
LUND UNIVERSITY
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# The Swedish mortgage structure

*- A time series analysis of mortgage rates in eight European countries 1999-2011*

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# Abstract

This study investigates the relationship between mortgage rates and other interest rates such as the repo rate and the long-term rate and whether this relationship has changed due to the financial crisis in 2008. This is done through time series estimation for eight European countries (Spain, Finland, France, Germany, Ireland, Italy, Sweden and United Kingdom) over the period 1999-2011 using quarterly data. The analysis focus on Sweden but provides a comparative perspective of the remaining countries. The generalized results reveals that mortgage rates tend to predominantly follow repo rate, which could indicate that the criticism of banks regarding high mortgage margins is unjustified. The most remarkable result however is that the crisis seems not to have affect this relationship significantly, where the only structural break was found in Ireland in 2003. Latest numbers show that mortgage rates are undergoing a downward trend as a result of increased competition in the bank sector. In light of this, policy actions should be addressed to increase the competition even further by for instance the state owned bank SBAB.

Keywords: *mortgage rate, monetary policy, mortgage margins, time series*

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# 1 Introduction

In recent years, an active debate about banks' mortgage conditions has taken place in Sweden. Buying a home is usually the largest investment an individual household makes and hence a subject that concerns many people. Since households' disposable income is affected by different lending rates, high lending rates tend to reduce the overall demand in the economy. A rising mortgage rate, ceteris paribus, will lead to less consumption capacity, lower GDP growth and reduced growth on the labor market. In addition, investments in housing and business will decrease (Riksbanken 2012: 56).

As a result of the financial crisis 2008/2009 and the subsequent debt crisis in Europe, the GDP growth in Sweden has been low. The Swedish central bank (Riksbanken) has sought to stimulate real economic growth by lowering policy rates to historically low levels (Johansson 2013). Despite this, many people argue that mortgage rates have not followed the repo rate[1] but continued to remain at a relatively high level. One that is critical of how the banks have acted in the matter of mortgage rates is the Swedish Finance Minister Anders Borg. He said that it is provocative that the banks are making billions of profits in spite of the crisis. The banks sustain their profitability by charging high interest margins on mortgages at a time when the economy would benefit from a decrease in interest margins. Moreover, Anders Borg argues that there are data suggesting that the Swedish banks have one of the highest interest margins in Europe when it comes to mortgages. This is on the other hand due to partly high bank concentration and partly the fact that the central bank, the Government and the National Debt Office (Riksgälden) has implemented a series of actions to stabilize the financial system in Sweden (Almgren & Neurath 2012).

A survey conducted by the German Deutsche Bank has shown the contrary, namely that the Swedish banks have had lower mortgage margins than their European counterparts. According to the study, only three of 36 European banks had lower interest margins on their mortgages than the four major banks in Sweden in 2011. Nevertheless Anders Borg believes that there are good

[1] The repo rate has been the Riksbank's policy rate since 1994 and it is the rate of interest at which banks can borrow or deposit funds at the Riksbank for a period of seven days.

arguments for Swedish banks to lower their mortgage rates even further; lowered repo rate and decreased funding costs should be reflected in the mortgage rates (Aronsson & Nilsson 2012).

One person who disagrees with the Finance Minister is the Governor of Swedish Riksbank Stefan Ingves. In a hearing in the Parliament, Stefan Ingves downplayed the link between repo rate and mortgage rates. He argued that the monetary policy is not designed to handle the short-term mortgage rate, although the discussion has sometimes indicated the opposite (Öjemar 2012). In line with this statement, the banks state further that the monetary policy's primary mission is to reach the inflation target; how the mortgage rate is related to the repo rate is only one of many factors that come into play when trying to reach that goal (Riksbanken 2012).

Given this controversial question whether there exist a relationship between mortgage rates and policy rates, only a few studies have been conducted in this area, especially in Sweden. Stefan Ingves has in the context of raised repo rate referred to runaway housing prices and higher mortgage rates, but when it comes to lowered repo rate he rather downplays the link (Öjemar 2012). Since this subject is an ongoing debate and a highly relevant issue for large parts of the population, the aim of this study is to analyze the relationship between mortgage rates and other interest rates such as the repo rate (which represents the short-term interest rate in this study) and the long-term interest rate. If a relationship between mortgage rates and repo rate can be established, this may indicate that the criticism of banks is unjustified. However, if the contrary is proved, it may be the case that banks are charging high margins in order to make profits. The analysis will contain an empirical investigation on the relationship between these different interest rates in Sweden and whether this relationship may have changed over time, due to the crisis. For comparison and to examine if there is a similar pattern in other countries, seven additional EU-countries (Spain, Finland, France, Germany, Ireland, Italy and United Kingdom) are included in the study. In light of this, the overall question is: *Are mortgage rates linked to short- or long-term interest rates and did this relationship change during the financial crisis in 2008?*

In order to answer this question, we aimed to use a panel data model on all eight countries. After conducting some tests it was found that time series estimation for each country was preferable to our data set. The difference between a panel data model and a time series model is that the latter one will instead contribute to a comparative perspective between Sweden and the remaining countries. Since we want to focus on Sweden, a time series model is to be preferred in our study.

Furthermore, our study contains some limitations, mainly because of lack of variables, as will be discussed more in section 4.2.

The study is divided into five sections. Section 2 and 3 will address background and theory and give a brief presentation of previous relevant research. In section 4 the empirical analysis is presented with the models, the data and the results obtained from the study. These results will then be commented in a following discussion in section 5, which also includes suggestions on policy actions. In section 6 we summarize the main conclusions.

# 2 Background

The Swedish household's debt in relation to disposable income has been increasing for nearly a quarter century. Since the end of 1990s this debt-to-income ratio (DTI) has increased from around 100 percent to 165 percent in 2012. This is primarily due to mortgage debt, which has been driven by generous lending by banks and other financial institutions. In recent years the growth in lending has slowed down and as a result, household DTI has been stabilized at this level. This means that, on average, debts are now increasing at the same rate as disposable income. Despite that, a comparison with other European countries shows that Sweden is ranked high on the list over highest debt-to-income ratio. Denmark for example, is ranked as number one where debt is nearly 270 percent of disposable income in 2011. By contrast, Finland's household debt is lower than Sweden's but shows a similar debt-to-income trajectory in the last decade with significantly increased liabilities. The only country in Europe that goes against the grain is Germany where debt ratio fell from 107 percent in 2000 to 86 percent in 2011 (SCB 2013: 12).

One of the main causes to Sweden's high DTI is the growth in borrowing as a result of home purchases. During the past decade household mortgage debt in nominal terms has tripled. In December 2011 the Swedish household debt to monetary financial institutes had reached a level at 2,649 billion SEK, of which more than 80 percent was housing loans. According to a study presented by the Swedish National Board of Housing, Building and Planning (Boverket), mortgages in Sweden amounts to about 60 percent of GDP. Despite that, Sweden is far from the highest percentage where both Denmark and the Netherlands have mortgage debt over 100 percent of GDP (SCB 2012: 8). In the case of Sweden, there was a boom in housing prices during the late 1990s and the early 2000s. Household mortgages showed very high growth rates but have had a declining trend since late 2005, with the exception for condominiums that are still rising, mainly in metropolitan areas due to migration and decline in new construction of residential flats (SCB 2013: 13). During a short period in late 2009, interest rates were at a record low and mortgage growth rates rebounded temporarily but then continued to wane in

early 2010[2]. One explanation could be the mortgage cap, introduced by the Swedish Financial Supervisory Authority (Finansinspektionen) in October 2010, which stated that mortgages should not exceed 85 percent of the property value. This in combination with the uncertain state of the global economy has played an important role in the demand for loans. Over the past two years, loan growth fell from over 10 percent to almost 5 percent annually (SCB 2012: 8).

The Swedish central bank attaches great importance to the development of household debt and warns of the risks that this entails. The same applies for high lending rates, which tend to reduce the overall demand in the economy. Due to the financial crisis in 2008/2009, central banks (particularly in Europe and the U.S.) drove down their policy rates to historically low levels in order to stimulate real economic growth. In Sweden, the repo rate was down to 0.25 percent during the second half of 2009 and first half of 2010. Even short-term mortgage rates[3] followed and bottomed out around 1.40 percent. A combination of stable housing prices and attractive savings via short-term mortgage rates as they trended down increased the demand for these mortgages. During this time, the share of mortgages with short-term interest rates was over 60 percent. A year later when interest rates rose, the share had decreased to around 50 percent. From a historical perspective this is still very high and in the mid-1990s, less than a tenth of the mortgage portfolio was of loans with short-term interest rates. This is an important development for policy makers since the greater proportion of loans with short-term interest rates, the greater and faster effects will the central banks monetary policies give.

