	(0.09923)
	[1.67048]	[1.61644]	[0.09932]
DBALANCESHEET(-6)	-1.18E-08	-7.08E-08	0.182465
	(8.8E-08)	(1.2E-07)	(0.09637)
	[-0.13376]	[-0.60800]	[1.89341]
DBALANCESHEET(-7)	9.65E-08	1.08E-07	-0.060959
	(8.9E-08)	(1.2E-07)	(0.09713)
	[1.08770]	[0.91944]	[-0.62760]
DBALANCESHEET(-8)	-1.34E-07	-6.11E-08	0.029178
	(9.0E-08)	(1.2E-07)	(0.09816)
	[-1.50070]	[-0.51539]	[0.29725]
C	0.005254	-0.000316	9286.150
	(0.00587)	(0.00777)	(6427.63)
	[0.89523]	[-0.04074]	[1.44472]

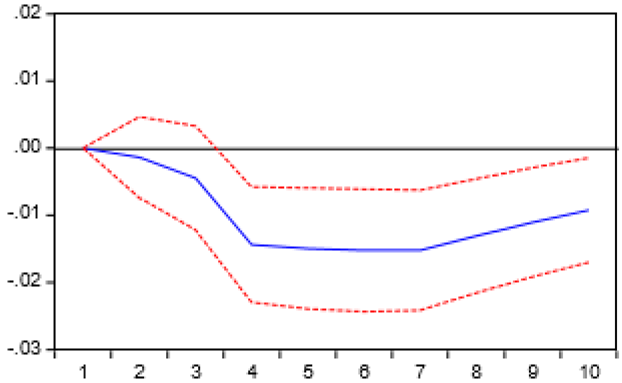
Appendix 17: IRF in graphs and table for the VAR(3)

Response to Cholesky One S.D. Innovations ± 2 S.E.

Response of DHOUSE to DECBINTEREST



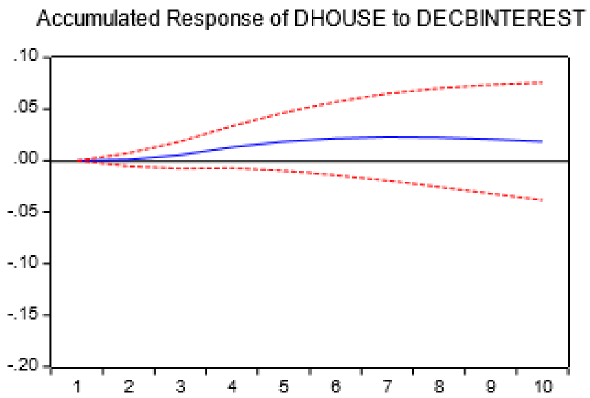
Response of DHOUSE to DBALANCESHEET

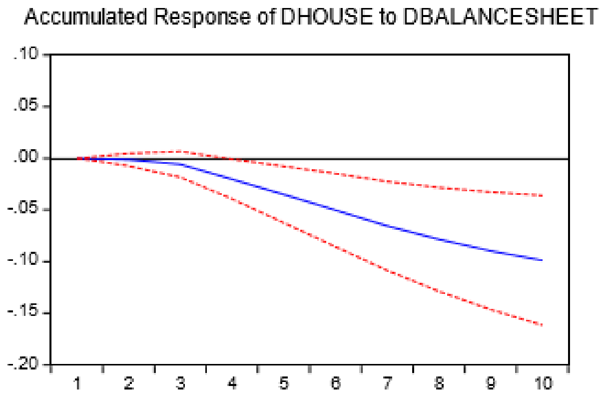


Period	DECBINTEREST	DBALANCESHEET
1	0.000000	0.000000
	(0.00000)	(0.00000)
2	0.000942	-0.001378
	(0.00314)	(0.00302)
3	0.004492	-0.004468
	(0.00406)	(0.00388)
4	0.007704	-0.014370
	(0.00451)	(0.00430)
5	0.005198	-0.014946
	(0.00451)	(0.00450)
6	0.003008	-0.015229
	(0.00432)	(0.00456)
7	0.001398	-0.015211
	(0.00392)	(0.00446)
8	-0.000521	-0.013065
	(0.00358)	(0.00424)
9	-0.001613	-0.011034
	(0.00321)	(0.00406)
10	-0.002077	-0.009224
	(0.00285)	(0.00388)

Appendix 18: IRF in graphs and table for the VAR (3) in accumulated responses

Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.



