Do House Prices Influence the Effect of Monetary Policy Shocks on Private Consumption?

-Evidence From Five EMU Member States

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Abstract

The aim of this thesis is to study the role of house prices in influencing the effect of monetary policy shocks on private consumption in five EMU member states during the period 1995Q1-2010Q4. The role of house prices may be increasingly important in effecting private consumption possibilities due to the deregulations of mortgage markets in many countries in recent years and the increasing availability of mortgage equity products. Moreover, this study investigates whether or not changing credit market conditions during a recession may have any influence on the role of house prices. Using structural VAR models to be able to identify the interest rate shocks, the response of consumption in the absence and presence of house prices is studied through impulse response analysis. The results show that house price sensitivity to monetary policy shocks is more pronounced in countries with more developed mortgage markets. While there was a visible and non-temporary divergence between the impulse responses of consumption in the two versions of the model (including and excluding house prices, respectively), this could not be proven to be statistically significant. Three out of five countries display a larger house price effect when using data from the whole period as opposed to the house price effect observed when using only data from the pre-crisis period, 1995Q1-2007Q2. However, the results were not statistically significant.

Keywords: House prices, monetary policy, consumption, structural VAR, impulse response analysis

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1 Introduction

The deregulations of the mortgage markets in many countries over the last two decades have made house prices increasingly important to individual households' consumption possibilities. As housing is the asset most widely used as collateral to obtain loans, home owners can take advantage of rising house prices by extracting loans to finance extra consumption (Girouard & Blöndal, 2001). The possibility to do so has increased with the liberalization of credit markets and the diffusion of home equity release products, enabling home owners to increase the amount of their present mortgage or apply for a second loan. The crucial collateral role of housing in the lending sector thus means that house prices have the potential of contributing in the propagating mechanism when monetary policy shocks are transmitted to the economy (Giuliodori, 2005: 519). The Swedish National Housing Credit Guarantee Board conclude in a report from 2009 that in the short run, house prices seem at least as important to the development of private consumption as changes in real disposable income (BKN 2009: 3). The role of house prices in the monetary transmission mechanism has received increasing attention over the last few years. Several studies have attempted to measure the magnitude and timing of the housing channel in affecting macroeconomic variables such as private consumption (see e.g. Aoki *et al.*, 2002: Aron *et al.*, 2006; Mishkin, 2007). However, so far, not many studies have been made on the EU area specifically.

Research on the housing channel is highly relevant due to the changing structure and increasing liberalization of the credit markets and its consequences for consumption patterns. Furthermore, it is motivated by the fact that housing makes up more than half of the net wealth of the private sector in Europe, and is more equally distributed among the population than financial wealth (Giuliodori 2005: 539). Thus, it concerns a large and widely distributed segment of the population.

The fact that there is considerable heterogeneity among the mortgage and housing markets of the EU countries suggests that if the housing channel plays a role in the monetary transmission mechanism, its role *may* be heterogeneous, reflecting the institutional differences between the countries. Potential variations in the transmission mechanism across different countries is especially interesting in the EMU context, since the EMU member states are subjected to the same monetary policy interest rate and the ECB faces the difficult task of optimizing the interest rate for all the member states collectively. While the issue of economic asymmetries within the monetary union has received much attention over the last decade, most studies have focused on the labor and capital markets and have ignored the markets of assets with a fixed spatial location, such as land, property and housing (Maclennan *et al.*, 2000). Carstensen *et al.* (2009) have researched differences in the transmission mechanism through house prices and argue that the asymmetries across the European countries are so large that the effect of house prices should be taken into account when designing monetary policy for the union (2009).

The aim of this study is to investigate the role of house prices in the monetary transmission mechanism across some EMU member states, following a method used by Giuliodori (2005). However, while Giuliodori studied the pre-EMU period, 1979-1998, this study is based on data from the period 1995-2010, thus including the implementation of the single currency- and monetary policy. Furthermore, since the process of deregulation of many mortgage markets had been more or less carried out around the mid 90s (Girouard & Blöndal, 2001), using data from 1995 onwards results in a sample from a more uniform period, as far as mortgage market structures are concerned.

Basing the study on more recent data also means the global financial crisis in 2007 will be included, which adds another dimension to the investigation as it may provide some evidence on how the housing channel is affected by a recession and the resulting credit tightening. Not only the financial crisis but also the specific characteristics of the years preceding it, may give valuable information about the role of housing at different stages of the business cycle. As observed in a report in European Economy 7 in 2009, the years before the crisis were marked by *"…a long period of rapid credit growth, low risk premiums, abundant availability of liquidity, strong leveraging, soaring asset prices and the development of bubbles in the real estate sector."*(2009: 1).

The contribution of this study thus consists in its use of new data, data from a more structurally uniform period as far as mortgage markets are concerned, as well as data including the global financial crisis of 2007. The models will be estimated both with and without the data from the financial crisis, to compare the output during the different stages of the business cycle.

The analysis will be conducted through estimations of structural VARs, where the monetary policy shocks are identified using a Cholesky decomposition of the residuals. The output is then analyzed through impulse response functions. To compare the response of consumption in the presence of house price effects to the response when the house price effect is 'shut off', Giuliodori runs a counterfactual simulation exercise which he contrasts with the original baseline scenario where house prices are present (2005). Due to practical reasons, however, it was necessary to estimate the house price effect through the estimation and comparison of two different structural VARs, including and excluding the house price variable, respectively. This will be explained more thoroughly in chapter 4.

While several previous studies have employed a panel data approach to increase the sample size and thus the power and efficiency of the estimated results, this study aims to quantify the *unique* responses of five individual EMU member states and will consider quarterly data from 1995 to 2010 to constitute a sufficient sample size to perform individual country estimations. The preference for individual country estimation rather than using panel data is motivated by the institutional heterogeneities across the EMU mortgage and housing markets discussed in section 2.3, which may be troublesome to account for adequately in a panel framework. For the purpose of this study, the ability to account properly for country-unique responses in an individual VAR framework is thus given higher importance than obtaining larger samples through the use of panel data.

Due to the limited scope of the thesis and the rather extensive method used, only five EMU countries will be studied. These were chosen so as to represent different 'categories' of EMU economies when it comes to mortgage and housing market developments.

The thesis begins with a theoretical background, which goes through the theoretical and empirical evidence of the housing channel in the monetary transmission mechanism, as well as the main points of previous research. This is followed by a chapter in which the method used is described in detail. In the fourth chapter, the model and its particular specification in this study will then be presented in combination with a discussion of the data used. The fifth chapter presents and discusses the empirical results obtained, followed by the sixth, concluding chapter with concluding remarks and suggestions for further research.

2 Theory

2. 1 The monetary transmission mechanism

Monetary policy is transmitted to the economy mainly through the following three channels: i) the *interest rate channel*, ii) the *credit channel*, and iii) the *exchange rate channel*. The *interest rate channel* describes how a tightening of monetary policy tends to dampen private consumption by making saving more attractive as well as increasing the costs of households' loans, among other things. Increasing interest rates also slows down the activity in the economy as companies borrow less in response to the increased costs for borrowing, thus lowering both investment and the profitability of companies. The fact that the present value of the yield of financial as well as real assets decreases as they are discounted with a higher interest rate means that an increase in interest rates tends to signify a decrease in wealth (Riksbanken).

The exchange rate channel refers to how changes in the relative interest rate levels between national and foreign interest rates have an effect on the exchange rate, where an increase in the domestic interest rate relative to the world interest rate tends to lead to a strengthening of the national currency as foreign money flows into the country. The appreciation of the currency affects the economy through its effect on the costs of exports and imports (Riksbanken).

Lastly, *the credit channel* encompasses the effects of the policy interest rate on the possibility of obtaining a credit. Following a monetary tightening, the banks want to lend less money and purchase treasuries instead, thus making it more difficult for households and companies to obtain credits. This dampens the activity in the economy as companies may have to postpone investments and households consume less since it is more difficult to loan money (Riksbanken).

This study focuses on the so called *housing channel* of the monetary transmission mechanism, which describes how shocks in the policy interest rate affect households' consumption via its effect on house prices. The effects involved in this channel are related both to the interest rate- and the credit channels, which will become clear in the following section explaining the characteristics of this mechanism.

2.2 The housing channel

As Giuliodori points out, in order for a housing-market effect to exist, two inter-connected channels should be at work. First, there should be an effect from policy interest rate shocks onto house prices, and second, these house price movements should affect the real economy (2005). Thus, the remainder of this chapter will go through the theory and empirical findings first of all concerning the effect of interest rates on house prices, and, secondly, concerning the effects of house price movements on private consumption.

2.2.1 The effects of interest rates on house prices

Carstensen *et al.*(2009) underline that the strength of both the housing wealth and housing collateral effects depends on the sensitivity of house prices to interest rate changes. As they estimate the housing channel based on panel data, they even divide their panels into two subgroups, a *strong*- and a *weak reaction* group, on the basis of how strongly the house prices in the different countries respond to interest rate shocks. They find that the group with the strongest response in house prices to a positive interest rate shock also displays the strongest drop in real consumption as a result.

The first aspect to consider in estimating the effects of monetary policy shocks on house prices is probably the magnitude and timing of the pass-through of target interest rate changes onto short term interest rates and mortgage rates. That is, the extent to which policy changes from the monetary authorities will be absorbed by the lending institutions and thus reflected in the mortgage interest rates will naturally play a role in how house prices are affected, since the changes in the lending and mortgage rates is the part of the monetary policy shock that is actually felt by prospective house buyers. Several studies have found significant asymmetries in the extent of the pass-through in different countries, where e.g. countries like the UK and Netherlands exhibit both faster and larger pass-through effects on lending and mortgage rates than the rest of Europe. These asymmetries are regarded as stemming partly from differences in banking sector structures and in the degree of development of financial markets (Giuliodori, 2005).

The degree of financial liberalization plays a central role in determining the extent of the effect of monetary policy shocks on house prices. Iacoviello and Minetti (2002) find a positive relationship between increasing financial deregulation and a stronger effect on house prices of changes in the short term interest rate. The level of financial liberalization refers to several aspects of the lending market, such as the degree of competition in the banking sector, the availability of lending and of housing equity products (e.g. mortgage equity withdrawal) and the prevailing interest rate structure (variable or fixed), to mention a few. While a process of financial deregulation has been observed in most European countries during the 1980s and 1990s, there are still marked differences between the countries (Giuliodori, 2005). These heterogeneities are discussed more in detail and illustrated with some statistics in section 2.4.

Another cost that affects the response of house prices to changes in the monetary policy rates is the transaction costs involved when purchasing a house. Transaction costs include e.g. solicitor's fees, taxes and property registration costs, and these costs also vary among the EU member states, as shown in the table in section 2.4. Lastly, the average amount of time required to obtain a mortgage credit and complete a housing transaction is yet another relevant characteristic of mortgage and housing markets that differs among the EU countries (Giuliodori, 2005).