However, in recent years the gap between short-term mortgage rate and repo rate has increased significantly. Only between December 2006 and December 2011 the interest rate differentials increased from 0.70 to 2.60 percentages (SCB 2012: 8). To some extent this increased gap can be explained by higher funding costs for the bank due to the crisis, but as lending rates are determined not only by the banks' borrowing costs, it is clear that the margins on mortgages have increased. A study by Finansinspektionen showed that spreads between funding costs and lending rates have increased steadily since the beginning of 2009. On the contrary, it is the gap between repo rate and interbank rate[4] that has decreased, which could indicate that the turmoil on the financial markets is reduced. Banks are requiring smaller risk premium to lend money to each other than before. Also yield on covered bonds, which form the bulk of the banks'

[2] See Figure 2a for Sweden.
[3] Short-term mortgage rates are tied to three months.
[4] The interbank rate is a daily reference rate based on the interest rates for unsecured loans that are offered by banks to other banks.

financing of mortgages, have decreased in the same rate as interbank rates. Since the Swedish central bank attaches great importance to the household debt, the central bank has tried to keep up interest rates in an effort to reduce demand for loans and thus the loan burden. It is therefore likely that interest rates would have been even lower if a majority of the executive board did not focus on this dimension (SCB 2013: 13).

As a consequence of the crisis, central banks lowered their policy rates in order to stimulate the economy. Both short- and long-term interest rates fell which eventually had an impact on mortgage rates. This indicates a relationship as has been found in several studies. One study presented by Ellingsen and Söderström (1999) have investigated the relationship between monetary policy and the term structure of interest rates, namely how changes in the repo rate will affect long-term rates. It is empirically well established that monetary policy affects both short- and long-term rates and that this relationship is on average positive; an increase in the central bank rate leads to an increase in interest rates of all maturities. However, Ellingsen and Söderström showed that the central bank's intentions behind the changes might influence the direction in which the long-term rate will be developed, i.e. this relationship might not always be positive. According to them, there are two underlying reasons for changes in monetary policy, either endogenous or exogenous. In the first case, the monetary authorities respond to new knowledge about the economy and in the second case, they changed their policy preferences. An endogenous policy action will move interest rates of all maturities in the same direction as the policy innovation while exogenous policy actions move the short- and long-term interest rates in opposite directions. Thus, if the short interest rate is increased and bond traders are confident that there has been no unanticipated change in the fundamentals, then they will typically infer that price stabilization has moved higher on the central bank's agenda. In this case, long interest rates will move in the opposite direction because average inflation is reduced. So, changes in monetary policy can thus affect the long-term rate in both a positive and negative direction depending on the expectations of the market (Ellingsen & Söderström 1999: 1-2).

Other studies of Sa-Aadu, Shilling and Wang (2000) and Marathe and Shawky (2003) investigated the relationship between different types of mortgage rates and interest rates with different maturities for the United States. The overall conclusion is that the mortgage rate and the long rate are positively correlated. Sa-Aadu et al. used time series data between 1965 and 1998 on commercial mortgage yields and yields on comparable-maturity Treasury securities to identify a long run cointegrated relationship for the yield on commercial mortgages. Their results

suggest a cointegrated relationship between the commercial mortgage rate and the long-term interest rate (10-year Treasury rate). However, this cointegrated relationship was far less than that found between the yield on residential mortgage and comparable-maturity Treasury. Indeed, there was a one-to-one relationship between changes in residential mortgage rates and changes in Treasury yields (Sa-Aadu, Shilling & Wang 2000). Marathe and Shawky showed a similar result in their study. From 1989 to 1996 both mortgage rates as measured by the GNMA rates and the conventional mortgage rates were highly correlated with long-term interest rates. Yet, changes in the short-term rates had little or no effect on mortgage rates. The results did also imply that mortgage rates adjust to changes in bond rates within a one-month period (Marathe & Shawky 2003).

There have also been studies on the UK housing market where the aim was to investigate the contribution of the housing market to macroeconomic volatility and the implications of changing the structure of mortgage finance. The author found a close relationship historically between changes in average mortgage rates and short-term interest rates. However, the differential between mortgage and short rates is not constant – the "margins" tends to narrow when short rates are very high (e.g. 1999-2000) and widen when short rates fall sharply (e.g. 2001). Furtermore, the cycles in long-term interest rates have been much more muted than those in either short rates or average mortgages rates, although all three have been on a similar downward trend over the last 20 years (Cooper 2004: 10, 12). The current system in UK is an adjustable rate system and hence linked to short-term interest rates. Changes in interest rates will affect the economy to a much greater degree than it would under a system linked to long-term interest rates. The main findings in the study were that the housing market has been a contributor to past volatility in the UK economy. Moving to a long-term rate structure would therefore reduce the impact of a change in interest rates on key macroeconomic indicators (Cooper 2004: 16, 18).

# 3 Theory

The underlying theory this study builds on is that interest rates can be distinguished in two aspects, maturity and risk. This is presented in the expectation hypothesis[5] whereby the long-term interest rate should be the average of expected short-term rates plus the risk premium. Since mortgages tend to have a very long maturity (about 40 years in Sweden), they also tend to have a higher risk and therefore higher interest rates than other loans. Earlier studies by for example Sa-Aadu, Shilling and Wang (2000) and Marathe and Shawky (2003) have shown that there is a positive correlation between mortgage rates and long-term interest rates. In addition, Ellingsen & Söderström (1999) have shown that the long-term interest rate is affected by changes in the repo rate, which is in line with the expectation theory. In the following sections, factors that affect mortgage rates will be discussed and the variables used in this study will be presented.

## 3.1 Mortgage rate

There are several factors that affect mortgage rates but, as mentioned above, it is mainly maturity and risk. Since mortgages have very long maturities and hence higher risk, interest rates on mortgages tend to be higher than on other loans. Further, short-term mortgage rates will to a larger extent be affected by the repo rate than the long term; however, in accordance to the expectation theory, changes in repo rate will eventually affect long-term rates. How much of the original change in repo rate that is affecting mortgage rates will fluctuate over time depending on the economic cycle. This means that there is just a part of the mortgage rate that depends on the state of the repo rate; the rest will depend on a margin (in which the risk is included) (Riksbanken 2012: 52-53).

To calculate the exact cost of a mortgage is complicated and usually requires information about each individual bank. For example, the margin cover costs incurred by the bank in connection

[5] See section 3.3.

with the mortgage such as administrative costs, costs to keeping a reserve of liquidity assets and costs of expected credit losses (Riksbanken 2012: 52-54). The reserve of liquidity assets ensures that banks continually fund its mortgage portfolio and thus avoids the risk of bankruptcy, especially in times of financial stress. Costs of expected credit losses on the other hand, takes into account that some mortgage borrowers cannot fully pay interest and amortization on their mortgages. The risk is affected not only by the customer's ability to pay but also by price trends in the property market. So when a bank grants a mortgage it must always take into account expected future credit losses (Finansinspektionen 2012: 22, 24-25).

Several studies have indicated that the gap between repo rate and short-term mortgage rates has been increasing over the past years. In other words, the margins on mortgages have increased. This trend is partly due to the financial crisis and increased financing costs. Although, those factors that depend on the crisis are not likely to persist as the market stabilizes in the future, but it is unlikely that risk premiums will return to the low levels before the financial crisis since pricing of credit and liquidity risks was too low. For example, pre 2008 banks paid very little over the interbank rate to convert interest rates of long-term loans to short term. This reflected the risk that a bank would go bankrupt was considered to be negligible. Today, risk awareness is greater and it is therefore unlikely that risk premiums will return to the low levels that prevailed before the crisis broke out. The crisis has also led to decreased banking competition and hence increased margins. In connection with the Basel III regulation, banks must hold more capital and liquid assets, which in the short term may have contributed to higher financing costs. On the other hand, the increased regulation should in the long term lead to economic gains in the form of more stable financial markets with progressively lower risk premiums and lower return for the banking sector as a whole. The difference between short-term mortgage rate and the repo rate is therefore likely to remain at an elevated level for a time and then decrease slightly (Riksbanken 2012: 54-55).

In conclusion, it is mainly variables such as repo rate, long-term interest rate, economic cycle, funding costs, bank competition and a margin that determines mortgage rates. It would therefore be optimal to include all those variables in our model but the problem is that some of them require information from each individual bank and some of them (e.g. the Herfindahl index[6]) were not available. Our model will hence be limited to only include explanatory variables as

[6] Herfindahl index is an indicator of the amount of competition among industries.

repo rate, long-term interest rate and GDP-gap. Those will be presented in the following sections.

## 3.2 Repo rate

The repo rate is the Swedish central bank's policy rate. Since banks can borrow or deposit money over night at the central bank, the overnight rate i.e. the interest rate is always in control of the central bank. By controlling this rate, the central bank also controls the economic activity in the country since it influences other short-term rates on the market. For example, a higher interest rate, ceteris paribus, tends to result in a lower level of activity and thus lower inflation and vice versa. There are several instruments that can be used in order to control the overnight rate where repo rate is one of them. As a result of that, repo rate is determined by the economic cycle, i.e. the GDP-gap. In Sweden, the repo rate signals the overnight rate seven days ahead. This means that the deposit rate at the central bank is usually 0.75 percentage points below the repo rate and the lending rate is usually 0.75 percentage points higher (Riksbanken 2011).