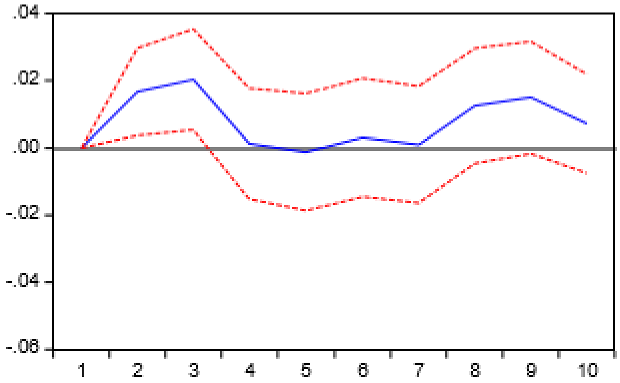


Period	DECBINTEREST	DBALANCESHEET
1	0.000000	0.000000
	(0.00000)	(0.00000)
2	0.000942	-0.001378
	(0.00314)	(0.00302)
3	0.005434	-0.005846
	(0.00657)	(0.00626)
4	0.013138	-0.020216
	(0.01016)	(0.00964)
5	0.018336	-0.035163
	(0.01409)	(0.01371)
6	0.021344	-0.050391
	(0.01780)	(0.01776)
7	0.022742	-0.065603
	(0.02108)	(0.02159)
8	0.022222	-0.078667
	(0.02395)	(0.02516)
9	0.020608	-0.089702
	(0.02641)	(0.02844)
10	0.018532	-0.098926
	(0.02849)	(0.03143)

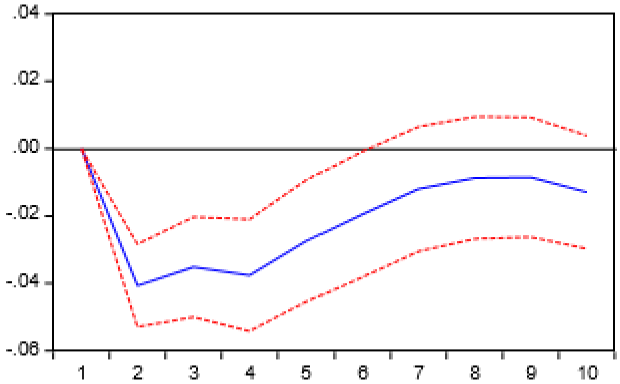
Appendix 19: IRF in graphs and table for the VAR (8)

Response to Cholesky One S.D. Innovations ± 2 S.E.