Changes in short term lending rates have a direct effect on the housing market through their effect on the user cost of capital. In standard neoclassical models, the user cost of capital has a central role in determining demand for housing capital (see e.g. Mishkin, 2007). The user cost of capital is affected by the relative purchase price of new housing capital (*ph*), the mortgage rate (*i*) (adjusted by the marginal tax rate, *t*,), the expected rate of appreciation of house prices (π_h^e) and the housing depreciation rate (δ) as follows:

$$uc = ph\ [(1-t)i - \pi_h^e + \delta] \qquad (1)$$

Regardless of whether a mortgage has a fixed or variable structure, the relevant time horizon is the expected life of the housing asset, which is long. For long-term, fixed rate mortgages, the interest rate reflects the long-term horizon. Even in the case of variable mortgage rates, however, it is not the current, but the average rate expected over the life of the housing asset that is of relevance. Thus, even in the case of variable mortgage rates, it is the long term mortgage rate that influences housing demand. However, the long-term interest rate reflects expectations of future short-term rates throughout the period of the homeownership. This link between long-term and short term interest rates means that movements in short term rates -induced by monetary policy- are followed by movements in the long-term interest rate. A positive shock to short term rates tends to be accompanied by a rise in long-term interest rates, leading to a higher user cost of capital, which, in turn, dampens housing demand. The fall in demand naturally has repercussions on the supply side of housing, and is met by a fall in residential construction. In accordance with Tobin's *q* theory of investment, a decrease in the market value of housing discourages further housing investment, and vice versa (see e.g. Mishkin, 2007).

Since positive interest rate shocks lead to a fall in housing demand and house prices, it seems reasonable that expectations of a future tightening of monetary policy could cause a fall in the expected appreciation of house prices. From the above equation (1), we see that this would increase the user cost of capital even in the current period (Mishkin, 2007).

The level of risk in the housing market plays an important role in determining house prices. This suggests that the sensitivity of house prices to changes in economic variables such as the policy interest rate may vary with the business cycle. The Swedish National Housing Credit Guarantee Board

(BKN) observes in a report from 2009 that the high uncertainty in the housing market during the recent financial crisis has caused a fall in house prices, since prospective house buyers require higher returns to compensate for the increased risk. The required higher returns will only be achieved if houses can be purchased at a lower price, and this is what causes the fall in house prices. This pattern and its effect on consumption will be discussed further in section 2.2.2 below.

Lastly, another way through which the business cycle may affect the link between interest rates and house prices is through variations in the availability of credit at different stages of the business cycle. Considering the findings that countries with more developed mortgage markets and easier availability of credit tend to exhibit stronger links between interest rates and house prices (e.g. Carstensen *et al.*, 2009), there is reason to investigate whether the tightening credit conditions during a recession *may* weaken the sensitivity of house prices to interest rate shocks. This aspect will constitute a new dimension in this study compared to previous ones, as it will be investigated whether the recent global financial crisis and the credit crunch has had any effect on the sensitivity of house prices to monetary policy shocks.

The correlations between the reference rate and house prices in each of the studied countries are reported in table 5.1 in chapter 5.

2. 2. 2 The effects of house prices on consumption

According to the permanent income hypothesis, an increase in wealth –whether financial or housing-should lead to an increase in consumption as people smooth their consumption over time (see e.g. Skudenly, 2009). Since this investigation focuses on the role of housing wealth exclusively, it may be helpful to distinguish between these two types of wealth before commenting further on the effects of housing wealth on consumption patterns:

Housing wealth differs from financial wealth in a number of aspects. First of all, house ownership tends to be more widely distributed among the population as a whole, whereas financial wealth tends to be confined to a smaller segment of the population. In fact, housing constitutes more than 50% of the net wealth of the private sector in most European economies (Giuliodori 2005: 519). Thus, in this aspect, one would expect changes in house prices to affect a larger part of the population.

Secondly, since house price changes are more stable than prices of financial assets, households have a natural tendency to perceive house price changes as more long-lasting and adapt their consumption levels fairly quickly as they see the value of their house change. Thus, in the short run, house prices play a larger role for private consumption than does changes in the value of financial assets, according to the Swedish National Housing Credit Guarantee Board (2009). Mishkin also argues that if the marginal propensity to consume out of wealth is lower for the richer households as is generally suggested by economic theory, changes in house prices may have a larger effect on consumption than changes in financial wealth (Mishkin, 2007: 10). However, it should be mentioned that there is varied evidence in the literature as to which of these two types of wealth that is more important in affecting consumption.

A third difference between housing wealth and financial wealth, which is highly relevant for this investigation, is that there is no obvious, traditional 'wealth effect' from changes in house prices. The reason for this is that changes in house prices only redistribute wealth but do not change aggregate wealth since *'…the capital gain to a last-time seller of a house represents a redistribution away from a first-time buyer…'* (Aoki *et al.*, 2002: 9). Thus, one may naturally ask how house prices may affect consumption if there is no such traditional 'wealth effect' as there is for financial wealth? There are, however, a number of ways through which house price changes, while not affecting the aggregate wealth in the economy as a whole, may still induce changes in private consumption, thus affecting the real economy:

First of all, if the two groups of agents, house owners and house buyers, have different marginal propensities to consume, then the positive effects on consumption for the house owners could exceed the negative consumption effects resulting for house buyers (Giuliodori, 2009: 525).

Another way through which changes in house prices can affect households' consumption levels is through so called 'confidence effects', affecting households' expectations about the future and where the economy is heading (Arnold *et al.*, 2002). Rising house prices, when driven by macroeconomic fundamentals and not by an asset bubble, may be an indication of increasing productivity in the economy, why rising house prices might make people feel optimistic about the future and increase consumption.

The problem of asymmetric information between lenders and borrowers creates friction in the credit markets. However, collateral such as housing reduces the problem of asymmetric information since it reduces the potential loss of the lender and makes the borrower less willing to take on excessive risk (Mishkin, 2007: 11). As Giuliodori points out, the crucial role of housing as collateral in lending makes it *'…a potential amplifying channel in the real effects of monetary disturbances.'* (2005: 519).
This may be one of the most important channels through which house price changes influence private consumption. With the deregulations of the credit markets in many countries over the last decades housing wealth plays an increasingly central role, directly affecting the size of the collateral against which the household may obtain so called mortgage equity withdrawals (MEW), also referred to as

home equity extraction (Mishkin, 2007: 12). The financial accelerator framework of Bernanke, Gertler and Gilchrist illustrates how the finance premium, i.e. the gap between the default-free interest rate and the effective interest rate for the house owner, is reduced when house prices rise and subsequently improve the households' balance sheet (1999). The extent to which households can make mortgage equity withdrawals (MEW) depends on the specific structure and characteristics of the credit market, such as its competitiveness and the ease in re-mortgaging (Giuliodori, 2005: 526). Several studies (see e.g. Calza *et al.*, 2007) have found that the correlation between house prices and consumption increases with the degree of development of the mortgage markets.

At the same time, as Calza *et al.* (2007) point out, it may be perplexing at first glance that the correlation increases with the level of deregulation of the financial markets, since economic theory of consumption smoothing suggests that agents should smooth their consumption to a larger extent in the presence of well-developed lending markets, compared to countries with less developed mortgage markets. Calza *et al.* account for this contradiction by assuming that at least a part of the population does not behave as permanent-income consumers (2007: 2).

As mentioned in section 2.2.1, discussing the link between interest rates and house prices, the risk premium paid by borrowers may not only be affected by the degree of development of the mortgage markets, but may also vary with the business cycle. In their report from 2009, the Swedish National Housing Credit Guarantee Board concludes that the price of risk has increased with the high uncertainty in the housing market resulting from the financial crisis. This, they observe, has led to a fall in private consumption. Thus, the level of risk in the housing market has an impact on private consumption already in the short run (BKN, 2009).

2. 3 Previous research

While several researchers have studied heterogeneities in the monetary transmission mechanism across European countries over the last few years, not as much research has been done focusing more in detail on the relative role of the different channels of the transmission mechanism, and even less research has been devoted specifically to the role of house prices in transmitting monetary policy shocks onto private consumption (Giuliodori, 2005). However, as previously mentioned, a great deal of research investigating the effects house price changes in general -i.e. not necessarily induced by monetary policy- on consumption have been done, especially over the last decades with increasing financial deregulations.

Both the research done specifically on the role of house prices in the monetary transmission mechanism and the research on the role of house prices *per se* in affecting consumption can be divided into macro- and micro-data studies. The studies based on micro-data are mainly done in the form of the relatively new branch of models called dynamic stochastic general equilibrium (DGSE) models, in which micro-economic principles are used to derive a macro-economic model. These type of models thus attempt to capture the decisions facing the agents in the economy, and make assumptions about what type of agents the economy is made up of, about their preferences, etc. Skudenly observes that studies based on micro-data are mainly confined to the US due to the limited availability of data (2009). Skinner (1993), among others, conducted micro-data based studies in the US and found that house prices had a significant effect on consumption.

Studies based on macro-data are a bit more numerous than micro-data studies. The macro studies are carried out almost exclusively through VAR models analyzed through impulse response analysis. These VAR models are predominantly made on panel data but some studies have also employed individual country data. The main issue with the panel studies involves accounting for the existing heterogeneities among the countries included. Some researchers have solved this by dividing the panels into groups on the basis of certain institutional indicators which are considered to be of importance based on theory and the results of previous research. Since it has been found in several studies (e.g. Iacoviello, 2004, Calza *et al.*, 2006) that differences in financial and mortgage market structures tend to influence the magnitude of the effect of the housing channel on consumption, indicators relating to the degree of development of the mortgage market have been used to divide the panels into subgroups. Such indicators include for example the down-payment rate, mortgage repayment rate, interest rate structure (fixed vs. variable), residential mortgage loans as a percentage of GDP, typical loan-to-value (LTV) ratio, house equity release products available (Calza *et* al., 2006).

Carstensen *et* al. (2009) object that the division into subgroups on the basis of subjectively chosen criteria is troublesome, as it is questionable on what basis certain indicators are viewed as relevant while others not. Furthermore, they point out that some indicators require a large degree of judgment when being compiled, such as evaluating whether mortgage rates are variable or fixed, since both versions often coexist. Additionally, the effects of certain indicators on the monetary transmission mechanism may point in exactly opposite directions for the one and same country. Thus, they suggest an alternative approach in which the data divides itself into subgroups: a strong reaction group and a weak reaction group, based on how strongly the country's house prices react to changes in the policy interest rate. They find that key macroeconomic variables, among them consumption, co-move with real house price movements in response to a policy interest rate shock, and that housing and mortgage market heterogeneity –represented by the strong and weak reaction groups, respectively- has a quantitatively significant impact on the effect (2009).

While several panel data studies have found significant results, Carstensen *et* al (2009) point out that since the reaction of real house prices to monetary policy shocks is largely decided by country-specific conditions on the housing and mortgage markets, estimation of individual country models would be optimal. However, in their case they choose a panel model in order to increase the sample size, since their research period only includes 1995-2006. In this study, on the other hand, the sample period is extended to include 1995-2010, and this period will be considered sufficient for a time-series estimation of each specific country. Rather than attempting to estimate some sort of average response to monetary policy shocks, representative of a fairly consistent group according to some subjectively chosen indicators, this study will estimate specific responses for each country studied. Through this approach, the hope is to provide empirical evidence on a range of different responses possible in economies with different structures. Thus, while individual VAR estimations means smaller sample sizes in each estimation, it has the advantage of each sample being more homogeneous. It also allows the data from each country to speak for themselves rather than being grouped together on the basis of some arbitrarily chosen indicators.