The American economist John B. Taylor proposed a rule for how the central bank should adjust short-term interest rate in reaction to observed deviations of inflation and output from their targets:

$$i = r^* + \pi + h(\pi - \pi^*) + b(y - y^*)$$

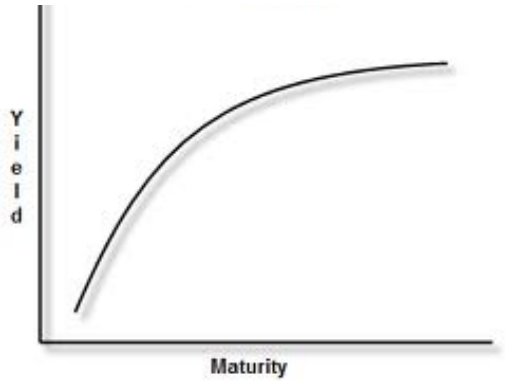
This equation is known as the *Taylor rule* where both $h$ and $b$ are positive. In this equation, $i$ is the target short-term nominal interest rate, $r^*$ is the assumed equilibrium real interest rate, $\pi$ is the rate of inflation, $\pi^*$ is the inflation target and $(y - y^*)$ is the output gap. The parameters $h$ and $b$ are chosen directly by policy makers, depending on their aversion to inflation and output instability. According to Taylor it is important that the value of $h$ is positive so that the real interest rate goes up when inflation increases. If $(1 + h)$ is less than one, a rise in inflation will drive down the real interest rate $(1 - \pi)$, and this in turn will further feed inflation by stimulating aggregate demand for goods, leading to economic instability. Based on macroeconomic experiences in the US, Taylor suggested that the parameter values $h = 0.5$ and $b = 0.5$ would lead to good economic performance (see e.g. Sørensen et al. 2010: 460-461).

There are several studies that have confirmed that the gap between short-term mortgage rates and repo rate has increased significantly. Some experts argue that the monetary policy is not designed to handle the short-term mortgage rate and therefore there is no clear link between them. The repo will only have a direct impact on interest rates with the shortest maturity, i.e. the overnight rate and then eventually spread to mortgage rates by a change in long-term interest rates with higher risk (Riksbanken 2012: 52).

## 3.3 Long-term interest rate

As mentioned before, interest rates can be distinguished in two aspects, maturity and risk. The relationship between interest rate and time to maturity is presented in the yield curve in Figure 1. The slope of the yield curve is the maturity premium, the compensation for risk based on the time to maturity. In other words, interest rate increases with time since the longer time to maturity means higher risk. The theory behind the yield curve assumes that the central bank does not change the short-term rate (Burda & Wyplosz 2009: 341-343).

**Figure 1: Yield curve**




For the market to be in equilibrium, the long-term interest rate shall be the sum of the rates with shorter maturities. This is called the expectation theory. In other words, following relationship needs to be satisfied:

$$i_t^L = \frac{1}{L}\sum_{i=1}^{L} i_{t+i}^e + \Psi_t^L$$

$L$ denotes the maturity, $i^L$ is the long-term interest rate and $i^e_{t+1}$ is the expected short-term interest rate. Since a longer loan means greater uncertainty, a risk premium $\Psi^L_t$ is added to the approximation. The left hand side represents the total return on a long-term loan and the right hand side is the sum of expected return on short-term loans plus the risk premium, where *e* is expectation and *t* is time. When the market is in equilibrium, it is not possible to make arbitrage profits, i.e. lend to a high interest and borrow to a low interest rate (see e.g. Burda & Wyplosz 2009: 341-343).

Based on the yield curve and the expectation theory, mortgages that tend to have very long maturities are associated with high risk. Therefore, interest rates on mortgages are in general higher than on other loans. As the long-term interest rate shall be the sum of the rates with shorter maturities plus a risk factor, this could explain the correlation between mortgage rates and long-term rates rather than the repo rate.

## 3.4 GDP-gap

The GDP-gap is used as an indicator of the economic cycle in a country. It allows for a comparison of the economic cycle both over time and between countries. The formula is given below, where the numerator is representing the economic cycle (see e.g. Fregert & Jonung 2005).

$$GDP_{GAP} = \frac{GDP_{ACTUAL} - GDP_{POTENTIAL}}{GDP_{POTENTIAL}}$$

If the GDP is above potential, then resource utilization is high and vice versa. The difference between a country's actual GDP and potential GDP is the GDP-gap. At a normal resource utilization level, GDP is equal to potential GDP and the output gap is zero. One way to calculate the trend rate of GDP is to use a Hodrick-Prescott trend (HP-trend). An HP-trend is an intermediate between a linear trend and actual GDP development (Öberg 2011). In order to determine the GDP- trend, $\tau_t$, following minimization-problem has to be solved:

$$\min_{\{\tau_t\}} \sum_{t=1}^{T} (x_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2$$

The first term represents "the goodness of fit" and the second "penalty for roughness". $\lambda$ measures the smoothness of the series and when it goes to infinity, the trend becomes linear (The World Bank 2006). Among economic cycles and quarterly data, $\lambda$ should be equal to 1600 (see e.g. Sørensen et al. 2010: 362).

There are some weaknesses with the HP-method. Firstly, HP-filter tends to give imprecise estimates of the trend at the end-points of a time series. If those values do not reflects values close to the cycle, the HP-method will under- or overestimate the trend value. Secondly, the HP-filter smooths out possible structural breaks in the series (Giorno et al. 1995). In spite of this, it is a frequently used method and provides relative reliable results (Öberg 2011).

As we have seen, the GDP-gap will determine the central banks monetary policy, i.e. the repo rate. For example, when the economy is in a recession, the central bank will sought to stimulate real economic growth by lowering the repo rate. Hence there is a correlation between GDP-gap and repo rate. Despite this, we decided to include both variables in our model since a negative gap will lead to lower house demand, falling house prices and therefore lower demand for mortgages.

# 4 Empirical analysis

The following section contains relevant information for the econometric model. First, a presentation of the model is given. The aim of this study was to use a model built on a panel analysis for eight countries within the European Union. After running some tests, we concluded that the slopes were not equal across countries and we could therefore not use a panel data model. Instead, our new model is built on a time series analysis for the same eight countries. Secondly, information about the data is presented including descriptive statistics. Thirdly, results from the regressions and tests are reported.

## 4.1 Model

The multiple linear regression model is constructed in such way that the mortgage rate is the dependent variable. The explanatory variables are repo rate, long-term interest rate and GDP-gap. According to previous studies in this area, a positive relationship between mortgage rate, repo rate and long-term interest rate should be found. Model 1 is given by:

$$Y_{it} = X_{it}^{'}\beta + \varepsilon_{it}$$

where $X'_{it}$ is a vector containing all the explanatory variables, $i$ represents the country specification and $t$ the time-dimension. Since our time series spans the financial crisis, developments in the housing market may have changed the rate ratio over time. To examine if the relationship between the variables changed during the crisis, the second model is extended with dummy variables with following interpretation:

$$\delta_i = \begin{cases} 1 \text{ if there is a breakpoint} \\ 0 \text{ if not} \end{cases}$$

In the second model, only Ireland is included as a structural break was found. Model 2 is an extended version of Model 1 including dummies:

$$Y_{it} = X_{it}^{'}\beta + \delta_i X_{it}^{'}\gamma + \varepsilon_{it}$$

## 4.2 Data

Data used in this study is mainly collected from Thomson Reuters Datastream, which is a global financial and macroeconomic database. Observations for mortgage rate, real GDP and repo rate are collected from Datastream. The Swedish repo rate is from the Swedish central bank and remaining observations for long-term interest rates are from OECD. More descriptive information about the data is presented in Table 1:

**Table 1: Data description**

| | |
|---|---|
| *Variable:* | Mortgage rate ($MOR_i$) |
| *Description:* | Interest rate on building society mortgages. |
| *Source:* | Datastream |
| *Variable:* | Repo rate ($R_i$) |
| *Description:* | The central banks policy rate whereof the repo rate is the Swedish Riksbank's policy rate. |
| *Source:* | Datastream, Riksbanken (for SWE) |
| *Variable:* | GDP-gap ($GDP_{GAP,i}$) |
| *Description:* | Real GDP ($GDP_{ACTUAL,i}$) per capita (seasonal adjusted), used to calculate $GDP_{GAP,i}$ |
| *Source:* | Datastream |
| *Variable:* | Long-term interest rate ($LONG_i$) |
| *Description:* | Long-term interest rate for government bond yields |
| *Source:* | OECD |

*i=ESP, FIN, FRA, IRL, ITL, SWE, UK.*
*All variables are in percent.*

The analysis is based on quarterly time series data over eight countries within the European Union: Spain (ESP), Finland (FIN), France (FRA), Germany (GER), Ireland (IRL), Italy (ITA), Sweden (SWE) and United Kingdom (UK). Six of them (ESP, FIN, FRA, GER, IRL and ITA) are euro area member states that have adopted the euro as their currency and hence share a single monetary policy. Therefore, we will refer to them as the "eurozone" when discussing monetary policy.