Response of DLOANSNFC to DECBINTEREST



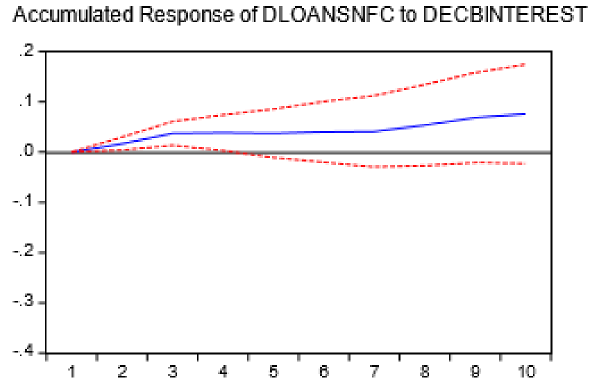
Response of DLOANSNFC to DBALANCESHEET

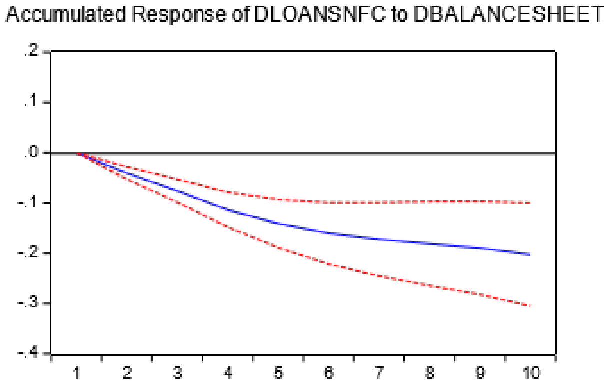


Period	DECBINTEREST	DBALANCESHEET
1	0.000000	0.000000
	(0.00000)	(0.00000)
2	0.016666	-0.040648
	(0.00650)	(0.00614)
3	0.020318	-0.035141
	(0.00749)	(0.00743)
4	0.001222	-0.037596
	(0.00822)	(0.00829)
5	-0.001232	-0.027438
	(0.00869)	(0.00902)
6	0.003070	-0.019464
	(0.00880)	(0.00932)
7	0.000953	-0.011975
	(0.00865)	(0.00924)
8	0.012520	-0.008701
	(0.00854)	(0.00904)
9	0.014979	-0.008515
	(0.00833)	(0.00887)
10	0.007178	-0.012947
	(0.00731)	(0.00838)

Appendix 20: IRF in graphs and table for the VAR (8) in accumulated responses

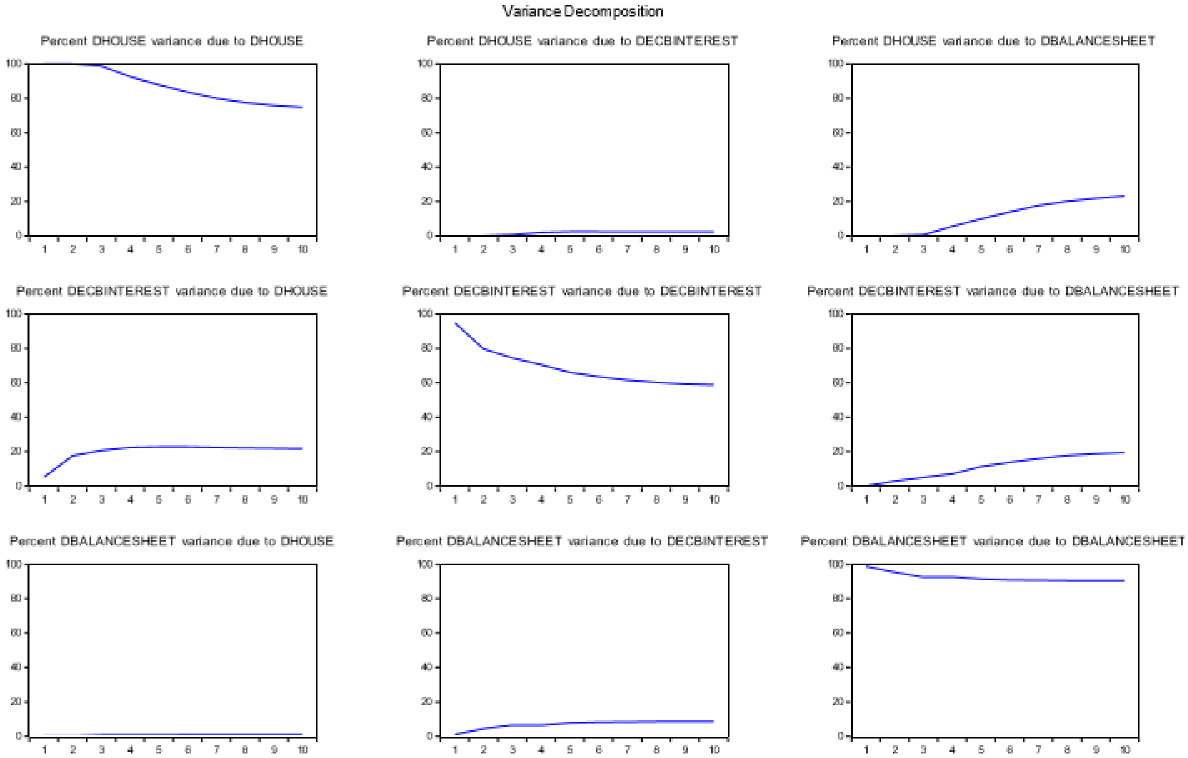
Accumulated Response to Cholesky One S.D. Innovations ± 2 S.E.