The majority of previous studies investigating the housing channel in the transmission mechanism include the following variables in their baseline VAR models: real GDP, the price level (CPI), real house prices and the monetary policy interest rate (see e.g. Carstensen *et al.*, 2009; Giuliodori, 2005).
The time periods covered in previous research include varying periods over the last 50 years, such as 1975-1996 (Case *et al*., 2001), 1978-1999 (Iacoviello & Minetti, 2003) and 1980-2004 (Calza *et* al., 2007). Thus, several of the studies incorporate periods of varying degree of financial development, as much of the financial deregulations in many countries took place during the latter half of the 80s and the first part of the 90s. The homogeny of the period studied may be an important consideration to the extent that the degree of development of the mortgage market has been concluded to have a significant impact on the housing channel effects on consumption. This is the reason Carstensen *et* al (2009) chose to work with a sample beginning *after* most financial deregulations had been implemented in the European countries studied, that is, beginning after 1995. For the same reason, this study will be based on a sample reaching from 1995 until 2010, thus using observations from a more ‘uniform’ period as far as financial deregulations are concerned.

2. 4 Heterogeneity among the EMU mortgage and housing markets

An issue that is frequently pointed out in research investigating the housing channel in Europe is the fact that the mortgage and housing markets of the EU countries still differ considerably. Giuliodori writes that differences in the intensity of competition of the banking sector, legal procedures, regulations in the rented sector and housing transaction costs, among other things, have left Europe with *‘…quite divergent and segmented housing and mortgage markets…’* (2005: 520). According to

Maclennan *et al.*, these institutional heterogeneities have a considerable impact on the housing channel in the monetary transmission mechanism (2000). Carstensen *et al.* also relate asymmetries in the responses of house prices to interest rate shocks in the different countries to country-specific mortgage market characteristics (2009). Thus, it is highly relevant to briefly go through the main institutional differences between the countries before commencing on the analysis.

The EU Single Market Program (SMP) implemented in 1992 was designed to encourage cross-border competition in various banking services, including mortgages. Although it was expected to result in a single market in mortgage finance, Maclennan *et al* observed in 2000 that cross-border operations were still small-scale and often without success, as mortgage markets remained to a substantial degree dominated by domestic institutions. In the European Mortgage Federation report from the fourth quarter in 2010, Alessandro Sciamarelli concludes that the figures on mortgage lending and house price developments indicate that the structures of the different EU countries remain mixed. Institutional factors that prevent convergence between the EU countries include for example the fact that it is difficult to standardize mortgage products, and the fact that mortgage security is nation-specific due to national valuation systems and laws. Moreover, some countries are dominated by state owned banks, making it difficult for foreign entrants to compete in such market structures. The different willingness of countries to deregulate their mortgage markets has also contributed to the picture of a continued mixture of different markets (Maclennan *et* al, 2000).

Maclennan *et al* divide the European countries into groups based on the degree of development of their consumer credit market, putting the UK at the end of the spectrum with the highest developed markets where housing collateral has a central role, accompanied by Sweden, Ireland and Finland, while countries like Germany, France and especially Italy represent the other end of the spectrum. In Italy, high transaction costs, a less developed consumer credit market and inefficiencies in the legal system has given housing a less significant role as collateral compared to other countries. Somewhere between these two ends, he places countries like the Netherlands and Spain (2000: 35).

Concerning housing tenure, the European average of home ownership is 68,2%. However, the cross-country variation is large (Hypostat, 2009). There is a clear division between north and south, where typical social welfare states like the Netherlands and Sweden have lower home ownership rate than the rest of Europe, especially in comparison with countries like Spain and Italy (Maclennan *et al.*, 2000). While the differences have decreased a bit over the last decade, Italy and Spain still have high ownership rates, 80% and 85%, respectively, compared to 57,2% in the Netherlands and 43,2% in Germany, as can be seen in table 1 below. The residential mortgage debt to GDP ratio also varies substantially across the EMU member states. While countries like Greece and Italy are among the lower ratios, 33.9% and 21.7%, respectively, the Netherlands tops the euro area with 105.6%. In between these extremes there is a variety of ratios such as that of Finland, 58%, France with 38%, Germany, 47,6% and Spain 64,6%, among others (Hypostat, 2009).

The loan-to-value ratio is often used as an indicator of the degree of credit market development and liberalization as it reflects how much households need to deposit to obtain a mortgage. The national averages of loan-to-value ratios vary considerably across the EU, with countries like the UK and the Netherlands having ratios significantly higher than most other countries. As can be seen in table 1, the Netherlands has the highest ratio among the countries studied here, 80%, followed by Germany and Finland with 74% and 70%, respectively. Italy and Spain, on the other hand, have ratios that are substantially lower, 50% and 56,2%, respectively.

Whether the dominating interest rate structure is fixed or variable also varies markedly across the union. Finland and Spain are largely dominated by variable interest rate adjustment, whereas the other countries mainly have fixed interest rates. While Italy and the Netherlands both have predominantly fixed interest rates, they still differ in the sense that in the Netherlands a large proportion of these rates are renegotiable, i.e. rates that are not fixed over the entire term but more than one year. In accordance with Maclennan's above mentioned division of countries into subgroups on the basis of their degree of development in credit markets, the table below shows that products such as mortgage equity withdrawal are available in Finland and the Netherlands, but not in Germany or Italy, and only to a limited extent in Spain.

Lastly, when it comes to total transaction costs of buying a house –expressed as a percentage of the house value- there is not as much variation between Germany, Italy and the Netherlands, which all lie around 7-8%. However, Finland and Spain stand out with values slightly lower (> 4%) and higher (10,4%) respectively.

Table 1. Key mortgage and housing market figures

	Residential mortgage debt to GDP ratio (%)	**Home ownership ratio (%)**	**Loan-to-value (LTV) ratio (national averages) (%)**	**Interest rate adjustment (fixed or variable)**	**Mortgage Equity Withdrawal (MEW) available**	**Total transaction costs (% of house value)**
Finland	58	59	70	Mainly variable	Yes	> 4
Germany	47,6	43,2	74	Mainly fixed	No	7,1
Italy	21,7	80	50	Mainly fixed	No	7,4
The Netherlands	105,6	57,2	80	Mainly fixed	Yes	7-8
Spain	64,6	85	56,2	Mainly variable	Limited	10,4

Sources: Hypostat 2009, Calza *et al.* (2007), Carstensen *et al*, (2009), Giuliodori (2005)

The above outlined housing and mortgage market heterogeneities provide strong evidence in favor of estimating individual country-models rather than grouping the data into panels with the risk of not accounting for the asymmetries adequately. As for the choice of countries included in the study, the selection was limited to include only five countries, due to the limited scope of this study. The countries were chosen so as to represent different parts of the spectrum (on the basis of the above provided information concerning their heterogeneity). The reason for choosing relatively heterogeneous countries was to have a 'wider' sample which may illustrate the housing channel influences not only in one type of economy, but at least in a couple of different types of economies, with which other EMU member states may identify themselves.

3 Method

3. 1 Structural VAR models

The VAR model was developed by Sims (1980), who argued that the restrictions placed on a simultaneous equations system in order to identify it were *'incredible'*, since all economic variables will affect one another in general equilibrium (Kennedy, 2006). Thus, rather than imposing restrictions to identify a system with too few exogenous variables, the VAR model estimates equations where all the explanatory variables are lagged values of the endogenous, dependent variables. The VAR is thus a reduced form, as the variables in the VAR are only functions of their own lagged values and lagged values of the other variables. In other words, this model does not allow for any contemporaneous effects between the variables. The advantage of the reduced form is that the model does not require any prior assumptions in order to be estimated. However, this feature is also the weakness of the model, and the reason it has received criticism for being atheoretical (Kennedy, 2006). As a result of the fact that it does not incorporate any economic theory or make any assumptions about the behavior of economic agents, but only explains the variations in its dependent variables through the past behavior of variables, the model can only be used for forecasting and not for structural analysis or policy evaluation (Enders, 2004).

The residuals from a standard VAR are only forecast errors and cannot be interpreted as structural errors, since they are composites of shocks, and cannot be uniquely identified with a specific variable. Thus, the impulse response functions from a reduced form VAR cannot be interpreted structurally. To be able to perform structural analysis and policy evaluation, the underlying structural shocks must be identified (see e.g. Kennedy, 2006).

In response to the critique of standard VARs and to meet the need for a model that could be used for policy evaluation, structural VARs (SVARs) were developed by Sims (1986), Bernanke (1986), Blanchard and Watson (1986). In SVAR models, economic theory is used to impose enough restrictions to be able to identify the shocks. A great advantage of the SVAR is that there is no need to build a structural model, and only a minimum number of restrictions are required to identify it (van Aarle *et al.*, 2003). To identify the shocks, one makes assumptions -based on economic theory- about how the variables are allowed to affect each other. The required assumptions can be imposed in the form of recursive structures, coefficient restrictions, variance or covariance restrictions, symmetry restrictions or restrictions on long-run relationships between variables (Kennedy, 2006). The most commonly used assumptions concern the timing of the interaction between the variables in the model, as these assumptions are the easiest ones to apply.

According to van Aarle *et al.*, the SVAR approach is particularly well suited to evaluate the effects of monetary and fiscal policy shocks since it isolates the response of each variable to the structural shocks and illustrate their transmission over time (2003).

3.1.1 The relationship between the structural and reduced forms

To illustrate the relationship between the reduced and the structural model, a formal presentation of how a structural VAR can be transformed into reduced form follows below. Note that several different structural VAR models can give rise to the *same* reduced form VAR, which is precisely why it is necessary to impose identifying restrictions in order to find the true, underlying SVAR. The example below, however, will only illustrate the transformation of one SVAR model into reduced form, since repeating the procedure with other SVAR models would result in a lengthy, elaborate description. However, it can be inferred from the way the VAR model is transformed into a reduced form that several versions of SVARs could result in the one and same reduced form once transformed.

Consider a simple structural VAR system with only two variables and two equations, where y_t and z_t are stationary variables and ε_{yt} and ε_{zt} are uncorrelated, white noise disturbances:

$$\left.\begin{aligned} y_t &= b_{10} - b_{11}z_t + \delta_{11}yt_{-1} + \delta_{12}z_{t-1} + \varepsilon_{yt} && (1) \\ z_t &= b_{20} - b_{21}y_t + \delta_{21}yt_{-1} + \delta_{22}z_{t-1} + \varepsilon_{zt} && (2) \end{aligned}\right\} \qquad \textit{Structural VAR}$$

This is a structural VAR, since it models mutual, within-period interaction between the variables. That is, z_t is allowed to have a contemporaneous effect on y_t, and vice versa, meaning the system models feedback between the two variables. In order to transform this system into a reduced form, which will be easier to estimate since all the explanatory variables will be lagged values, we can write the two equations together in matrix form as:

$$\begin{bmatrix} 1 & b_{11} \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} \delta_{11} & \delta_{12} \\ \delta_{21} & \delta_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix} \qquad (3)$$

which can be written in a more compact form:

$$BX_t = \Gamma_0 + \Gamma_1 X_{t-1} + \varepsilon_t \qquad (4)$$

where $B=\begin{bmatrix} 1 & b_{11} \\ b_{21} & 1 \end{bmatrix}$, $X_t=\begin{bmatrix} yt \\ zt \end{bmatrix}$, $\Gamma_0=\begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix}$, $\Gamma_1=\begin{bmatrix} \delta_{11} & \delta_{12} \\ \delta_{21} & \delta_{22} \end{bmatrix}$, $X_{t-1}=\begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix}$, $\varepsilon_t=\begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$