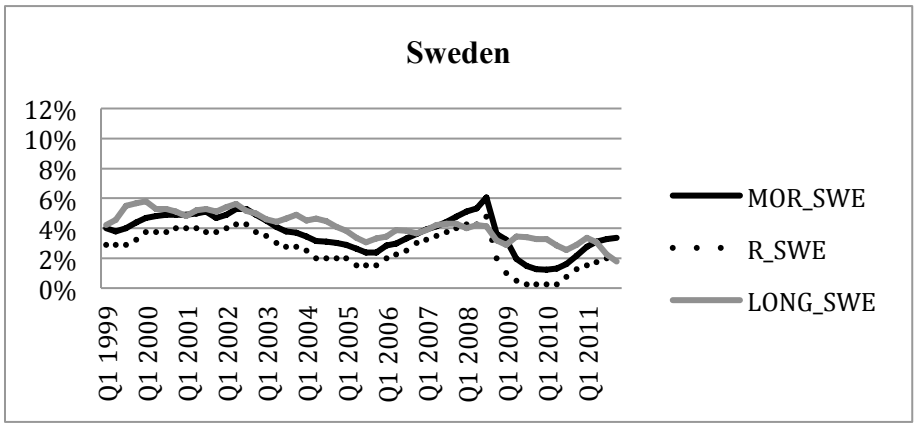
The data covers a period from the first quarter (Q1) of 1999 to the fourth quarter (Q4) in 2011 and contains 52 observations for each country. It is a relatively limited time period, which may affect the robustness of our results. However, the choice of time period is related to the introduction of the euro in 1999 and the limited access to data after 2011. Hence there was a trade-off between fewer countries with longer time periods and more countries with shorter time periods. Since the aim with this study was to investigate whether there exist a common pattern

between mortgage rates and other interest rates in Europe, the alternative with more countries and shorter time periods was preferable.

When estimating a model with more than one explanatory variable, there is a risk that these depend on each other in a systematic way. The problem with a linear relationship among the explanatory variables is called multicollinearity. Multicollinearity problems will lead to unreliable regression estimates since the parameters in which we are interested are estimated highly inaccurately. In other words, our sample does not provide sufficient information about these parameters (see e.g. Verbeek 2012: 44, 46). The results are presented in Table 2 in appendix and confirm that no multicollinearity between the explanatory variables was found.

To get an overview of the interest rates in each county, the variables for mortgage rate, repo rate and long-term interest rate was plotted between 1999Q1 to 2011Q4. The chart for Sweden is presented in Figure 2a and the remaining charts are available in Figure 2b-h in appendix. Some common pattern was found, primarily from 2008 due to the financial crisis.

**Figure 2a:**




Based on Figure 2a, we can state that the Swedish mortgage rate has tended to follow repo rate rather than the long-term interest rate. More generally when observing the remaining charts, interest rates were relatively low during 2003/2004-2006. It was a period of both good economic growth and low inflation. The central banks acted in accordance with their goals and hence reduced their policy rates. Yet, the period of low inflation expectations broke in 2005/2006. Central banks started to gradually tighten its monetary policy with increased policy rates. The Swedish central bank raised the repo rate a last time in September 2008. A couple of days later the financial crisis broke out and central banks started to cut interest rates sharply in late 2008

and early 2009. In 2010, interest rates started to rise again. Notable is that in the eurozone, policy rates are determined by the European Central Bank (ECB) on the basis of development of the entire EMU-area (Boverket 2010: 16).

An important component when comparing mortgage rates between countries is that each country offers different mortgage products. The design of mortgage loans differs in terms of for example maximum term, prepayment penalties[7] and the share of short-term versus long-term mortgage rates. The ECB states that the most common maturity for the eurozone is ranged between 20 to 30 years in 2007. Spain, France and Finland on the other hand are offering maturity products up to 60 years. After the financial crisis in Europe, the overall maximum term has shortened, e.g. in France and Spain (Lea 2010). Prepayment penalties exist in most countries except for France, Germany and Italy where the existence is confined. That confinement includes additional costs for the bank and will result in higher mortgage rates for all customers. This can explain the high level of mortgage rates in those countries (Leonhard 2012).

Furthermore, the Finnish, Irish, Spanish, Swedish and British markets are dominated by short-term rates. In France, Germany and Italy it is rather long-term mortgage rates that dominates the market (Statens bostadskreditnämnd 2011: 8).

As can be seen from the descriptive statistics in Table 3 in appendix, interest rates (including mortgage rates) seem to be very volatile. The repo rate in the UK has a relatively higher standard deviation than the eurozone and Sweden, which may indicate that the repo rate is more volatile in UK. All countries have faced a recession in the economy due to negatively minimum values for the GDP-gap. When it comes to mean values, mortgage rates are more similar to long-term interest rates than repo rates.

[7] Prepayment penalty is the amount that the borrower has to pay for early deposit

## 4.3 Results

### 4.3.1 Unit root

To apply a standard estimation or testing procedures in a dynamic time series model it requires that the various variables are stationary, I(0). For example, regressing a nonstationary variable $Y_t$ up on a nonstationary variable $X_t$ may lead to a spurious regression, in which estimators and test statistics are misleading. Yet, there is one important exception, which is when two or more nonstationary variables are cointegrated. If a particular linear combination of these nonstationary variables exist that is stationary, a long-run relationship between these variables exists (see e.g. Verbeek 2012: 338). Since nonstationary variables are common in macroeconomics and finance, three different tests are performed to test for presence of unit roots, I(1). All results from the tests are presented in Table 4 in appendix.

First, Augmented Dickey Fuller Test (ADF) was performed. For the variables mortgage rate, long-term interest rate and repo rate an intercept was included. In the case for GDP-gap, the intercept was not included since the mean of output gap is zero. To summarize the results, it is clear that the GDP-gap is stationary in all countries while the other variables are nonstationary with the exception for mortgage rate in Italy. As ADF has low power against other tests for unit roots, we wanted to run additionally tests to be sure that we did not reject the null hypothesis incorrectly (a type I error). Therefore a second test was conducted, namely the Elliot, Rothenberg and Stock (ERS) test. Likewise the ADF test, ERS does also have the unit root hypothesis. The results from the ERS tests indicate that some of the variables are still nonstationary. Thirdly, a Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests was performed. This test differs from the other two in the sense that KPSS has stationarity as a null hypothesis. Both ERS and KPSS will provide their own critical values instead of p-values, which are presented in Table 4. To conclude, all three tests confirm the presence of unit roots in the series. Since some variables are stationary, testing for cointegration is not possible. In order to get stationary variables, we transformed both Model 1 and Model 2 into first difference. The ADF-test was performed a second time and the null hypothesis could not be rejected, hence the variables were stationary. Model 3 is Model 1 in first difference and is given by:

$$\Delta Y_{it} = \beta(X'_{it+1} - X'_{it}) + \varepsilon_{it}$$

### 4.3.2 Panel data

The aim of this study was to analyze the relationship between mortgage rates and other interest rates using a model built on panel data analysis. After establishing that all variables are I(0), we had to test for poolability across the slope parameters of regressions in order to estimate a panel data model. In other words, we had to test if the slope parameters are equal across the countries (see e.g. Verbeek 2012: 411). This test is called Roy-Zellner poolability test and can be performed in a panel framework since the error terms are not white noise. The first step was to remove the cross-sectional dependence across the units. In order to allow the slope coefficients to be different across cross-sections, dummy variables for each country $\delta_j$ was created and each variable and intercept was interacted with a country-specific dummy variable. All variables (including the dummy variable) are in vector form, stacked for all countries. The following regression was estimated:

$$MOR = \sum_{j=1}^{8} \beta_j \times \delta_j + \sum_{j=9}^{16} \beta_j \times LONG \times \delta_{j-8} + \sum_{j=17}^{24} \beta_j \times GDP_{GAP} \times \delta_{j-16} + \sum_{j=25}^{32} \beta_j \times R \times \delta_{j-24} + \varepsilon$$

$$\delta_j = \begin{cases} 1 \text{ for country } j \\ 0 \text{ otherwise} \end{cases} \qquad \text{whereas } j = 1,\ldots,8.$$

After running the regression, a Wald test was performed to test the null hypothesis that the coefficient for each variable was equal across countries. However, the null was rejected for both long-term interest rates (0.000) and repo rates (0.000) which means that the panel data model was not poolable. The numbers inside the parenthesis represents the p-values from the test (Park 2011: 13).

