Can recent developments in banking explain weak interest rate pass-through during the financial crisis?*

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Abstract

The financial crisis resulted in drastic consequences for the functioning of the monetary transmission mechanism. This thesis makes an attempt at uncovering why interest rate pass-through has been weak during the financial crisis. First, by estimating an error-correction model, I find that the pass-through from funding rates to retail rates has indeed deteriorated since the onset of the financial crisis. This thesis then proceeds to show that banks with higher regulatory capital ratios tend to have higher pass-through estimates. In addition, there is weak evidence that when non-performing loans are numerous, pass-through is lower. Furthermore, no significant effect of the funding gap on pass-through could be reported. Finally, fierce competition among banks leads to higher pass-through, in line with previous literature. The results lead me to the policy recommendation that banks should be recapitalized; Stronger regulatory capital ratios are expected to improve pass-through, thereby contributing to the restoration of the monetary transmission mechanism.

Keywords: Interest rate pass-through, cointegration, error-correction, funding gap, bank capital, competition, non-performing loans

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1 Introduction

The global financial crisis had large consequences for the conduct of monetary policy. Whereas prior to the financial crisis – a period with low and stable inflation and effective monetary transmission – monetary policy was often seen as uneventful, times are surely much different now. Since the eruption of the financial crisis, the interbank lending market largely closed down, as can be seen in the following figure.

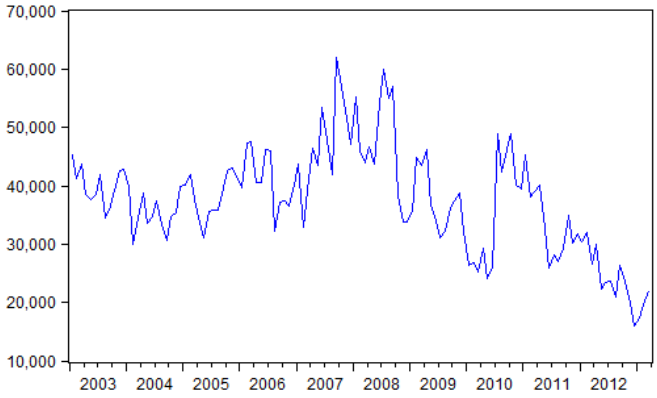


Figure 1: **Eonia volumes in millions of euro, 2003M01-2013M03. Source: ECB**

To prevent the transmission channels of monetary policy from breaking down completely, the European Central Bank has enacted on a number of unconventional policies, effectively serving as a substitute for the interbank market. The classic bidding scheme on the main refinancing operations (MRO), where banks bid on attracting base money in exchange for collateral, has been replaced by the fixed rate full allotment procedure, where any bank can get access to liquidity at a fixed rate. In addition, the ECB extended the maturity on the longer term refinancing operations, so that banks can satisfy their long-term need for liquidity. Regardless of the expansionary monetary policy and the unconventional measures taken, the transmission of monetary policy remains broken. There are a number of ways in which monetary policy affects the real economy via its transmission channels. This thesis is limited to the examination of the interest-rate channel[1] of monetary policy, where a change in the policy rate set by the ECB first transmits to money- and capital market rates (henceforth: funding rates), and subsequently to retail rates, affecting real economic variables such as consumption and investment[2]. Hence, there are two stages of the transmission process that may be problematic in the current crisis. Empirical work on the former can be found in Beirne [2012] and Rodrigues and Soares [2011], while my work focusses on the latter: the transmission from funding rates to retail rates. Examination of channels other than the interest rate channel of monetary transmission in the context of the recent crisis, such as asset- and credit channels (Mishkin [1996]), although very interesting, are beyond the scope of this thesis. Some contributions to the literature on the effect of the crisis on non-interest rate channels will be discussed in the literature review.

Figure 2 displays the comovement between EONIA - a money market interest rate - and the interest rate on bank loans to firms up to 1 million in Greece. As is inmediately apparent, the money market and retail rate comoved rather well before the onset of the financial crisis. In the period thereafter, the relationship between the two interest rates was to a large extent tampered. Even though the retail rate seemed to respond well to a drop in eonia in Q4 2008, it started

[1] The transmission of the policy rate to retail rates is also known as pass-through in the economic literature. In the remainder of this paper, the interest rate channel of monetary policy will be denoted by interest rate pass-through, where full pass-through indicates that a change in the policy rate translates one to one to retail rates.