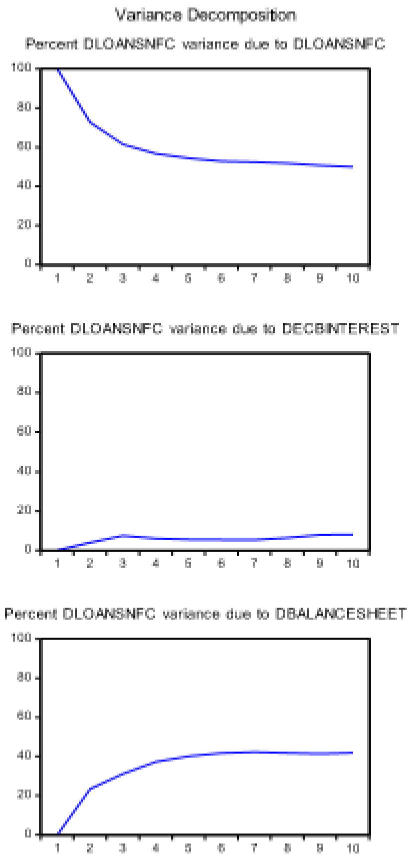


Period	DECBINTEREST	DBALANCESHEET
1	0.000000	0.000000
	(0.00000)	(0.00000)
2	0.016666	-0.040648
	(0.00650)	(0.00614)
3	0.036984	-0.075789
	(0.01186)	(0.01131)
4	0.038205	-0.113385
	(0.01778)	(0.01728)
5	0.036973	-0.140823
	(0.02415)	(0.02396)
6	0.040043	-0.160287
	(0.03024)	(0.03056)
7	0.040996	-0.172262
	(0.03551)	(0.03645)
8	0.053515	-0.180963
	(0.04037)	(0.04183)
9	0.068494	-0.189478
	(0.04479)	(0.04641)
10	0.075672	-0.202425
	(0.04921)	(0.05122)

Appendix 21: Variance Decomposition from VAR (3) based on Cholesky decomposition



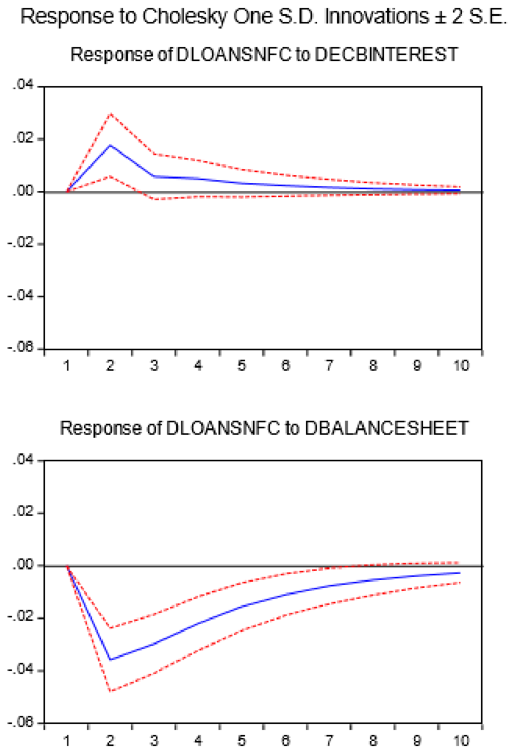
Appendix 22: Variance Decomposition from VAR (8) based on Cholesky decomposition