We did also run a regression based on only countries in the eurozone since we thought that they might be more similar to each other, but even then the null hypothesis was rejected.

### 4.3.3 Time series

Even though it would have been interesting with a panel data analysis on all countries, a model for each country had to be estimated individually (using OLS) since the panel data was not poolable. On the other hand, the main focus in this study is Sweden and therefore time series models might be preferable in order to compare the results with other European countries.

Model 3 in first difference was estimated individually for each country. Since time series data is being used, it is very common that the error terms of one or more consecutive periods are correlated. In other words, the error term is subject to autocorrelation. Especially in macro-economic time series models, first-order autoregressive errors are not uncommon. For quarterly data, which this analysis is based on, it is possible that there is a periodic effect that is causing the errors across the same periods but in different years to be correlated. To test for higher orders of serial correlation the Breusch-Godfrey test (LM-test) was performed (see e.g. Verbeek 2012: 112, 122). As expected, autocorrelation was found in the model but only for two countries, France and Italy. In order to correct for this, the mortgage rate variable was lagged one period in France respectively two periods in Italy. The next step was to test for heteroscedasticity by using White and Breusch-Pagan. Both tests for deviations from the null of homoscedasticity but the difference is that the White test is extremely general; it detects more general forms of heteroscedasticity than the Breusch-Pagan test. Therefore, both tests were performed to be positive that no heteroscedasticity existed. Even though it is not a very common problem in time series, the null hypothesis was rejected for most countries (Sweden, Finland, France, Spain, Germany and United Kingdom). In light of this, we decided to use White robust standard errors in all models, regardless if the null was rejected or not since it did not affect our results negatively.

To test for normality a Jarque-Bera test was performed. As can be seen in the results, the null hypothesis was rejected in almost all models (except for Germany and Italy). This means that the models seem not to have normally distributed error terms. Despite that, non-normality of error terms does not invalidate consistency of the OLS estimator or its asymptotic normality (see e.g. Verbeek 2012: 202). Unfortunately, our data sample is relatively small when it comes to macro-economic studies but we do not think that the problem with non-normality will affect our results negatively.

The results from Model 3 for all countries are found in Table 5 below. The coefficient for repo rate is significant for most countries. This pattern was found in for example Sweden where the coefficient for repo rate shows a strong positive effect on mortgage rate. This is an expected result since the share of mortgages with short-term interest rates is almost 50 percent. In Germany on the other hand it is rather the long-term interest rate that is significant. Also this result may be due to the fact that long-term interest rates are dominating on the German market (Statens bostadskreditnämnd 2011: 9). Further, the GDP-gap is significant at a 10 percent level and the negative sign indicates that an improvement in the economic cycle is followed by a lowered mortgage rate. United Kingdom, Ireland, Finland and Spain shows a similar pattern as Sweden since repo rate is the only significant variable and also shows a positive effect on mortgage rates. The results for France imply that the only significant variable that has a positive effect on mortgage rates is the mortgage rate with one lag. Finally, the mortgage rate in Italy can be explained by the long-term interest rate, the repo rate and the mortgage rate with two lags.

**Table 5: Regression Results for all countries**
*All variables are in first difference*

| **Dependent variable:** Mortgage rate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Model:** | **ESP** | **FIN** | **FRA** | **GER** | **IRL** | **ITA** | **SWE** | **UK** |
| $\boldsymbol{\beta_1}$ | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Long-term rate | -0.011 | 0.026 | 0.021 | 0.797*** | -0.061 | 0.345*** | -0.031 | -0.079 |
| | (0.125) | (0.073) | (0.082) | (0.062) | (0.056) | (0.123) | (0.137) | (0.051) |
| Repo rate | 0.604** | 0.641*** | 0.121 | 0.052 | 0.762*** | 0.402*** | 0.929*** | 0.503*** |
| | (0.259) | (0.150) | (0.134) | (0.050) | (0.097) | (0.064) | (0.072) | (0.094) |
| GDP-gap | 0.014 | -0.054 | -0.005 | -0.027* | 0.009 | 0.018 | -0.026 | 0.002 |
| | (0.049) | (0.038) | (0.014) | (0.013) | (0.035) | (0.027) | (0.030) | (0.016) |
| Mortgage rate(-1) | | | 0.437*** | | | | | |
| | | | (0.085) | | | | | |
| Mortgage rate(-2) | | | | | | 0.456*** | | |
| | | | | | | (0.065) | | |
| $\boldsymbol{R^2}$ adjusted | 0.373 | 0.469 | 0.202 | 0.904 | 0.659 | 0.740 | 0.808 | 0.798 |
| Prob. (F-statistic) | 0.000 | 0.000 | 0.006 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Durbin-Watson | 1.715 | 1.467 | 2.115 | 1.435 | 1.842 | 2.173 | 2.220 | 1.841 |
| **Diagnostic tests:** | | | | | | | | |
| Whites | 0.000 | 0.000 | 0.097 | 0.008 | 0.855 | 0.214 | 0.000 | 0.000 |
| B.P. | 0.000 | 0.000 | 0.058 | 0.423 | 0.411 | 0.315 | 0.048 | 0.000 |
| Jarque-Bera (P-value) | 0.000 | 0.000 | 0.0016 | 0.507 | 0.000 | 0.464 | 0.000 | 0.000 |
| LM Test | 0.490 | 0.167 | 0.110 | 0.114 | 0.791 | 0.553 | 0.639 | 0.868 |
| Chow Prob. (F-statstic) | | | | | 0.000 | 0.000 | | |

Number of observation=51
Whites Robusta Standard errors in parentheses.
*** significant 1%, ** significant 5%, * significant 10%

In the Model 3, we assumed that the functional form of the model is the same for all observations in the sample. However, the coefficients in the model may be different before and after for example a major change in macro-economic policy. As we mentioned in section 4.1, our time series spans the financial crisis, which could have changed the pattern between mortgage rates and other interest rates. To investigate whether a structural break occurs in our sample, a Chow test can be performed. This requires a known break date, which in turn can be found through a CUSUM test (see e.g. Verbeek 2012: 71-72). The graphs are presented in Table 6 in appendix. According to the graphs, there might exist a break point in Ireland in 2003Q1. As the break point was known, it could be used in the Chow test. The null hypothesis for the Chow test is that there is no break point at 2003Q1. A p-value of 0.000 implies that the null is rejected. In order to examine how the change appears before and after the year of 2003, Model 2 in first difference was introduced. Results from the second regression are presented below.

**Table 7: Regression Results for Ireland with dummy**

*All variables are in first difference*

| **Model:** | **Ireland** |
|---|---|
| $\boldsymbol{\beta_1}$ | 0.000 |
| | (0.000) |
| Long-term interest rate | -0.636** |
| | (0.250) |
| Repo rate | 0.974*** |
| | (0.185) |
| GDP-gap | -0.149** |
| | (0.066) |
| Dummy GDP | 0.197*** |
| | (0.070) |
| Dummy Long | 0.626** |
| | (0.251) |
| Dummy Repo | -0.283 |
| | (0.212) |
| $\boldsymbol{R^2}$ adjusted | 0.789 |
| Prob. (F-statistic) | 0.000 |
| Durbin-Watson | 2.260 |
| **Diagnostic tests:** | |
| Whites | 0.159 |
| Breush Pagan | 0.188 |
| Jarque-Bera (P-value) | 0.000 |
| LM Test | 0.198 |

Number of observation=51
Whites Robusta Standard errors in parentheses.
*** significant 1%, ** significant 5%, * significant 10%

When taking account of the structural break by including dummy variables, the outcome changes significantly. Before the break point all three variables was significant. The repo rate had a strong positive effect on mortgage rate while the coefficient for both long-term interest rate and GDP-gap was negative. After the break point, the repo rate shows a negative sign but is on the other hand no longer significant and can thus not explain changes in mortgage rate. Furthermore, the coefficient for long-term interest rate has changed from -0.636 to 0.626 and for GDP-gap from -0.149 to 0.197, i.e. a positive change for both variables. The interpretation is that in 2003, the mortgage rate started to a greater extent influence by long-term interest rate rather than the repo rate. In addition, mortgage rate was more sensitive to changes in the economic cycle. After 2003 long-term interest rate is significant at a 5 percent level while GDP-gap is significant at a 1 percent level.

# 5 Discussion

In our empirical study, a common model for the eight EU-countries could not be found, which could be explained by country differences in mortgage systems. In the selected countries, the most predominantly system between long- or short-term interest rate is the short-term (Statens bostadskreditnämnd 2011: 8). From a central banks perspective this system is to be preferred since the greater proportion of loans with short-term interest rates, the greater and faster effects will the monetary policy give. Looking at the results in Table 5, a significant positive relationship between mortgage rate and repo rate was found in most countries except for Germany and France. Moreover, a significant positive relationship between mortgage rate and long-term interest rate was found in Germany and Italy. This is in line with the fact that market shares of long-term mortgage rates rose from 10 to 70 percent between 2005 and 2009 in Italy (Uberti et al. 2013).