By multiplying each term on the right hand side by B^{-1}, that is, solving for X_t, one arrives at the reduced form expression, i.e. the standard VAR:

$$X_t = A_0 + A_1X_{t-1} + e_t \qquad (5)$$

where $A_0 = B^{-1}\Gamma_0$, $A_1 = B^{-1}\Gamma_1$, $e_t = B^{-1}\varepsilon_t$

To be able to write the model in the form of two equations, we define a_{i0} as the i'th element of the vector A_0, a_{ij} as the element in row i and column j of matrix A_1, and lastly, e_{it} is defined as element i of the vector of error terms, e_t. Thus, the matrix in (5) can be unfolded into the following two equations, which together constitute a standard VAR system:

$$\left.\begin{aligned} y_t &= a_{10} + a_{11}y_{t-1} + a_{12}z_{t-1} + e_{1t} \qquad (6) \\ z_t &= a_{20} + a_{21}y_{t-1} + a_{22}z_{t-1} + e_{2t} \qquad (7) \end{aligned}\right\} \quad \text{VAR}$$

The reduced form equations above do not rely on any assumptions concerning mutual interactions between the variables or concerning the behavior of economic agents. This has important implications for the error terms in the two different types of VAR models. The error terms in the structural model - equations (1) and (2) - are interpreted as structural innovations to the system, that is, they reflect the underlying structural relationships between the economic variables. The error terms in the standard VAR above, on the other hand, are merely forecast errors and composites of the two structural shocks ε_{yt} and ε_{zt} (Enders, 2004). Using $e_t = B^{-1}\varepsilon_t$, e_{1t} and e_{2t} can be written as:

$$e_{1t} = (\varepsilon_{yt} - b_{11}\varepsilon_{zt}) / (1 - b_{11}b_{21}) \qquad (8)$$

$$e_{2t} = (\varepsilon_{zt} - b_{21}\varepsilon_{yt}) / (1 - b_{11}b_{21}) \qquad (9)$$

Imposing a sufficient number of restrictions on the VAR will make the system identifiable, i.e. it will be possible to identify the structural components in the forecast errors of the standard VAR. The following paragraph explains one of the commonly used methods to identify the model: Cholesky decomposition.

3.1.2 Identification of the model: Cholesky decomposition

In the structural form system represented by equations (1) and (2), also called the primitive system, the error term ε_{zt} is correlated with y_t, and ε_{yt} is correlated with z_t. Since standard regression techniques require zero correlation between the independent variables and the error term (recall for example the Gauss-Markov assumptions of the OLS estimator), it is only possible to run OLS on the reduced form model, i.e. equations (6) and (7). The question of whether or not the structural system is identifiable amounts to whether or not it is possible to obtain all the information contained in the structural system, on the basis of the OLS estimates of the reduced model (Enders, 2004).

Since the number of parameters in equations (1) and (2) add up to 10, while the parameters of the reduced model in (6) and (7) only sum to 9, it requires that a restriction is imposed on one of the variables for the system to be identified. A method commonly used within monetary policy analysis to identify such a model -thus identifying the monetary policy shocks- is the recursive system introduced by Sims (1980), where the residuals are decomposed through *Cholesky decomposition*. To exemplify the Cholesky decomposition procedure, suppose the parameter b_{21} is restricted to equal zero. This means that while z_t is allowed to have a contemporaneous effect on y_t, y_t is only allowed to affect z_t with a lag. Here, z and y are only examples to illustrate the procedure, but generally one would apply economic theory in deciding which variable that is allowed to have a contemporaneous effect on the other. With the above restriction, equations (1) and (2) become:

$$y_t = b_{10} - b_{11}z_t + \delta_{11}yt_{-1} + \delta_{12}z_{t-1} + \varepsilon_{yt} \qquad (10)$$

$$z_t = b_{20} + \delta_{21}yt_{-1} + \delta_{12}z_{t-1} + \varepsilon_{zt} \qquad (11)$$

The relationship between $\varepsilon_{yt}, \varepsilon_{zt}$ and the error terms in (8) and (9) can be rewritten as:

$$e_{1t} = \varepsilon_{yt} - b_{11}\,\varepsilon_{zt}$$

$$e_{2t} = \varepsilon_{zt}$$

Imposing the above restriction gives a system that is exactly identified. With this system, B^{-1} is given by:

$$B^{-1} = \begin{bmatrix} 1 & -b_{11} \\ 0 & 1 \end{bmatrix}$$

Multiplying all the right hand side terms of the structural model by B^{-1} gives:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} b_{10} - b_{11}b_{20} \\ b_{20} \end{bmatrix} + \begin{bmatrix} \delta_{11} - b_{11}\delta_{21} & \delta_{12} - b_{11}\delta_{22} \\ \delta_{21} & \delta_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} - b_{11}\varepsilon_{zt} \\ \varepsilon_{zt} \end{bmatrix} \qquad (12)$$

This equation illustrates the implication of the restriction $b_{21} = 0$, namely, that y_t is contemporaneously affected by ε_{yt} and ε_{zt}, whereas z_t is only contemporaneously affected by ε_{zt}. Running OLS on the system, the parameter estimates from the reduced model in (6) and (7) are obtained. These parameter estimates relates to the parameters from the structural model in the following way:

$a_{10} = b_{10} - b_{11}b_{20}$

$a_{11} = \delta_{11} - b_{11}\delta_{21}$

$a_{12} = \delta_{12} - b_{11}\delta_{22}$

$a_{20} = b_{20}$

$a_{21} = \delta_{21}$

$a_{22} = \delta_{22}$

Furthermore, from the restriction $b_{21} = 0$, we have that $e_{1t} = \varepsilon_{yt} - b_{11}\varepsilon_{zt}$ and $e_{2t} = \varepsilon_{zt}$. The respective variances of e_{1t} and e_{2t} and the covariance between them are thus:

$\mathrm{Var}(e_1) = \sigma_y^2 + b_{11}^2\sigma_z^2$

$\mathrm{Var}(e_2) = \sigma_z^2$

$\mathrm{Cov}(e_1, e_2) = -b_{11}\sigma_z^2$

Looking at these nine equations just listed above (6 for the parameters plus 3 equations for the variance and covariance), it is clear that, using the parameter estimates obtained in the OLS regression of the reduced form model, it is possible to solve for b_{10}, b_{11}, δ_{11}, δ_{12}, b_{20}, δ_{21}, δ_{22}, σ_y^2, and σ_z^2. Having solved for these values, it will also be possible to find the structural shocks ε_{yt} and ε_{zt}, as:

$\varepsilon_{zt} = e_{2t}$

$\varepsilon_{yt} = e_{1t} - b_{11}\varepsilon_{zt}$

The above described method of recovering the structural shocks by decomposing the shocks triangularly is the Cholesky decomposition. This was only a simple example of two variables with one period lags, used for illustrative purposes. To put the application in more general terms, a VAR consisting of *n*- variables, where *B* is an *n* x *n* matrix, necessitates $(n^2-n)/2$ restrictions regarding the relationship between the regression error terms and the structural innovations. The triangular decomposition of the Choleski approach means that *exactly* $(n^2-n)/2$ parameters in the B matrix are restricted to equal zero (Enders, 2004).

3. 2 Impulse Response Analysis

Impulse response analysis constitutes one of the most important tools used to interpret the output of SVAR models and thus analyze the effects of shocks to the economy such as e.g. monetary policy shocks. The impulse response function shows the effects of the analyzed shock on the adjustment path of the variable, i.e. how the variable responds to the shock over time. To illustrate the impulse response function as simply as possible, consider first the case with only one variable: $y_t = \rho y_{t-1} + v_t$. Suppose the starting value at time t=0 is simply 0, so that $y_0 = 0$, and that in period t=1 there is a shock of size v. As a result of the shock, the value of *y* in period 1 will be $y_1 = \rho y_0 + v_1 = v$. Assume the shocks was only temporary, so that $v_2, v_3 = \ldots = 0$. In period 2, y_2 will be $\rho y_1 = \rho v$, in period 3, y_3 will be $\rho^2 v$, and so on (Carter Hill *et al*,. 2008).

To exemplify what the IRF looks like when there is more than one variable, consider the following VAR system of only two equations:

$$y_t = \delta_{10} + \delta_{11} y_{t-1} + \delta_{12} x_{t-1} + e_t^y$$
$$x_t = \delta_{20} + \delta_{21} y_{t-1} + \delta_{22} x_{t-1} + e_t^x$$

As can be seen, there are two possible shocks to the above system of equations: either *x* or *y* can be subjected to a shock. However, since lagged values of *y* appear as an exogenous variable in the equation for *x*, and vice versa, it is clear that over time *x* will also be affected by a shock to *y*, and vice versa. Thus, in a two-equations system such as the one exemplified above, we are interested in the following four impulse responses:

1) the effects of a shock to y on y,
2) the effect of a shock to y on x,
3) the effect of a shock to x on x,
4) the effect of a shock to x on y

Suppose that at time *t*=1there is a shock to *y*, the size of one standard deviation, $v_1^y = \sigma_y$, but that in the subsequent periods the shock is zero, , $v_t^y = 0$. Asssume there is no shock to *x*, $v_t^x = 0$ for all *t*. The impulse response function illustrates how *y* and *x* respond to the shock over time:

At time t=1 the effect of $v_1^y = \sigma_y$ on y is $y_1 = v_1^y = \sigma_y$, while the effect to x at this time is zero. In the following period, t=2, the effect on y is $y_2 = \delta_{11} y_1 + \delta_{12} x_1 = \delta_{11} \sigma_y + \delta_{12} 0 = \delta_{11} \sigma_y$. The effect on x in this period will be $x_2 = \delta_{21} y_1 + \delta_{22} x_1 = \delta_{21} \sigma_y + \delta_{22} 0 = \delta_{21} \sigma_y$. Thus, due to the lagged y-values present in the equation for x, a shock to y has an effect on x as well, over time. At time t=3, the effect on y will be $y_3 = \delta_{11} y_2 + \delta_{12} x_2 = \delta_{11}^2 \sigma_2 + \delta_{12} \delta_{21} \sigma_y$, while the effect on x will be $x_3 = \delta_{21} y_2 + \delta_{22} x_2 = \delta_{21} \delta_{11} \sigma_y + \delta_{22} \delta_{21} \sigma_y$ (Carter Hill *et al.*, 2008).

As mentioned above, it is necessary to impose a sufficient number of restrictions in order to identify the structural, so called primitive system. Thus, once sufficient restrictions are imposed, in the form of e.g. a Cholesky decomposition of the residuals, it will be possible to obtain the parameters of the structural equations from the information contained in the reduced form. With these parameters it will be possible to trace the reaction of each of the dependent variables over time to a structural shock, ε (Enders, 2004).

4 Data and Model Specification

4.1 Data

Below follows an account of the sources of the data used for the analysis, followed by a brief discussion of some of the problematic related to the comparability of house price data which needs to be mentioned.

4.1.1 Data Sources

The data used for the different VAR estimations was collected via Thomson Reuthers Datastream, which is a database gathering data from a vast collection of national and international sources worldwide. Series such as GDP, private consumption, and GDP deflators were taken from national statistical bureaus and national central banks. The countries' individual central bank target rates until December 1998 as well as the common ECB reference rate from January 1999 were all collected from Eurostat. House prices, on the other hand, were collected from the Bank of International Settlements (BIS). The BIS collection of house price data from different countries' national statistical bureaus and central banks is extensive, and it is clear that there has been a serious attempt to gather all available house price indices for different countries. However, the gaps in many countries' house price data remains an issue, which will be discussed more below. For the Netherlands, house price data from NVM (National Brokers' Association) was used instead of the data from BIS, since the data from BIS generated a positive correlation with interest rates, which is odd for a country with well-developed credit and housing markets such as the Netherlands. Comparing the BIS and NVM series, the BIS series appears smoothed in comparison to the NVM series, and it seems that the NVM series captures the house price movements in each quarter better.