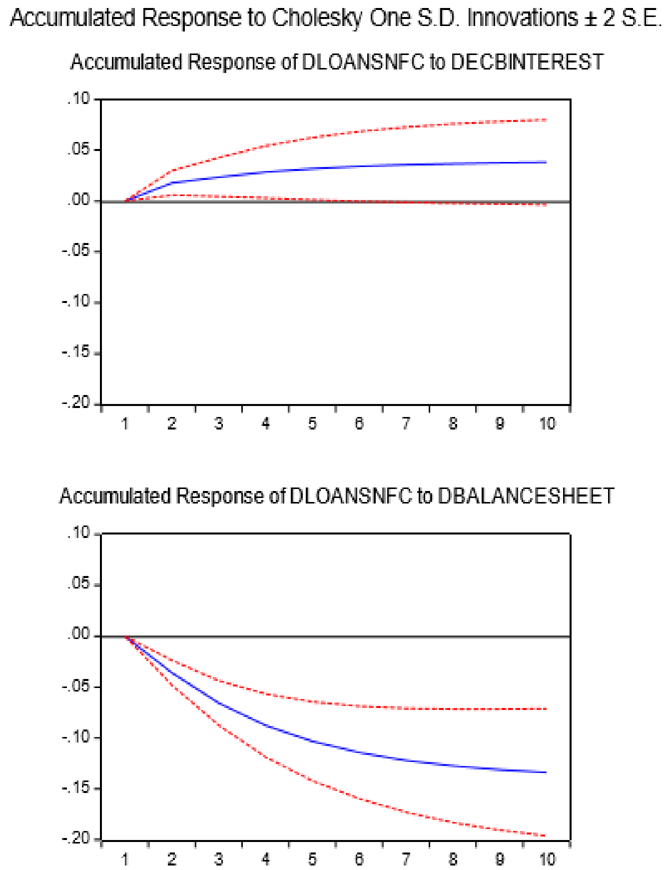


Appendix 23: Estimation of VAR(1) in differences for lending rates for NFC loans

	DLOANSNFC	DECBINTEREST	DBALANCESHEET
DLOANSNFC(-1)	0.548249 (0.07029) [7.80001]	0.787749 (0.08516) [9.24981]	-25736.97 (72970.1) [-0.35271]
DECBINTEREST(-1)	0.207182 (0.06118) [3.38621]	0.015582 (0.07413) [0.21019]	105760.4 (63518.5) [1.66503]
DBALANCESHEET(-1)	-4.70E-07 (7.5E-08) [-6.24729]	-4.19E-07 (9.1E-08) [-4.59581]	0.096987 (0.07818) [1.24059]
C	0.003642 (0.00601) [0.60568]	0.008549 (0.00728) [1.17353]	17094.25 (6241.65) [2.73874]

Appendix 24: IRF from VAR (1) in differences for lending rates for NFC loans, including also for accumulated responses

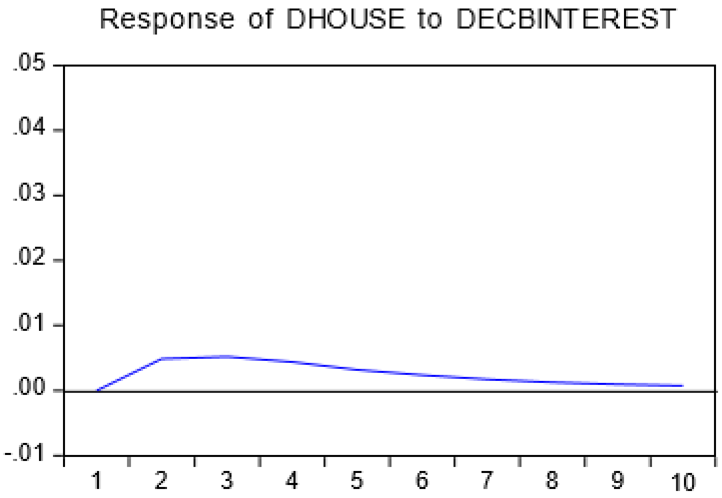


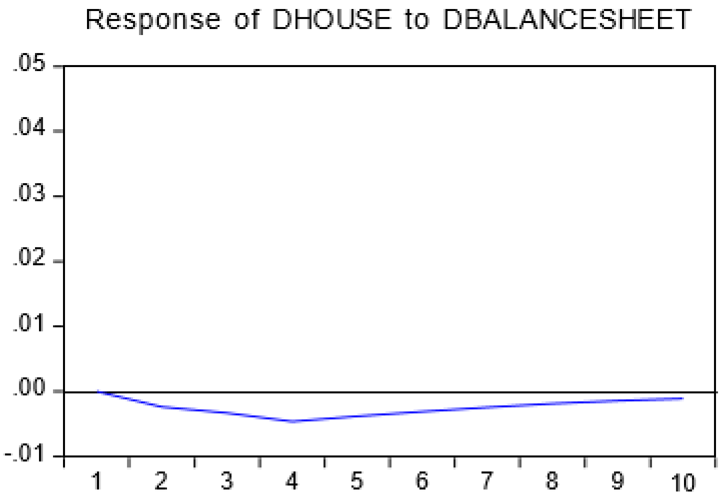


Appendix 25: Estimation of a BVAR (3) for the model of differences in lending rates for house purchase