The above results are consistent with the hypothesis, namely that there exist a positive relationship between mortgage rate, repo rate and long-term interest rate. It also suggests that our results are in line with earlier studies, e.g. Marathe and Shawky (2003) and Ellingsen and Söderström (1999). However, according to these studies, repo rate will only affect mortgage rate through long-term interest rate. Our results differ in such that repo rate will in some cases have a direct impact on mortgage rate. For example, Sweden had the highest coefficient value for repo rate (0.9) and thus the strongest link to mortgage rate was found. This could indicate that the criticism of banks regarding high mortgage margins is unjustified. Then again, there might be other factors that affects mortgage rate but which are not included in the model. Based on our model and results, we cannot draw any conclusions about mortgage margins. On the other hand, we could expect that in countries where short-term rates are dominated and the repo rate is significant, mortgage rates were most affected by the crisis (Lea 2010).

Another important component when comparing mortgage rates is that each country offers different mortgage products. Commonly for the German and Italian system is their restriction of pre-payment penalties, that is extra costs for banks and higher mortgage rates for customers. This could be a conceivable explanation for the similarity in their results. Notable for Germany is also

that the GDP-gap was significant negative; an improvement in the economic cycle is followed by a lowered mortgage rate. This means that when there is an economic boom, the overall demand will increase as well as new construction of housing and hence lowered mortgage rate.

Furthermore, the only model with a structural break was the one for Ireland. This is remarkable as a majority of the including countries were affected by the crisis. A structural break around 2008 would therefore not have been surprisingly. For Ireland, a break point occurred in the first quarter of 2003 but a specific occurrence such as a policy action or a house bubble at the time was not found. However, when Ireland became a member of the EMU in January 1999, Ireland was in an economic boom and had an inflation rate of around 5 percent. Consequently, the EMU-membership led to decreased nominal interest rates and low real interest rates which in turn fueled the boom: over-investments, increasing debts, inflated property prices, wage increases and inflation. As a result, Ireland gradually lost competiveness in the export sector and GDP growth fell dramatically. The problem was that there was no way to encounter the recession by lowering interest rates since ECB decides on the monetary policy. Instead, employment, production and profits had to suffer negative (Gottfries 2003: 44, 47). All this could explain the break point in 2003.

The general outcome is that far from all variables was significant which may be due to limited model and lack of variables. Our time series only extends until the fourth quarter of 2011 and hence does not take account of what has happened since then. According to latest numbers, mortgage rates are undergoing a downward trend as a result of increased competition in the bank sector (Neurath 2013a). Given that the central bank's policy have got reduced impact on the economy because of decoupled interest rates from the policy rate, policy makers should rather focus on increased banking competition. Besides, on an efficient market, banks had not been able to pass on the full cost of higher borrowing costs and more stringent capital adequacy requirements to the customers. Some argue that this indicates lousy competition and that the Swedish banking situation can be compared to an oligopoly. They argue further that the Government should let the state owned bank SBAB promote for a stronger competition. Even though the bank has a good financial position to take the lead in improving the functioning of the mortgage market, it chooses to act the same way as its competitors (Nilsson 2012). This is an area where policy makers should seek to improve. Limited banking competition contributes to a downward spiral in form of higher interest rates and reduced demand, both from households and business, which in turn will be negative for the economy as a whole.

In this study, we have also discussed that short-term mortgage rates tend to be more at risk during a crisis but from a historical point of view, short-term mortgage rates has been most profitably for customers. Despite this, banks continue to recommend loans that are partly long term and partly short term, with around five years to maturity. In addition, studies shows that banks standard recommendations can be very risky for many reasons. For example, if the customer needs to terminate the loan they will have to pay the interest differential compensation (which can be very expensive) (Svenska Dagbladet 2013). Latest numbers also shows that many households are now planning to tie their interest rate. This is mostly due to the current low interest rate. However, the reason why long-term rates are low is that the short-term is expected to be low for many years to come, which the customers are not aware of (Neurath 2013b). This is another area where policy makers should act in since the conditions are to disadvantage for customers and leads to further increased profits for banks. Lastly, Stefan Ingves suggests that policy makers should impose rules for the banks that require amortizations on mortgage loans. He says that it is not good if the loans are undated maturity as it entails excessive risks for both customers and banks (Schück 2013).

# 6 Conclusion

In this study we have examined the relationship between mortgage rates and other interest rates such as repo rate and long-term interest rate and whether this changed during the financial crisis in 2008. This was studied using a time series model on eight European countries[8] of which focus was on Sweden. The hypothesis was based on previous studies that the relationship between the interest rates should be positive.

Following, a quarterly data set that spans from the introduction of the common monetary policy in 1999 to 2011, the results are consistent with the hypothesis and reveals a significant positive relationship between mortgage rate and repo rate in all countries except for Germany and France. This result could indicate that the criticism of banks high mortgage margins is unjustified. Moreover a significant positive relationship between mortgage rate and long-term interest rate was found for Germany and Italy, which can be explained by the fact that long-term mortgage rates dominate these markets. What was most surprising with the results was that only one model had a structural break, namely Ireland. Since most of the countries were affected by the crisis, a structural break at that time would therefore not have been surprisingly. In the Ireland case, a break point was found at the first quarter in 2003. However, a specific occurrence at this time was not found but it could be the consequences from Ireland's membership in the EMU.

To sum up the main findings in this study and answer the question, far from all variables was significant. This may be because of limited model and lack of variables, but in spite of this we can conclude that mortgage rates tend to predominantly follow repo rate. In Sweden, this link was the strongest compared to the other countries with a coefficient value of 0.9. Additionally, the crisis seems not to have affected this relationship significantly.

According to latest numbers, mortgage rates are undergoing a downward trend as a result of increased competition in the bank sector. This should send signals to policy makers to focus on increasing banking competition. One solution could be to let the state owned bank SBAB promote for a stronger competition.

[8] Spain, France, Finland, Germany, Ireland, Italy, Sweden and United Kingdom.

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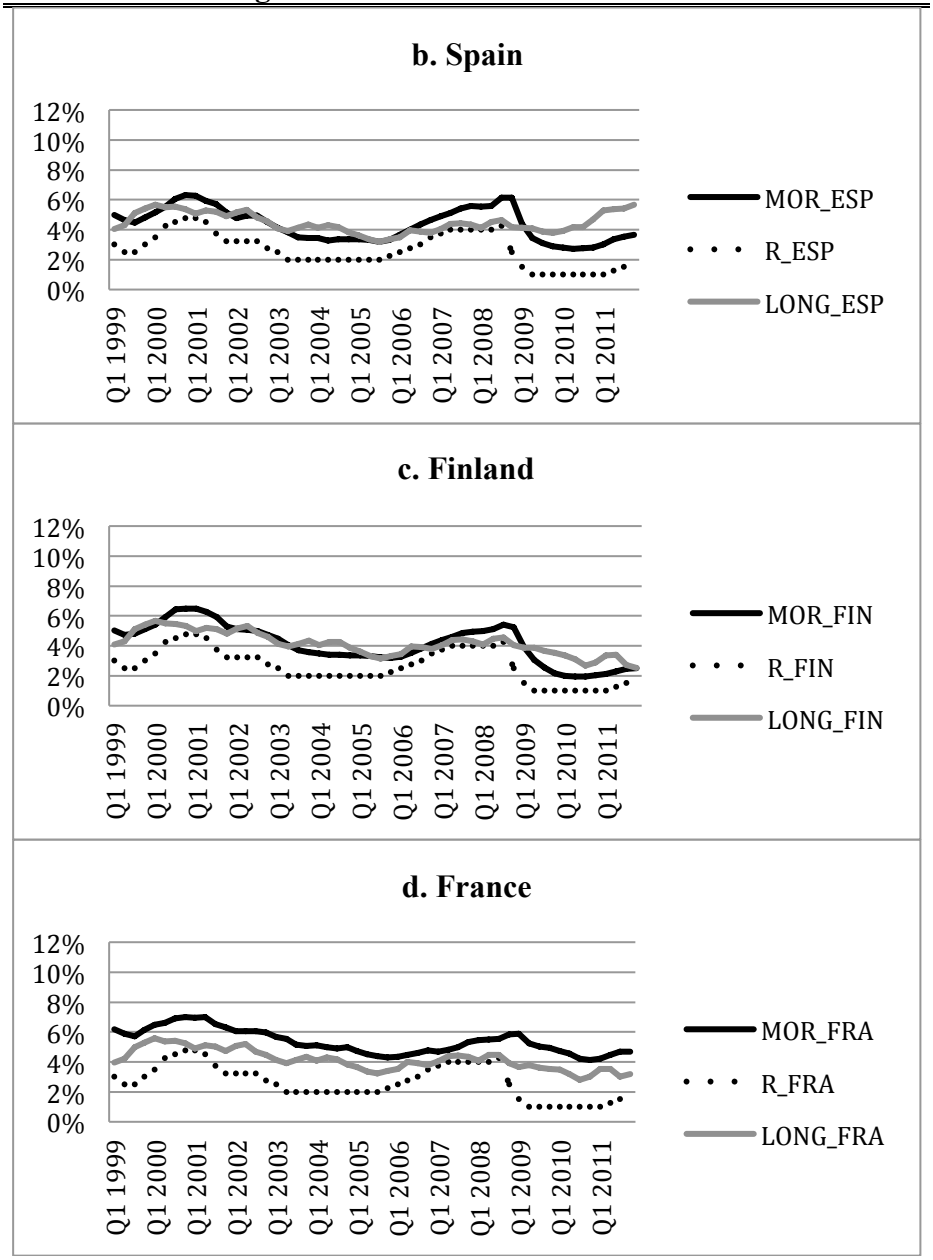
# 8 Appendix