4.1.2 Data transformations

All series have been logged in order to remove heteroskedasticity, except the interest rate. As for the house price series from Italy and Germany, only semi-annual and annual data, respectively, were available. Thus, these series have been interpolated linearly into quarterly data in *Excel*, and then seasonally adjusted in *Eviews*, to get rid of any seasonal effects.

All variables in all the various models specified below are estimated in levels. This practice is widely used among researchers investigating monetary policy issues with structural VARs. Sims, among others, recommends against differencing the series even in those cases where the variables are non-stationary (1980). His motivation is that the aim of VAR analysis is to investigate the interrelationship between the variables rather than to determine the parameter estimates. Differencing the data will cause a loss of information on co-movements in the data. The form of the variables should follow the true data generating process, especially when attempting to model structural relationships (Sims, 1980).

4.1.3 Comparability of data between countries

While series such as GDP, private consumption and GDP deflators are collected and compiled relatively similarly among different countries and consequently lend themselves more to comparison, this is clearly not the case with house price data. The lack of comprehensive, comparable house price data from different countries is a well-known problem.

The availability of reliable asset price data is of central importance to economic research, design of monetary policy and detecting asset price bubbles, among other things. However, unlike the case of financial assets, where price data is readily available and tends to be reliable, the case of house price data is slightly more problematic. The reason is that no two houses, even in the same neighborhood, are the same. Houses may differ in many aspects, such as e.g. construction year, space, location, quality, window views, vicinity to public transport, etc. There are also differences between countries when it comes to how the data is collected and compiled. Ito means that house price indices that do not correct for the above mentioned heterogeneities are incomplete (2010). For the above mentioned reason, house prices are increasingly analyzed through so called hedonic price models, which study the separate components that together determine the price. However, since this is relatively new, it is hard to find hedonic price indices on historic data.

The availability of uniform house price data in the different EMU countries is limited. Calza *et al.* investigate monetary policy effects on house prices and consumption within the EU area, and point out that *'Even within the euro area house price data are not fully comparable.'*(2007: 9). They underline the importance of taking this heterogeneity in the data into account and being cautious in the interpretation of the results. Some countries have indices of transaction prices of various categories of dwellings as well as geographical regions, while other countries only have indices of one or two types of house structures or only of new or old houses, respectively, over a longer period. While many countries make distinctions e.g. between existing and new dwellings in their collection of house price data, other countries only have such distinctions for shorter periods of time or none at all, i.e. they only collect data from new and existing dwellings together. Thus, when collecting data that reaches the whole period studied, 1995Q1-2010Q4 from each country, it was necessary to use data on existing dwellings for some countries, and data including existing *and* new houses from other countries, all in accordance with what was available.

Since the timing and magnitude of the pass-through of the policy interest rate onto mortgage rates may be of relevance when considering the effects of policy interest rate shocks on house prices –as mentioned in section 2.2.1- it would be interesting to compare this pass-through effect in the different economies studies. However, due to the difficulties involved in finding comparable mortgage rates between the countries, a meaningful comparison of this kind is difficult to accomplish. Giuliodori points out that the mortgage rates used in his study do not lend themselves to comparison due to the varying definitions of the rates used (2005: 534).

4.2 Model specification

Below follows an outline of the different models that were estimated. As mentioned above, all variables in the different models are estimated in levels. The recursive order used when imposing the Cholesky decomposition places the policy interest rate last, in all models. This ordering signifies that the interest rate is contemporaneously affected by all the other variables, while these other variables are only allowed to react with a lag, i.e. they only react in the following quarter to changes in any of the four variables. In other words, this ordering assumes that the monetary authorities are quick enough to both observe and react to changes in price levels and production within the same quarter. The price level and house prices, on the other hand, are assumed to be sticky and react sluggishly to changes in the interest rate. Equally, real GDP is also assumed to require some time to adjust to changes in the monetary policy rate, thus only reacting in the following quarter.

Table 2. Model specifications

MODEL:	TESTING:	TIME PERIOD:	VARIABLES:
1 a)	***Effects of R-shocks on RHP***	1995Q1 - 2010Q4	*P, GDP, RHP, R*
1 b)	***Effects of R-shocks on C (2 SVARs: with/without RHP)***	1995Q1 - 2010Q4	*P, GDP, C, (RHP), R*
1 c)	***Robustness check***	1995Q1 - 2010Q4	*P, GDP, RHP, B, R*
2 a)	***Effect of R-shocks on RHP: Pre-crisis period***	1995Q1 - 2007Q2	*P, GDP, RHP, R*
2 b)	***Effect of R-shocks on C (2 SVARs: with/without RHP): Pre-crisis period***	1995Q1 - 2007Q2	*R, (RHP), C, GDP, P*

Definitions: *B* = 10 year bond rate, *C*= real consumption, *GDP* = real GDP, *P* = price level (CPI), *R* = ECB policy interest rate, *RHP* = real house prices.

Model 1a) Effects of interest rate shocks on house prices

First of all, a baseline model is estimated to investigate the relationship between the target interest rate and house prices. This simple baseline model including the variables price level, real GDP, real house prices and the target interest rate, will allow us to obtain impulse responses for the reaction of house prices to monetary policy shocks. Through Cholesky decomposition, the following recursive order is imposed:

$$X = [P, GDP, RHP, R]$$

In order to illustrate how the structural model looks when the lower triangular Cholesky decomposition is applied, the four equations of this model will be specified explicitly below. This is only thought to serve as a demonstrative example, and thus will only be specified in writing for this model and not for the rest.

$$P_t = b_{10} + 0GDP_t + 0RHP_t + 0R_t + \delta_{11}P_{t-1} + \delta_{12}GDP_{t-1} + \delta_{13}RHP_{t-1} + \delta_{14}R_{t-1} + \varepsilon_P$$

$$GDP_t = b_{20} + b_{21}P_t + 0RHP_t + 0R_t + \delta_{21}P_{t-1} + \delta_{22}GDP_{t-1} + \delta_{23}RHP_{t-1} + \delta_{24}R_{t-1} + \varepsilon_{GDP}$$

$$RHP_t = b_{30} + b_{31}P_t + b_{32}GDP + 0R_t + \delta_{31}P_{t-1} + \delta_{32}GDP_{t-1} + \delta_{33}RHP_{t-1} + \delta_{34}R_{t-1} + \varepsilon_{RHP}$$

$$R_t = b_{40} + b_{41}P_t + b_{42}GDP_t + b_{43}RHP_t + \delta_{41}P_{t-1} + \delta_{42}GDP_{t-1} + \delta_{43}RHP_{t-1} + \delta_{44}R_{t-1} + \varepsilon_R$$

As can be seen, the zero restrictions placed on the coefficients of the contemporaneous values in the system form an upper triangle, while the coefficients that are not restricted form the lower triangle used in the Cholesky decomposition of the shocks. Only in the last equation is the dependent variable (R_t) allowed to be affected by contemporaneous values of *RHP*, *GDP* and *P*.

Model 1b) Effects of interest rate shocks on consumption (2 SVARs: with/without RHP)

This model consists of two versions, one including and the other one excluding the house price variable. As mentioned in the introduction, Giuliodori (2005) and Bernanke *et al.* (1997), among others, have used a so called two-stage approach to estimate the effect of house prices. Their approach consists of running a counterfactual simulation exercise in the second scenario where the house price effect is 'shut off', which is then compared to the baseline scenario. In the counterfactual scenario, they use the coefficients obtained in the baseline model (including P, GDP, C, RHP, R), while setting to zero the coefficients of house prices, thus 'shutting off' the house price effect. They then compare the impulse responses from these two scenarios and interpret the difference between the respective impulse responses as a measure of the contributing effect of house prices in the monetary transmission mechanism.

As it is not an option to program the two different scenarios (i.e. setting the coefficients of RHP to zero in the counterfactual scenario) and obtain an impulse graph including the two responses in Eviews, this study uses an alternative approach. Estimating a second SVAR model excluding the house price variable and then comparing the impulse response of this model to the one generated when house prices were included, the difference between the response of consumption in the two SVARs is interpreted as a measure of the propagating contribution of house prices in the transmission of monetary policy shocks onto consumption.

Model 1c) Robustness check

Following the example of Giuliodori (2005) in testing the robustness of the baseline model, model 1a) is extended with another variable central to the monetary transmission mechanism. In an attempt to capture and account for investment and consumption decisions influenced by long-term interest rates, the rate of 10 year bonds is added to the baseline model. Observing how this long-term interest rate responds to shocks in the short term policy interest rate as well as how house prices react when the long-term interest rate is included, will give an idea of how well short-term interest rates reflect the effects of policy shocks operating through long-term rates. This is relevant since –as mentioned in chapter 2- the interest rates relevant to prospective home buyers are really the interest rates over the longer term. However, because the latter are connected to short term interest rates (for more on this, see the Fischer hypothesis), the monetary policy interest rate, which is short term, may still affect investment and consumption decisions.

Model 2a) Effects of interest rate shocks on house prices: Pre-crisis period

In this section, model 1a) is estimated again using only the data from 1995Q1 to 2007Q2. The results from this estimation are then compared to those in 1a), to see if the financial crisis and the credit crunch has had any effect on the role of house prices in the monetary transmission mechanism. The reason for using the pre-crisis period rather than the crisis years, 2007-2010, is that the crisis period includes quite few observations, making any meaningful impulse response analysis difficult.

Model 2b) Effects of interest rate shocks on consumption (2 SVARs: with/without RHP): Pre-crisis period

Similar to the above outlined procedure, model 1b) is also applied on data from 1995Q1 to 2007Q4, to investigate if there is any difference between the contributing effects of house prices at different stages of the business cycle.

4.3 Discussion of the model

Below follows a brief discussion of two central concerns that one should be aware of in order to understand the SVAR approach and its results better.

4.3.1 SVAR models

SVAR models are extensively used within monetary policy research and the fact that it can be used for structural analysis and policy evaluation is clearly a great advantage over models that can only be used for forecasting. The fact that it is completely data-driven is argued by its proponents to be its main advantage. However, it has also been criticized for the same reason. It is argued that the economic theory implemented through the identifying restrictions may not be enough, and this may give rise to counterintuitive results such as the so called *price-puzzle*. The *price-puzzle* is a well-known problem that refers to the fact that the impulse responses of prices often display an initially positive response to a positive shock in the policy interest rate, which is odd since an unexpected increase in the interest rate is expected to lead to a fall in prices. It has been explained by some as a puzzle that occurs when the central bank responds too weakly to future inflation forecasts, thus not managing to prevent a rise in prices since the interest rate increase was not large enough (e.g. Balke and Emery, 1994). Others have explained it as a problem that occurs when the VAR model does not include certain variables that the monetary authorities may be responding to when they set the interest rate, such as e.g. commodity price indices (e.g. Sims, 1992). However, including for example a commodity price index in the model to get rid of the price puzzle may also come at a cost, if in fact a commodity price index is not included in the model used by the monetary authorities. It may then be difficult to interpret the structural shocks if the model includes two price levels while the theoretical model only is based on one price index (Giordani, 2001).