	DHOUSE	DECBINTERES T	DBALANCESH EET
DHOUSE(-1)	0.600036	0.643105	-22158.55
	(0.05310)	(0.14093)	(99053.8)
	[11.3001]	[4.56340]	[-0.22370]
DHOUSE(-2)	0.040235	0.007596	5468.786
	(0.04155)	(0.10983)	(77231.8)
	[0.96833]	[0.06916]	[0.07081]
DHOUSE(-3)	-0.001408	0.004498	-11076.61
	(0.02920)	(0.07717)	(54265.7)
	[-0.04822]	[0.05828]	[-0.20412]
DECBINTEREST(-1)	0.052671	0.132433	61055.60
	(0.02385)	(0.06376)	(44657.6)
	[2.20881]	[2.07690]	[1.36719]
DECBINTEREST(-2)	0.019957	0.062666	19127.40
	(0.01592)	(0.04272)	(29825.4)
	[1.25333]	[1.46674]	[0.64131]
DECBINTEREST(-3)	0.007247	0.018444	831.2219
	(0.01146)	(0.03078)	(21463.8)
	[0.63247]	[0.59914]	[0.03873]
DBALANCESHEET(-1)	-3.08E-08	-1.55E-07	0.078835
	(3.2E-08)	(8.5E-08)	(0.06010)
	[-0.96241]	[-1.82007]	[1.31181]
DBALANCESHEET(-2)	-1.41E-08	-5.13E-08	0.057988
	(2.2E-08)	(5.9E-08)	(0.04176)
	[-0.63894]	[-0.87000]	[1.38847]
DBALANCESHEET(-3)	-2.16E-08	-2.19E-08	0.046186
	(1.6E-08)	(4.3E-08)	(0.03058)
	[-1.33222]	[-0.50871]	[1.51059]

Appendix 26: IRF from the BVAR (3)



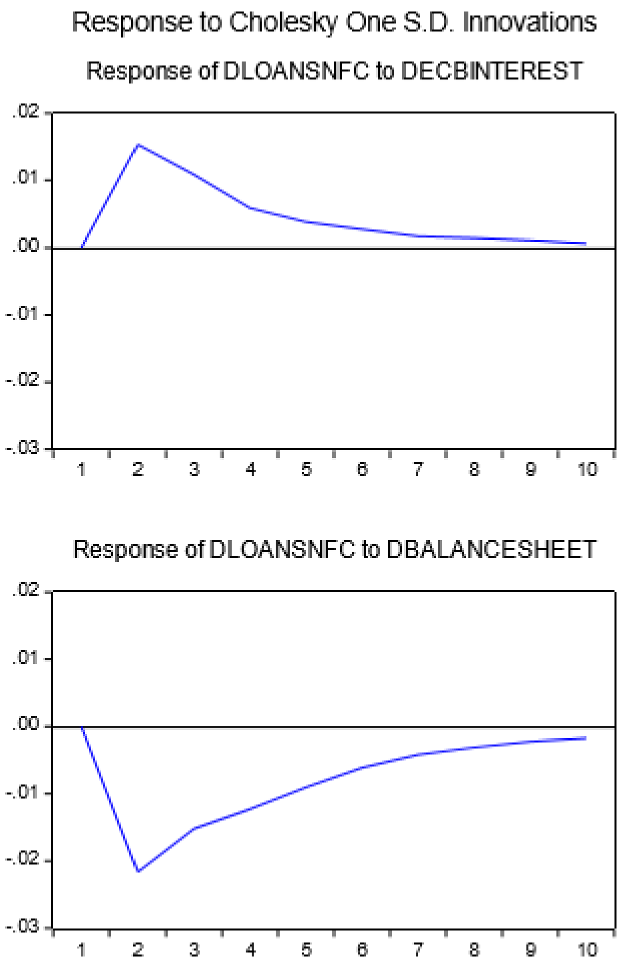


Appendix 27: Estimation of a BVAR (8) for the model of differences in lending rates for NFC loans