**Figures 2b-h: Plots of interest rates**



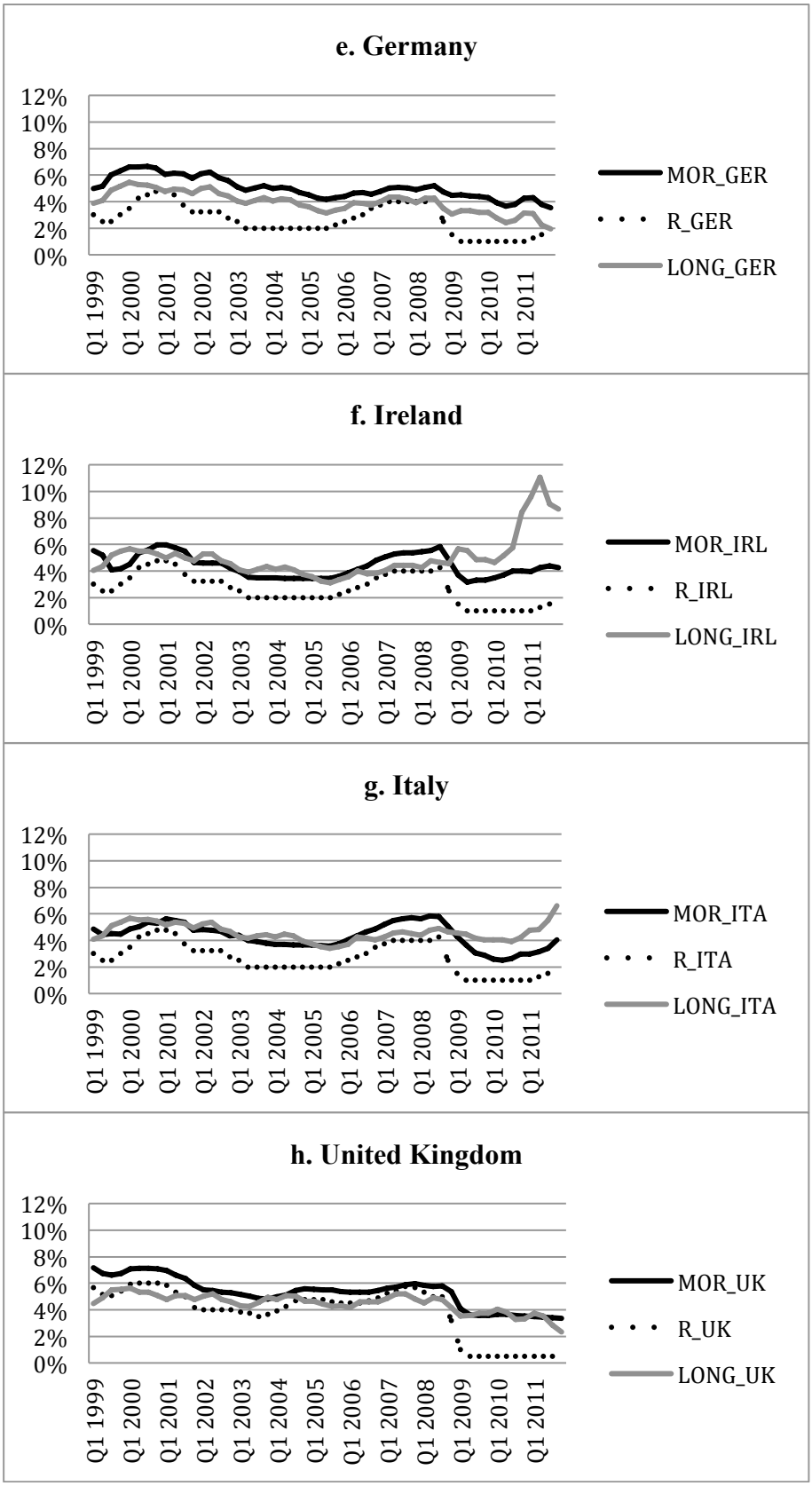

e. Germany
12%
10%
8%
6%
4%
2%
0%
Q1 1999
Q1 2000
Q1 2001
Q1 2002
Q1 2003
Q1 2004
Q1 2005
Q1 2006
Q1 2007
Q1 2008
Q1 2009
Q1 2010
Q1 2011
MOR_GER
R_GER
LONG_GER
f. Ireland
MOR_IRL
R_IRL
LONG_IRL
g. Italy
MOR_ITA
R_ITA
LONG_ITA
h. United Kingdom
MOR_UK
R_UK
LONG_UK

**Table 2: Correlation matrix**

| Country | Variable | GDP gap | Long rate | Repo rate |
|---|---|---|---|---|
| Germany | GDP gap | **1.000** | | |
| | Long rate | 0.082 | **1.000** | |
| | Repo rate | 0.485 | 0.341 | **1.000** |
| Spain | GDP gap | **1.000** | | |
| | Long rate | 0.235 | **1.000** | |
| | Repo rate | 0.275 | 0.291 | **1.000** |
| Finland | GDP gap | **1.000** | | |
| | Long rate | 0.123 | **1.000** | |
| | Repo rate | 0.574 | 0.282 | **1.000** |
| France | GDP gap | **1.000** | | |
| | Long rate | 0.240 | **1.000** | |
| | Repo rate | 0.314 | 0.280 | **1.000** |
| Ireland | GDP gap | **1.000** | | |
| | Long rate | 0.049 | **1.000** | |
| | Repo rate | 0.470 | 0.009 | **1.000** |
| Italy | GDP gap | **1.000** | | |
| | Long rate | 0.069 | **1.000** | |
| | Repo rate | 0.390 | 0.163 | **1.000** |
| Sweden | GDP gap | **1.000** | | |
| | Long rate | 0.105 | **1.000** | |
| | Repo rate | 0.484 | 0.340 | **1.000** |
| United Kingdom | GDP-gap | **1.000** | | |
| | Long rate | 0.236 | **1.000** | |
| | Repo rate | 0.452 | 0.320 | **1.000** |

**Table 3: Descriptive statistics (%)**

| Country | Variable | Mean | Max | Min | Std. dev. |
|---|---|---|---|---|---|
| Spain | Mortgage | 4.3 | 6.3 | 2.7 | 1.1 |
| | GDP gap | 0.0 | 3.2 | -2.8 | 1.5 |
| | Long rate | 4.5 | 5.7 | 3.2 | 0.7 |
| | Repo rate | 2.6 | 4.8 | 1.0 | 1.2 |
| Finland | Mortgage | 4.1 | 6.5 | 1.9 | 1.3 |
| | GDP gap | 0.0 | 3.7 | -5.1 | 2.1 |
| | Long rate | 4.1 | 5.7 | 2.5 | 0.8 |
| | Repo rate | 2.6 | 4.8 | 1.0 | 1.2 |
| France | Mortgage | 5.4 | 7.0 | 4.1 | 0.8 |
| | GDP gap | 0.0 | 6.0 | -4.8 | 2.4 |
| | Long rate | 4.1 | 5.6 | 2.8 | 0.7 |
| | Repo rate | 2.6 | 4.8 | 1.0 | 1.2 |
| Germany | Mortgage | 5.0 | 6.7 | 3.5 | 0.8 |
| | GDP gap | 0.0 | 3.2 | -3.8 | 1.6 |
| | Long rate | 3.9 | 5.5 | 1.9 | 0.8 |
| | Repo rate | 2.6 | 4.8 | 1.0 | 1.2 |
| Ireland | Mortgage | 4.4 | 6.0 | 3.2 | 0.8 |
| | GDP gap | 0.0 | 3.8 | -4.5 | 1.8 |
| | Long rate | 5.0 | 1.1 | 3.1 | 1.6 |
| | Repo rate | 2.6 | 4.8 | 1.0 | 1.2 |
| Italy | Mortgage | 4.3 | 5.8 | 2.5 | 0.9 |
| | GDP gap | 0.0 | 3.5 | -3.4 | 1.4 |
| | Long rate | 4.6 | 6.6 | 3.4 | 0.6 |
| | Repo rate | 2.6 | 4.8 | 1.0 | 1.2 |
| Sweden | Mortgage | 3.7 | 6.1 | 1.2 | 1.2 |
| | GDP gap | 0.0 | 5.5 | -5.6 | 2.5 |
| | Long rate | 4.1 | 5.8 | 1.8 | 1.0 |
| | Repo rate | 2.6 | 4.8 | 0.3 | 1.3 |
| United Kingdom | Mortgage | 5.3 | 7.2 | 3.4 | 1.1 |
| | GDP-gap | 0.0 | 2.5 | -3.0 | 1.2 |
| | Long rate | 4.5 | 5.6 | 2.3 | 0.7 |
| | Repo rate | 3.8 | 6.0 | 0.5 | 1.9 |