[2] See Taylor [1995] for an overview of evidence on the existence of interest-rate channels.

rising again quickly. Indeed, not only for Greece, also for other Euro area countries – albeit in a less extreme fashion – retail rates have responded weakly to reductions in funding rates. The proper functioning of the interest rate channel

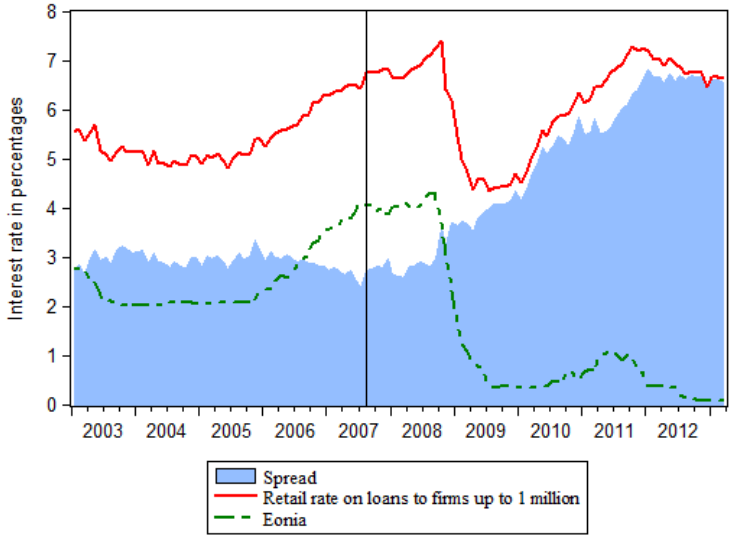


Figure 2: **Eonia and rates on loans for firms up to 1 million euro, 2003M01-2013M03. Vertical line indicates the onset of interbank market disturbances. The blue area reflects the interest rate spread between EONIA and the interest rate on loans for firms up to 1 million. Source: ECB, global-rates.com**

of monetary transmission is highly important to allow the economy to recover. With the policy rate close to the zero lower bound, conventional monetary policy is unable to induce a further drop in key policy rates. In case policy is able to improve interest rate pass-through, the interest rate channel of monetary policy will be partly restored, improving recovery and paving the way for an exit from unconventional policies of which both the beneficial and harmful effects are uncertain.

A number of studies (Blot and Labondance [2011], Aristei and Gallo [2012], ECB [2009]) already identified that long run pass-through has deteriorated since the start of the financial crisis, but literature on why this is the case is scarce and incomplete. The aim of this paper is twofold. First, I provide an up-to-date measure of long run pass-through for 11 countries and 6 corresponding retail rates, and second, I try to determine what has caused long run pass-through to deteriorate. Error-correction models are able to identify both short run and long run responses in retail rates to changes in funding rates. In my analysis, I focus on long run pass-through, since it captures all dynamics in the adjustment procedure of the relevant retail rate. For example, capital ratios may significantly affect long run pass-through, whereas the short run response is only moderate. In addition, during times of crisis, banks may partly pass-through a reduction in funding rates in the short run, but not on the long run. Indeed, Blot and Labondance [2011] show that short run pass-through has increased during the crisis, whereas long run pass-through decreased. The downside of using long run pass-through is that it necessitates a cointegrating relationship to be present, whereas the short run pass-through can be estimated without one as well. Hence, the trade-off here is one between accuracy and completeness, since cointegration could not always be found (see section 4).

With respect to the employed methodology, this paper closely resembles the one of Mojon [2000]. In this thesis, the identification strategy is to find whether capital ratios, loan to deposit ratios, competition, and non-performing loans are able to explain cross-sectional differences in long run pass-through. The remainder of this thesis is structured as follows. Section two provides theoretical insights that may explain why interest rate pass-through is broken, and proposes

hypotheses accordingly. Section three provides an overview of the data, section four delivers test results for cointegration between retail rates and funding rates, which is a prerequisite in order to estimate the error-correction model. Having found the appropriate underlying funding rate to use in the error-correction model, section five presents the long run pass-through results by means of a VECM. In section six, I test whether capital ratios, loan to deposit ratios, competition, and non-performing loans are able to explain cross-sectional heterogeneity in long run pass-through, and section seven concludes.