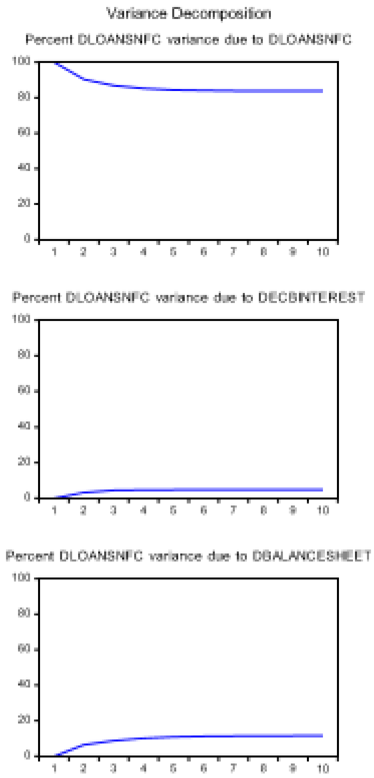
	DLOANSNFC	DECBINTEREST	DBALANCESHEET
DLOANSNFC(-1)	0.341652	0.489483	13628.29
	(0.06237)	(0.08254)	(55750.0)
	[5.47749]	[5.93034]	[0.24445]
DLOANSNFC(-2)	0.053190	0.054987	-11768.45
	(0.04330)	(0.05707)	(38559.3)
	[1.22849]	[0.96357]	[-0.30520]
DLOANSNFC(-3)	0.018006	0.010311	13129.45
	(0.03070)	(0.04042)	(27317.6)
	[0.58645]	[0.25507]	[0.48062]
DLOANSNFC(-4)	0.001193	0.003846	-9493.189
	(0.02363)	(0.03109)	(21012.7)
	[0.05048]	[0.12369]	[-0.45178]
DLOANSNFC(-5)	-0.003183	0.009092	-5597.017
	(0.01920)	(0.02526)	(17070.8)
	[-0.16579]	[0.35995]	[-0.32787]
DLOANSNFC(-6)	0.000977	-0.000276	5845.671
	(0.01616)	(0.02126)	(14366.7)
	[0.06045]	[-0.01298]	[0.40689]
DLOANSNFC(-7)	-0.001532	-0.005448	1455.526
	(0.01394)	(0.01834)	(12392.8)
	[-0.10985]	[-0.29713]	[0.11745]
DLOANSNFC(-8)	0.003046	-0.003663	1998.204
	(0.01225)	(0.01611)	(10891.0)
	[0.24856]	[-0.22730]	[0.18347]
DECBINTEREST(-1)	0.168935	0.079018	59598.77
	(0.04976)	(0.06632)	(44623.3)
	[3.39470]	[1.19148]	[1.33560]
DECBINTEREST(-2)	0.065473	0.044693	20134.48
	(0.03242)	(0.04336)	(29085.7)
	[2.01953]	[1.03069]	[0.69225]
DECBINTEREST(-3)	-4.58E-05	0.010647	2108.137
	(0.02319)	(0.03106)	(20810.6)
	[-0.00197]	[0.34277]	[0.10130]
DECBINTEREST(-4)	-0.005324	-0.002794	2165.054
	(0.01782)	(0.02388)	(15993.3)
	[-0.29873]	[-0.11700]	[0.13537]
DECBINTEREST(-5)	0.002451	0.003339	-2725.848
	(0.01444)	(0.01936)	(12962.1)
	[0.16967]	[0.17244]	[-0.21029]
DECBINTEREST(-6)	-0.000555	0.001646	-162.2988

	(0.01213)	(0.01627)	(10889.6)
	[-0.04570]	[0.10120]	[-0.01490]
DECBINTEREST(-7)	0.002510	0.001205	2759.655
	(0.01046)	(0.01402)	(9383.17)
	[0.24009]	[0.08594]	[0.29411]
DECBINTEREST(-8)	0.002752	-0.002354	1457.740
	(0.00918)	(0.01231)	(8241.60)
	[0.29968]	[-0.19115]	[0.17688]
DBALANCESHEET(-1)	-2.81E-07	-2.36E-07	0.048523
	(6.7E-08)	(8.9E-08)	(0.06070)
	[-4.16802]	[-2.63597]	[0.79938]
DBALANCESHEET(-2)	-4.81E-08	-2.04E-08	0.048153
	(4.7E-08)	(6.2E-08)	(0.04230)
	[-1.02675]	[-0.32861]	[1.13837]
DBALANCESHEET(-3)	-1.85E-08	-6.71E-09	0.040616
	(3.4E-08)	(4.5E-08)	(0.03070)
	[-0.54496]	[-0.14897]	[1.32281]
DBALANCESHEET(-4)	1.43E-09	2.29E-09	0.004337
	(2.6E-08)	(3.5E-08)	(0.02386)
	[0.05443]	[0.06537]	[0.18176]
DBALANCESHEET(-5)	2.00E-09	1.26E-08	0.003145
	(2.1E-08)	(2.8E-08)	(0.01937)
	[0.09342]	[0.44343]	[0.16235]
DBALANCESHEET(-6)	-5.62E-11	-3.91E-09	0.014995
	(1.8E-08)	(2.4E-08)	(0.01630)
	[-0.00312]	[-0.16367]	[0.92022]
DBALANCESHEET(-7)	2.30E-09	-5.09E-10	0.000955
	(1.6E-08)	(2.1E-08)	(0.01406)
	[0.14837]	[-0.02471]	[0.06794]
DBALANCESHEET(-8)	-9.70E-11	-1.19E-09	0.002922
	(1.4E-08)	(1.8E-08)	(0.01234)
	[-0.00712]	[-0.06602]	[0.23672]
C	0.001214	0.001399	16849.88
	(0.00685)	(0.00910)	(6152.57)
	[0.17706]	[0.15374]	[2.73867]