**Table 4: Unit root tests**

*a. ADF*

| | **ESP** | **FIN** | **FRA** | **GER** | **IRL** | **ITA** | **SWE** | **UK** |
|---|---|---|---|---|---|---|---|---|
| $GDP_{GAP}$ | -2.816 | -2.106 | -3.140 | -3.598 | -2.322 | -3.211 | -2.086 | -2.424 |
| | (0.006) | (0.035) | (0.002) | (0.001) | (0.021) | (0.002) | (0.037) | (0.016) |
| $\Delta GDP_{GAP}$ | -7.015 | -5.884 | -9.817 | -6.051 | -6.161 | -7.341 | -5.837 | -8.013 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| $MOR$ | -2.616 | -2.080 | -1.437 | -1.286 | -2.800 | -4.090 | -2.763 | -1.081 |
| | (0.097) | (0.253) | (0.557) | (0.628) | (0.066) | 0.002 | (0.071) | (0.716) |
| $\Delta MOR$ | -4.278 | -2.864 | -4.318 | -3.288 | -4.297 | -3.443 | -2.990 | -3.898 |
| | (0.001) | (0.057) | (0.001) | (0.021) | (0.001) | (0.014) | (0.043) | (0.004) |
| $LONG$ | -1.660 | -0.731 | -1.179 | -0.253 | -0.563 | -1.853 | -0.283 | 0.124 |
| | (0.445) | (0.829) | (0.677) | (0.924) | (0.870) | (0.351) | (0.920) | (0.964) |
| $\Delta LONG$ | -5.085 | -6.089 | -6.392 | -6.497 | -4.868 | -3.747 | -6.273 | -6.430 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.006) | (0.000) | (0.000) |
| $R$ | -1.765 | -1.765 | -1.765 | -1.765 | -1.765 | -1.765 | -1.904 | -1.274 |
| | (0.393) | (0.393) | (0.393) | (0.393) | (0.393) | (0.393) | (0.328) | (0.635) |
| $\Delta R$ | -4.057 | -4.057 | -4.057 | -4.057 | -4.057 | -4.057 | -5.037 | -3.626 |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.000) | (0.009) |

The value inside the brackets is p-value.

*b. KPSS*

| | **ESP** | **FI** | **FR** | **GER** | **IR** | **IT** | **SE** | **UK** |
|---|---|---|---|---|---|---|---|---|
| $GDP_{GAP}$ | 0.068 | 0.058 | 0.072 | 0.053 | 0.049 | 0.073 | 0.060 | 0.059 |
| $MOR$ | 0.279 | 0.551 | 0.591 | 0.738 | 0.178 | 0.250 | 0.409 | 0.708 |
| $LONG$ | 0.261 | 0.687 | 0.671 | 0.761 | 0.343 | 0.244 | 0.846 | 0.736 |
| $R$ | 0.366 | 0.366 | 0.366 | 0.366 | 0.366 | 0.366 | 0.435 | 0.584 |

Critical values KPSS; 1%: 0.739, 5%: 0.463, 10%: 0.347

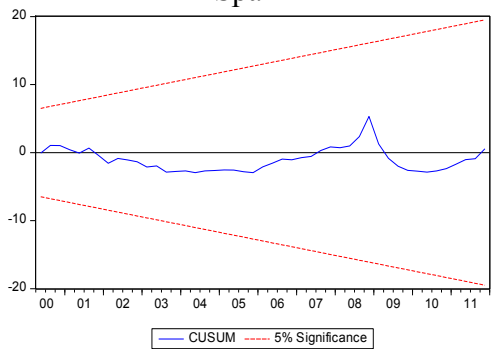
*c. ERS*

| | **ESP** | **FI** | **FR** | **GER** | **IR** | **IT** | **SE** | **UK** |
|---|---|---|---|---|---|---|---|---|
| $GDP_{GAP}$ | -2.021 | -2.094 | -1.626 | -1.611 | -2.012 | -3.095 | -2.085 | -2.188 |
| $MOR$ | -2.524 | -2.004 | -1.205 | -1.567 | -2.240 | -4.028 | -2.769 | -0.481 |
| $LONG$ | -1.594 | -1.033 | -1.240 | -0.658 | -0.461 | -1.812 | -0.614 | -0.455 |
| $R$ | -1.775 | -1.775 | -1.775 | -1.775 | -1.775 | -1.775 | -1.912 | -1.067 |

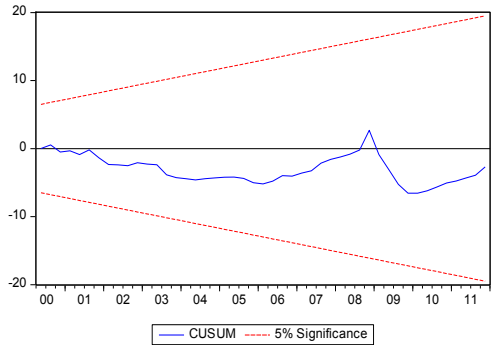
Critical values ERS; 1%: -2.612, 5%: -1.948, 10%: -1.613

**Table 6: CUSUM test**

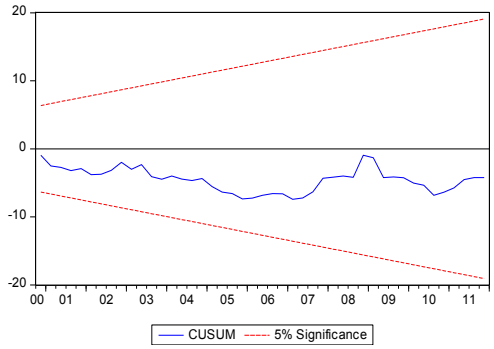
Spain



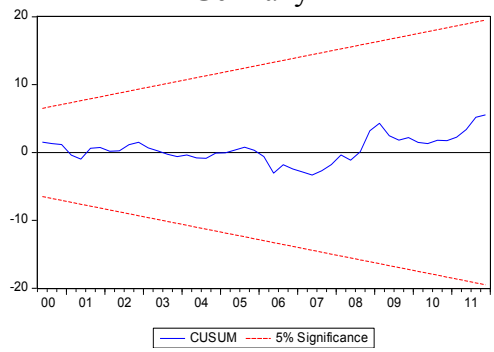

Finland



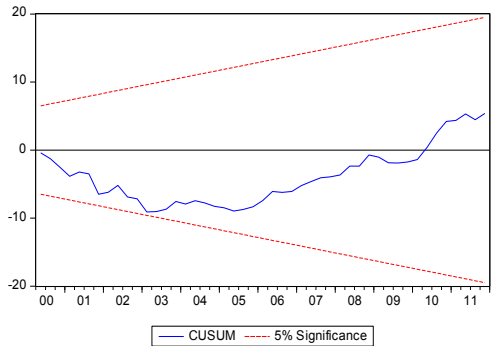

France



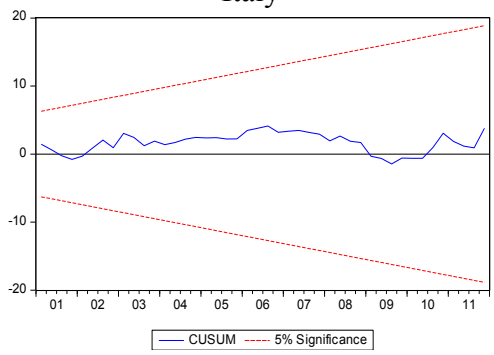

Germany



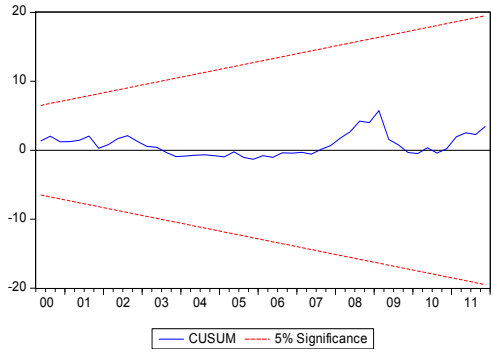

Ireland




Italy




Sweden




UK