While it is essential to be aware of the above stated weakness, the model still has many advantages over other models –as mentioned initially- and continues to be used extensively within monetary policy research.

4.3.2 Implications of the recursive order

As previously mentioned, the recursive order imposed on the model means an assumption is made about the timing of the effects between the different variables. One assumes that a certain variable is contemporaneously affected by the other variables, while the other variables only react with a lag.
The order is chosen on the basis of economic theory and the estimated slope coefficients in the resulting VAR model and consequently also the impulse responses are a result of the chosen order.

As pointed out by Bjørnland and Jacobsen (2010) it is a *'major challenge'* to identify the system when investigating the effects of monetary policy on asset prices such as for example house prices. The reason is that both variables may respond contemporaneously, i.e. within the same quarter, to economic news. Thus, the decision of how to specify the recursive, contemporaneous restrictions, is complex. Ordering house prices last among the variables would mean they respond contemporaneously to changes in the other variables while the other variables only respond in the following quarter. This type of restriction assumes that policy makers do not use all the current information when setting the interest rate, which may be a faulty assumption. On the other hand, ordering the policy interest rate last, assuming it responds within the same quarter to changes in house prices, GDP and the price level comes at the cost of thus assuming that e.g. house prices only respond with a lag to news. This may potentially also be a faulty assumption *if* asset prices are in fact forward-looking and expected to respond more quickly to monetary policy news.

As it is difficult to satisfy every possible mutual relationship that may exist between the variables in the model, it seems reasonable to prioritize the recursive order that seems most correct among the ones possible. This could be done on the basis of economic theory and/or by experimenting with different recursive orders to see which resulting impulse that seems most realistic. For the purpose of this investigation, the recursive order presented in section 4.2, with the policy interest rate responding within the same quarter to changes in the other variables, was considered most appropriate. This is also the order used by e.g. Giuliodori (2005) and Goodhart and Hofmann (2001).

It made sense to assume that house prices, prices and GDP respond with lags. As far as prices go, they are generally considered to be sticky, as it is costly and takes time to change pricing and since wages are also rigid in the short run. The assumption that GDP reacts with a lag to changes in macroeconomic variables such as the policy interest rate is motivated by the fact that it takes time to increase production and demand may also respond with a lag if prices and wages are sticky. Above all, it seemed reasonable to assume that policy makers set the interest rate based on information available within the same quarter, since they generally have access to monthly economic reports and prognoses made by statistical bureaus and research institutions.

5 Analysis

5.1 Descriptive statistics: correlations

Before presenting the output of the impulse responses from the different models, it may be interesting to look at the correlations between interest rates and house prices on the one hand, and house prices and private consumption, on the other, to compare the relative sizes of these correlations in the different EMU countries studied. Thus, the below table presenting the respective correlations for each country is merely intended to give a simple overview of the basic relationship between the variables in question before moving onto the impulse response analysis. Since the variables of interest tend to display fairly similar trends over time, the correlations presented below have been calculated on the first differences of the variables, as otherwise the resulting correlations become unreasonably high.

Table 5.1 Correlation coefficients between key variables

	Correlation between interest rate & house prices	Correlation between house prices & private consumption
Finland	-0,363	0,170
Germany	-0,160	0,076
Italy	-0,112	-0,021
The Netherlands	-0,097	0,579
Spain	-0,058	0,304

As expected, all five EMU countries display a negative relationship between the reference interest rate and house prices, which accords with economic theory (see chapter 2). The magnitude of this correlation, however, is much larger in Finland, -0, 363, compared to only -0, 058 and -0, 0907 in Spain and the Netherlands, respectively. Germany and Italy rank somewhere in the middle with correlation coefficients of -0, 160 and -0, 112, respectively.

As for the correlations between house prices and private consumption, two observations in particular deserve some attention. First of all, the Netherlands stands out with a coefficient that is markedly higher than the rest. Its correlation coefficient of 0, 579, is nearly the double of that of Spain, which is the second highest in the group (0, 304). Secondly, the negative correlation coefficient of Italy (-0, 021) strikes as somewhat puzzling, since theory suggests a positive relationship between these variables. While there may be many plausible explanations behind this result, such as e.g. the relatively underdeveloped Italian credit market and the lack of home equity release products, it is hard to conclude anything based only on the correlation coefficient as it says nothing about causal relationships or about the presence of other variables which may have effects on both house prices and consumption. Thus, it should only be noted that the coefficient of Italy based on this sample is quite close to zero and provides little evidence of a correlation between house prices and consumption. The weak link between house prices and private consumption in Italy has been noted also in previous research (e.g. Calza *et al.*, 2007).

5.2 Results from the Impulse Response Analysis

Below follows a presentation of the results from the impulse responses of all the models presented in table 2, chapter 4. The impulse responses cover a time horizon of 20 quarters. The lag order in each model has been chosen on the basis of the AIC and SBC criteria. In model 2a)-b), however, where a smaller sample size is used since only the data from the pre-crisis period is used, a limit has been drawn to include no more than two lags even in a couple of cases where autocorrelation LM tests indicated that two lags did not suffice to exclude the presence of auto-correlated error terms. The reason for restricting the number of lags to maximum two is that adding more lags would have caused too large a loss of degrees of freedom considering the relatively small sample size. Since the inclusion of more than two lags did not change the qualitative results on the whole, it made sense to prioritize the objective of preventing a further loss of degrees of freedom.

1 a) Effects of interest rate shocks on house prices

The results from running the baseline model including the monetary policy rate, real house prices, real GDP and the price level (all in logs) are presented below. The diagrams display the impulse responses of real house prices to a shock in the policy interest rate. The confidence intervals (dotted lines) have been computed using a 1000 Monte Carlo simulations rather than the asymptotic distribution, since the samples only range from 63-64 observations, depending on the country.

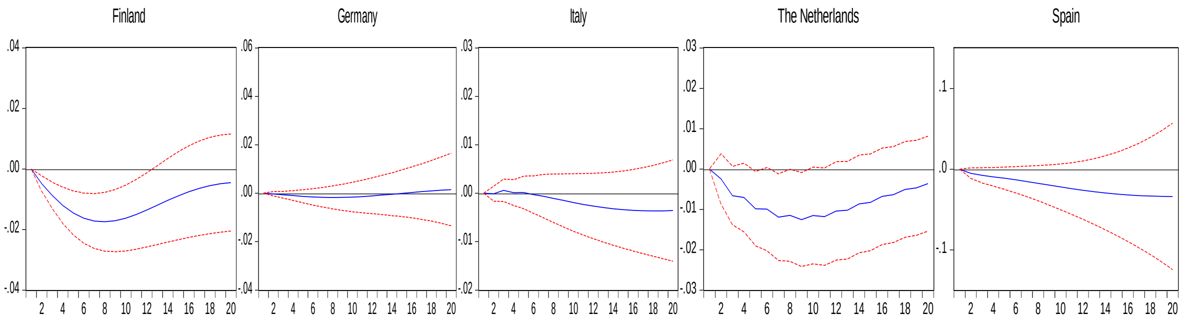


Fig. 1 IRFs of house prices to a monetary policy rate shock

As can be seen, Finnish house prices display a fairly strong response to an interest rate shock, with a fall that starts around two quarters after the shock and reaches its maximum (approximately -0,02) after about seven quarters. Following the eighth quarter, house prices begin to return to their pre-shock levels. Both Germany and Italy, on the other hand, display quite small responses to interest rate shocks. German house prices fall minimally, with only -0,002 units around the fifth quarter subsequent to the shock, and begin to converge towards zero again after ten quarters. In Italy, there is initially a small, positive reaction of around 0,001, which only converts into a negative house price reaction after about seven quarters. However, the negative reaction that follows after the ninth quarter is also minimal, only -0,004. The weak reaction of German and Italian house prices accords with their mortgage markets characteristics discussed in section 2.4.

In the Netherlands, the house price reaction to an interest rate shock is stronger than in Italy and Germany. It reaches its maximum of -0,013 after about nine quarters following the shock, and after ten quarters house prices begin to return slowly to previous levels. Among the five countries studied here, the strongest response to the interest rate shock is found in the Spanish housing market. Spanish house prices fall continually in response to the shock and after 17 quarters they reach -0, 03. Interestingly, they do not display any return to their pre-shock levels within the 20-quarter period showed in the impulse response output. However, it is important to note that while this is the strongest response observed, it is not statistically significant.

The negative reaction of house prices to a monetary policy shock is only statistically significant in Finland and in the Netherlands. Considering the heterogeneities of mortgage- and housing markets discussed in section 2.4, this finding could be related to the fact that Finland and the Netherlands have the most well-developed and liberalized mortgage markets among the countries studied here. They are the only countries in the group that make use of home equity release products, and have the highest (The Netherlands) and the third highest (Finland) loan-to-value ratios of 80- and 70%, respectively.

Another interesting finding that deserves some attention is the fact that the Netherlands display a significant response of house prices in spite of having a mainly fixed interest rate structure. While not wishing to attribute too much importance to any single mortgage market indicator, this aspect is interesting from the point of view that variable- and fixed rates both depend on the expectations of future short term rates as discussed briefly in section 2.3.

1b) Effects of interest rate shocks on consumption (2 SVARs: with/without RHP)

The diagrams below illustrate the reaction path of real consumption in response to a policy interest rate shock in the two different SVARs. The solid lines illustrate the response of consumption to a monetary policy shock in the SVAR model where house prices are included, and thus allowed to be affected by the shock and to affect consumption patterns. The dotted lines, on the other hand, illustrate the reaction path of consumption in response to an interest rate shock in the absence of house prices. As previously mentioned, the difference between the impulse responses in the two different versions of the model –including and excluding RHP, respectively- can be interpreted as a measure of the size of the contribution of house prices in the monetary transmission mechanism.

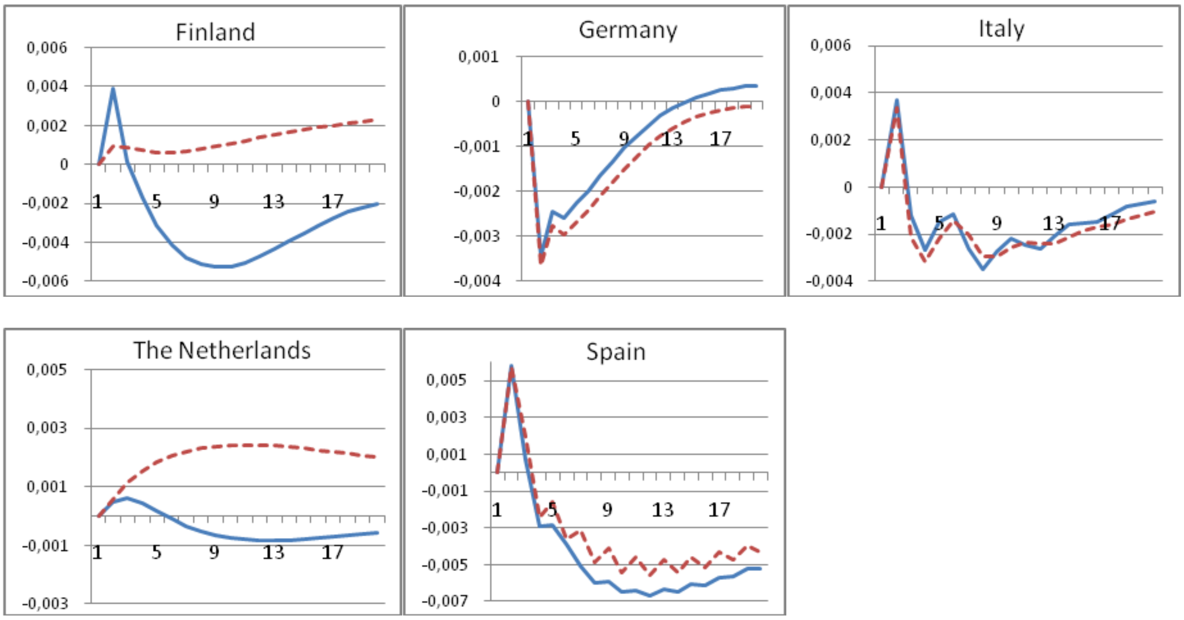


Fig. 2 Impulse responses of consumption to a shock in the policy interest rate.