Appendix 28: IRF from the BVAR (8)



Appendix 29: Variance Decomposition from BVAR (8) based on Cholesky decomposition



Appendix 30: Granger causality test considering the model for differences in lending rates for house purchase with the optimal lags and other lags

Lags: 3

Null Hypothesis:	Obs	F-Statistic	Prob.
DECBINTEREST does not Granger Cause DHOUSE	166	2.08272	0.1046
DHOUSE does not Granger Cause DECBINTEREST		8.88618	2.E-05
DBALANCESHEET does not Granger Cause DHOUSE	166	3.76313	0.0121
DHOUSE does not Granger Cause DBALANCESHEET		0.90966	0.4378
DBALANCESHEET does not Granger Cause DECBINTEREST	166	5.39739	0.0015
DECBINTEREST does not Granger Cause DBALANCESHEET		3.36853	0.0201

Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
DECBINTEREST does not Granger Cause DHOUSE	168	1.50955	0.2210
DHOUSE does not Granger Cause DECBINTEREST		32.8129	5.E-08

Appendix 31: Granger causality test considering the model for differences in lending rates for NFC loans with the optimal lags

Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
DECBINTEREST does not Granger Cause DLOANSNFC	168	11.0462	0.0011
DLOANSNFC does not Granger Cause DECBINTEREST		66.1478	1.E-13
DBALANCESHEET does not Granger Cause DLOANSNFC	168	38.6994	4.E-09
DLOANSNFC does not Granger Cause DBALANCESHEET		1.00221	0.3182
DBALANCESHEET does not Granger Cause DECBINTEREST	168	6.46412	0.0119
DECBINTEREST does not Granger Cause DBALANCESHEET		3.68044	0.0568

Lags: 8

Null Hypothesis:	Obs	F-Statistic	Prob.
DECBINTEREST does not Granger Cause DLOANSNFC	161	3.54195	0.0009
DLOANSNFC does not Granger Cause DECBINTEREST		9.55489	1.E-10
DBALANCESHEET does not Granger Cause DLOANSNFC	161	8.16583	5.E-09
DLOANSNFC does not Granger Cause DBALANCESHEET		1.81262	0.0792
DBALANCESHEET does not Granger Cause DECBINTEREST	161	2.46146	0.0158
DECBINTEREST does not Granger Cause DBALANCESHEET		1.81843	0.0781

Appendix 32: VAR residual heteroskedasticity test and VAR residual serial correlation LM test for both models

- **VAR for changes in the lending rates for house purchase**

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Sample: 2003M01 2017M02
Included observations: 166

Lags	LM-Stat	Prob
1	15.98229	0.0673
2	17.29187	0.0443
3	12.06159	0.2099
4	7.361552	0.5995

Probs from chi-square with 9 df.

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Sample: 2003M01 2017M02
Included observations: 166

Joint test:

Chi-sq	df	Prob.
370.2690	108	0.2363

- **VAR for changes in the lending rates for NFC loans**

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Sample: 2003M01 2017M02
Included observations: 161

Joint test:

Chi-sq	df	Prob.
428.6741	288	0.1731

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Sample: 2003M01 2017M02
Included observations: 161

Lags	LM-Stat	Prob

1	13.55737	0.1390
2	6.106767	0.7292
3	11.91751	0.2180
4	9.604629	0.3834
5	11.12884	0.2670
6	17.28008	0.0445
7	6.064334	0.7335
8	14.53239	0.1046
9	16.28652	0.0611

Probs from chi-square with 9 df.