Following the example of Giuliodori, the confidence intervals of each response are not reported in the diagrams above, as it would be confusing with too many series and hard to distinguish between the intervals. However, it should be mentioned that the drop in consumption following a monetary policy shock was insignificant in both scenarios –with and without RHP- in Germany and the Netherlands, while equally significant in both cases for Italy. In Finland and Spain, the drop in consumption was significant only in the model where house prices were included.

The reaction path of consumption in the absence of house price effects (dotted lines) differs between the countries both in terms of how large its deviation is from the baseline scenario as well as how prolonged this deviation is. In Finland, the Netherlands and in Spain, the impulse response without RHP diverges from the impulse response of the baseline model for a large part of the 20 quarter period studied. In both Finland and the Netherlands, consumption reacts positively to a monetary tightening in the model excluding RHP, which seems counterintuitive as theory predicts a negative relationship between the interest rate and consumption. In the baseline model, however, the reaction of consumption is negative in all five economies. The impulse response of consumption in the baseline model displays a fairly deep dive in the case of Finland (-0,005) and Spain (-0,007). The maximum difference reached between the two scenarios, i.e. the measure of the house price effect, is ca 0,006 units in Finland, 0,003 in the Netherlands and 0,002 in Spain. The largest difference between the two responses is thus observed in these three economies.

In Germany and Italy, on the other hand, the reaction path of consumption in response to a monetary policy shock does not appear to be influenced by the presence of house prices, as the two impulse responses follow each other closely throughout the entire 20-quarter period. The maximum differences observed are negligible: 0, 0005 in the case of Germany, and 0, 0006 for Italy.

A look at the respective impulse graphs in *Eviews* to see whether or not the impulse response of the model without house prices falls outside the confidence interval of the baseline model (including RHP) could give some sort of indication of whether or not the differences are statistically significant. The results from such a basic check indicate that the differences observed in all five countries are too small to be statistically significant.

Although it is hard to establish any significant house price effect, it is worth noting that there is a divide between the five countries studied: in the Netherlands, Spain, and especially in Finland, the inclusion of house prices alters the response of consumption to a monetary policy shock visibly. As for Germany and Italy, by contrast, there is hardly any sign that house prices would play a role in the transmission mechanism of monetary policy shocks onto consumption.

The overall pattern of the results from the analysis in both 1a) and 1b) accord with the picture that emerged in section 2.4 concerning the heterogeneities in the mortgage and housing markets of the respective countries. Italy and Germany, which have the lowest mortgage debt to GDP ratios in the group and do not make use of home equity release products, are the countries where house prices display the weakest response to an interest rate shock, and where house price changes do not appear to influence consumption patterns. Finland and the Netherlands, on the other hand, both have high mortgage debt to GDP ratios as well as loan-to-value ratios and are also the countries that generate the most visible and durable effect of house prices. Spain could be categorized somewhere in the middle, both with respect to the mortgage market indicators discussed in section 2.4 as well as its results from the impulse response analysis.

1c) Robustness check

Since the robustness check is merely a parenthesis included as diagnostic testing, its results are not presented here, but included as a reference in the appendix. It should be mentioned here, however, that the results showed that the 10-year bond rate responded to a shock in the short-term policy interest rate in all five countries, and since the impulse responses of the other variables all looked more or less the same as in the model without the 10-year bond rate (model 1a), it seems that the ECB policy interest rate manages to pick up the effects working through the long-term interest rate.

2a) Effects of interest rate shocks on house prices: Pre-crisis period

The diagrams below illustrate the impulse responses of house prices to a monetary policy rate shock that were computed using only the observations from the pre-crisis period 1995Q1-2007Q4. Comparing these to the impulse responses in 1a) might reveal something about the role of the business cycle in influencing the strength of the housing channel.

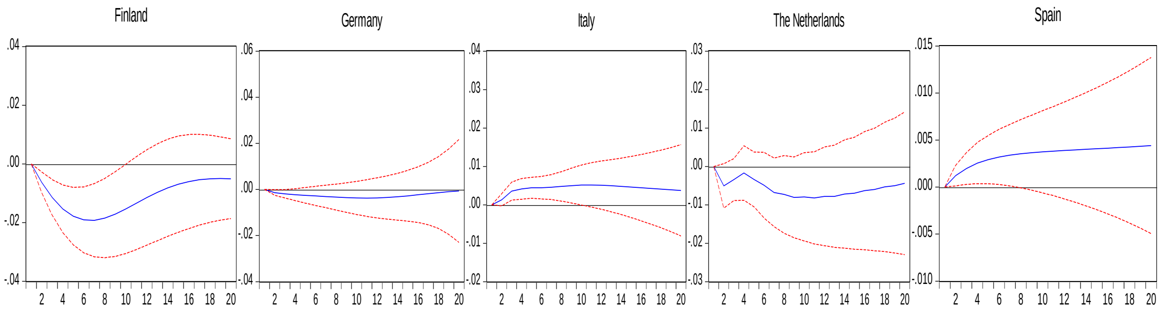


Fig. 3 Impulse responses of house prices to an interest rate shock: Pre-crisis period

While the responses in Finland and Germany from this period are almost identical to the responses estimated on the whole period, the responses of real house prices in Italy, the Netherlands and Spain differ from the ones estimated on the whole period. The reaction path of house prices in the Netherlands looks fairly similar to before, although with the important difference that there is a small hump during the first quarters and that the response no longer is statistically significant.

In both Italy and Spain the impulse responses estimated on this period have become positive (and statistically significant), meaning house prices respond with a rise to a tightening of monetary policy, which seems counterintuitive. However, since the period estimated in this case, 1995-2007, was marked by high economic growth overall and optimism in asset markets for much of the period, it is possible that changes in the interest rate did not do much to curb the upwards trend in house prices. In those cases where there is strong evidence of a house price bubble during this period, such as in Spain, it is possible that the traditionally negative relationship between the policy interest rate and real estate prices is offset as prices were driven by a bubble and not by macroeconomic fundamentals. Thus, it may be that when prices deviate from fundamentals during economic booms it becomes harder to identify a negative link between the policy interest rate and the housing market. During recessions, on the other hand, when credit availability is tight, interest rate sensitivity increases and there is more evidence of a negative relationship between the two. Since markets tend to be characterized by instability and anxiety during recessions, the signaling role of the policy interest could become intensified in such periods.

As mentioned in chapter 2, the process of increasing the housing stock naturally requires some time. This may also explain why a tightening of monetary policy does not necessarily have to lead to a fall in house prices in times when housing demand is strong due to economic growth and optimistic markets, while the housing stock is slow to respond. In such circumstances, one could not exclude the possibility of there being a parallel rise of interest rates and house prices.

2 b) Effects of interest rate shocks on consumption (2 SVARs: with/without RHP): Pre-crisis period

The below diagrams show how consumption responds to an interest rate shock in the baseline model (solid lines) as well as in the model excluding RHP (dotted lines), when the impulse responses are calculated using only the data from before the financial crisis.

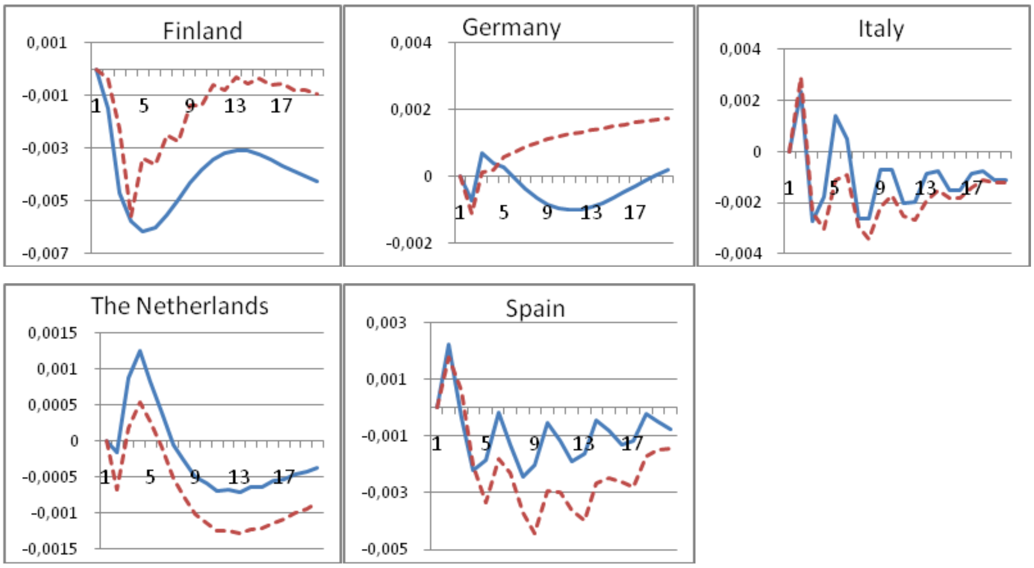


Fig. 4 Impulse responses of consumption to a policy rate shock (2 scenarios): Pre-crisis period

A quick glance at the above diagrams immediately shows that the impulse responses computed using only the pre-crisis observations (1995Q1-2007Q2) look rather different from the impulse responses in 1b), the only exception being Italy. In Italy, the drop in consumption following a monetary tightening is still significant in both models –including and excluding house prices, respectively- and follows more or less the same pattern as in 1b). In Germany and the Netherlands, the drop in consumption is insignificant in both scenarios, as was the case when using data from the whole period. However, the pattern of their impulse responses has changed slightly, as will be discussed below.

In Finland, the drop in consumption is now statistically insignificant in both cases. In Spain, on the other hand, the negative response of consumption is now significant only when excluding the house price variable from the model (dotted lines). When using data from the whole period in 1b), a majority of the countries displayed a stronger drop in consumption levels when house prices were included as opposed to when they were removed from the model. Using data from the period prior to the financial crisis, however, this pattern is reversed. Three out of five countries now display a stronger drop in consumption in the absence of house price effects (while significant only in the case of Spain). This seems a bit odd, as theory suggests that the house price effect –if existent- should have an enhancing role in the propagation of monetary policy shocks onto consumption. However, it should be remembered that, with the exception of Spain, the responses were not significant. In the case of Spain, this could perhaps have something to do with the fact that, the model including house prices only included two lags, which was not enough to remove autocorrelation and normalize the residuals.

The somewhat shaky responses of Italy and Spain in the above diagrams have the appearances of seasonal effects. However, since the data has in fact been seasonally adjusted this is not necessarily the case. Comparing the size of the differences between the solid and the dotted impulse responses -i.e. the estimated house price effect- obtained here with the ones estimated in 1b), the house price effect observed is larger in the estimations based on the whole period for Finland, the Netherlands and Spain. For Germany and Italy, on the other hand, the largest house price effect observed occurs in the above estimations based on pre-crisis data. However, since the differences are not significant neither here nor in 1b), it is hard to make any meaningful comparisons or conclusions based on these results.

It is possible that the sample size used when excluding data from the financial crisis is a bit too small, the sample for each country only includes 49 observations in this part of the study and the estimated model includes 5 variables and 5 equations. The analysis could probably have benefitted from the inclusion of data from other recessions. As can be seen in the results from the LM tests in the appendix, there is still autocorrelation in the error terms for several countries in this section even though the number of lags suggested by the SBC has been used. Most likely, the SBC indication reflects the fact that the gain from introducing more lags to eliminate autocorrelation is offset by the rapid loss of degrees of freedom.

One concern with the model used was that since the house price variable is excluded in one version of the model, this could cause omitted variable bias if house prices are highly correlated with one of the other variables in the model. As the correlations in table 5.1 show, however, this does not necessarily have to be a problem, since the correlations are not that high. Apart from the house price variable, however, there are other variables that could possibly be included when studying the effects of monetary policy. Examples of such variables include the exchange rate, as it would be reasonable to believe that it is included in the analysis when the monetary authorities design their policy. However, when adding more variables this also adds to the problem of simultaneity and the difficulties in obtaining a recursive order that is realistic, as the exchange rate could e.g. not be considered to react with a lag. For this reason, it is assumed to be exogenous in the model.

6 Conclusion

The analysis of the effects of monetary policy shocks on house prices in five EMU economies by means of SVARs and impulse responses revealed that there are heterogeneities in the interest rate sensitivity of house prices in the different countries. These heterogeneities can be linked to country-specific mortgage and housing market characteristics, where countries like Finland and the Netherlands that make use of home equity release products and have high loan-to-value ratios display a significant negative response of house prices to a monetary tightening, while countries like Germany and Italy with less developed mortgage markets only display small, insignificant responses. This suggests that as mortgage markets are increasingly liberalized, the role of real estate prices in the monetary transmission mechanism is not diminishing, and should be studied further. Moreover, it suggests that research could benefit from the use of more individual country data as a complement to the panel data studies done so far.

As for the role of house prices in enhancing the response of consumption to a monetary policy shock, there is no statistically significant difference between the impulse responses of consumption when excluding or including house prices in the sense that the impulse response in the model without house prices did not fall outside the confidence interval of the impulse response incorporating house prices. However, when using data from the whole period 1995Q1-2010Q4, there was a both visible and durable difference between the two impulse responses for Finland, the Netherlands and Spain. There was also a difference in the sense that the drop in consumption in Finland and Spain was only statistically significant when incorporating the house price variable in the model, but not when it was excluded.

Part of the aim of the thesis was also to compare the role of house prices in the monetary transmission mechanism at different stages of the business cycle. As for the sensitivity of house prices to a monetary tightening, there was a stronger response of house prices in Finland, the Netherlands and Spain when using data from the whole period, i.e. including the financial crisis. However, there were no statistically significant differences. In fact, comparing the impulse responses of consumption obtained with data from the whole period to those from the pre-crisis period (1995Q1-2007Q2), the picture that emerges is quite uneven and divergent. Any meaningful comparison between the two time periods is difficult to accomplish since the house price effect is not significant and since the drop in consumption is only significant in some cases. However, the difference in house price sensitivity seen when comparing the results of 1a) with those of 2a) suggests that this area could be further investigated, perhaps using data from a longer period including more recessions.

APPENDIX

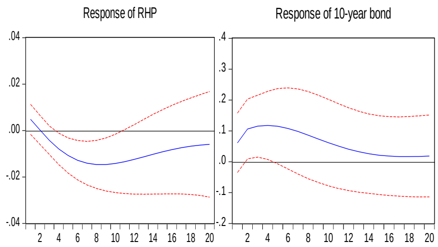
I. House price data

Country:	*Source and definition:*	*Availability:*
Finland	BIS: National Statistical Office: Residential property prices, existing dwellings (urban areas), per sq.m	Quarterly data from 1987
Germany	BIS: Deutsche Bundesbank: Residential property prices, existing dwellings, per sq.m	Annual data from 1995
Italy	BIS: Central bank: Residential property prices, all dwellings, per sq.m	Semi-annual data from 1990
Netherlands	NVM: Transaction prices existing houses, 'pure' quarterly prices	Quarterly data from 1990
Spain	BIS: National Statistical Office: Residential property prices, existing dwellings, per sq.m	Annual data from 1995Q1

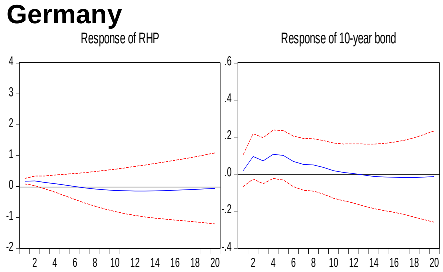
II. Results from robustness check, model 1 c)

The impulse responses below refer to the reaction of RHP and the 10-year bond rate, respectively, in response to a monetary policy shock. The model tested is X= [P, GDP, 10_bond, RHP, R].

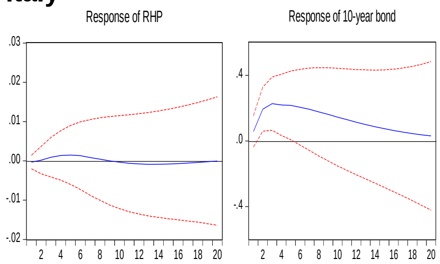
Finland



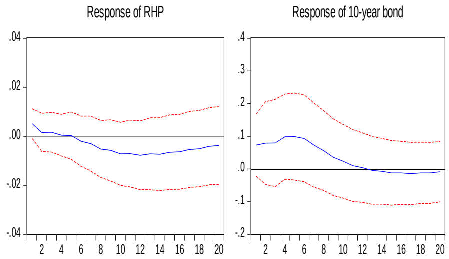
Germany



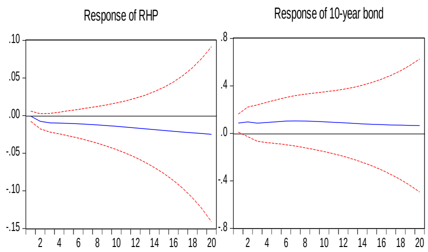
Italy



The Netherlands



Spain



III. Diagnostics for Lag Selection

Model	Country	Number of lags	SBC	Lag order	Number of lags	LM-stat
1a)	Finland	1 2	-14.08357 -13.62403	AR (1)	1	13,31
	Germany	1 2 3	-23,27460 -23,41887 -22,57319	AR (2)	1 2 3	15,16 6,92 13,29
	Italy	1 2 3	-16,21653 -17,08325 -16,87242	AR (2)	1 2 3	31.23** 88.02*** 12.04
	The Netherlands	1 2 3	-14.97354 -15.28703 -15.06136	AR (2)	1 2 3	19,56 39,28*** 19,74
	Spain	1 2 3	-14.97354 -15.28703 -15.06136	AR (2)	1 2 3	34,10*** 32, 21*** 30,66**
1b)	Finland	1 2 3	-19.51952 -19.36306 -18.52074	AR (1)	1 2 3	44,95*** 50,00*** 42,80**
	Germany	1 2 3	-27,18902 -26,95742 -25,82988	AR (1)	1 2 3	75,28*** 53,14*** 39,63**
	Italy	1 2 3	-25.60598 -26.68630 -26.29861	AR (2)	1 2 3	53.04*** 49,83*** 17,40
	The Netherlands	1 2	-21.44883 -21.30127	AR (1)	1	35,06* 10,15
	Spain	1 2 3	-19.17968 -19.77066 -20.11187	AR (3)	1 2 3	94,86*** 53,95*** 37,80*
2a)	Finland	1 2	-14.47377 -13.81359	AR (1)	1 2	16,66
	Germany	1 2 3	-23,66060 -23,91254 -23,07323	AR (2)	1 2 3	18,54 12,15 18,39
	Italy	1 2 3	-21,37235 -21,58282 -21,16285	AR (2)	1 2 3	30,08** 25,55* 19,99
	The Netherlands	1 2 3	-15.59536 -16.06180 -15.27099	AR (2)	1 2	16,53 10,73
	Spain	1 2 3	-17.14654 -17.31635 -17.63755	AR (2)[b]	1 2 3	49,95*** 52,13*** 21,59
2b)	Finland	1 2	-19.74573 -19.53524	AR (1)	1 2 3	50,76*** 48,22*** 29,62
	Germany	1 2 3	27,56606 27,17255 27,19565	AR (1)	1 2 3	61,51*** 49,14*** 22,92
	Italy	1 2 3	-26,35078 -26,90986 -26,29444	AR (2)	1 2 3	43,26** 43,70** 33,77
	The Netherlands	1 2 3	-22,15203 -22,26425 -21,13709	AR (2)	1 2	27,01 33,65
	Spain	1 2 3	-22,91708 -25,16825 -25,43171	AR (2)[b]	1 2 3	64,19*** 38,14** 14,00

[b] According to the SBC value as well as the LM-stat, Spain should have 3 lags to ensure there is no autocorrelation in this model. However, as discussed in the paper, in order not to lose too many degrees of freedoms in the already small sample, only 2 lags are used. *, ** and *** refer to the significance levels on which the null hypothesis has been rejected: 10, 5 and 1%, respectively.

IV. Residual normality test

Model	Country	Skewness	Kurtosis	J-B Statistic
1 a)	Finland	8,12*	74,04***	82,17***
	Germany	6,73	31,40***	38,12***
	Italy	14,82***	13,07**	27,90***
	The Netherlands	4,62	48,41***	53,03***
	Spain	5,57	73,40***	78,97***
1 b)	Finland	9,56*	66,76***	76,33***
	Germany	6,86	30,80***	37,66***
	Italy	10,26*	6,62	16,88*
	The Netherlands	5,66	37,37***	43,03***
	Spain	9,85*	27,13***	36,99***
1 b) Excluding RHP	Finland	7,01	22,30***	29,31***
	Germany	14,63	43,68***	58,31***
	Italy	11,54**	6,43	17,98**
	The Netherlands	7,11	23,27***	30,38***
	Spain	9,83**	180,10***	189,83***
2 a)	Finland	18,21***	93,20***	111,42***
	Germany	3,01*	25,43***	28,45***
	Italy	14,02***	1,031**	25,05***
	The Netherlands	3,32*	50,68***	54,00***
	Spain	7,38	28,05***	35,42***
2 b)	Finland	4,78	64,60***	69,38***
	Germany	8,05	31,78***	39,84***
	Italy	12,27**	10,24*	22,51**
	The Netherlands	13,69**	82,05***	95,75***
	Spain	5,55	20,83***	26,39***
2 b) Excluding RHP	Finland	6,68	22,71***	29,37***
	Germany	28,65***	64,45***	93,08***
	Italy	11,58**	12,60**	24,18***
	The Netherlands	9,67**	49,01***	58,68***
	Spain	4,7	3,2	7,92

*, ** and *** refer to the significance levels on which the null hypothesis has been rejected: 10, 5 and 1%, respectively.

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