2 Theory and literature review

There may be numerous explanations as to why pass-through from funding rates to retail rates has been so weak since the eruption of the financial crisis. This section provides some insights based on the recent developments in European banking. In most cases, graphs are included with time-series data of four selected countries. In order to make a distinction between core and periphery, I plot time series of two countries (Finland and Germany) based in the former, and two countries based in the latter (Greece and Spain).

2.1 The funding gap

In the run-up to the global financial crisis, banks across the Eurozone engaged in increasingly risk-taking activities. With continuing house-price increases in many Eurozone countries, demand for mortgage credit was high and rising. This eventually led to a rapid rise in securitization activities. The easy funding conditions and low credit risk perceptions allowed most demand for mortgage credit to be fulfilled. When house prices in most Eurozone countries stagnated and subsequently deteriorated, housing bubbles burst and the financial crisis erupted. The banking sector realized that securitization accompanied a general misperception of risk, so that the markets for securization largely closed down, as can be seen in figure 3. After a short spike in the stock of debt securities in Q4 2008, it quickly declined to well below pre-crisis levels. The collapse of the market for securitised loans resulted in a sharp contraction of funding opportunities for banks.

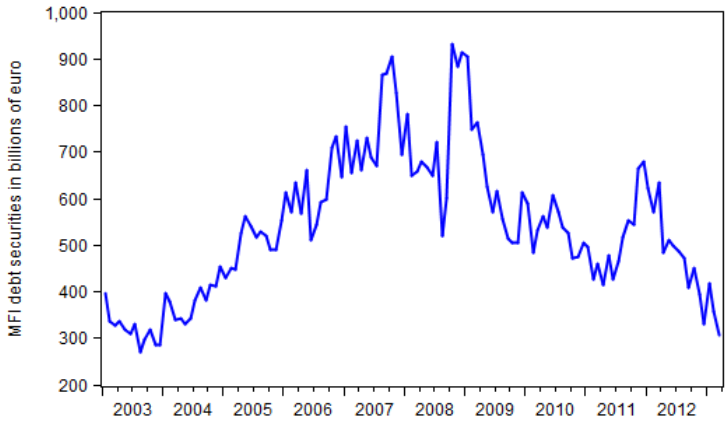


Figure 3: **MFI outstanding short-term debt securities in the Euro area, 2003M01-2013M05. Source: ECB**

Here, the failure of the Modigliani-Miller theorem for banks becomes apparent: In calm economic times, the financing mix for banks does not matter: when the central bank eases the monetary stance, deposit supply is expected to decrease, but will be perfectly offset by an increase in other forms of external financing. In times of crisis, however, markets for external finance dry up, and bank demand for liquidity will be unsaturated (Van den Heuvel [2002]). This results in weak funding

conditions, which have vast implications for the functioning of monetary policy. Under the assumption that bank loans are primarily financed by deposits and issues of securities, banks have to increasingly rely on deposits to finance their investments. In order to maintain funding, banks will then offer high deposit interest rates to stimulate deposit supply[3]. In case banks are characterized by a low loan to deposit ratio (a low funding gap), a reduction in securitization activity has little consequences for funding conditions. In contrast, banks that rely heavily on securitisation to finance loans will be forced to increase deposit interest rates to attract enough funding, and subsequently pass the higher deposit rates on to retail interest rates. Here, the connection between funding rates and retail rates breaks down, so that pass-through will be low.

Hypothesis 1. *A higher loan to deposit ratio leads to a lower pass-through in times of financial crisis.*

2.2 Capital ratios

The crisis induced turmoil in banking resulted in a sudden realization by supervisors that bank regulatory capital requirements weren't quite strict enough. Indeed, the unprecedented losses as a result of the financial crisis posed a direct threat to bank solvability. In response to this, the Basel III regulatory framework introduced more stringent capital requirements for banks. Banks have however been reluctant to issue new equity under the pressure of shareholders that fear stock dilution. Capital ratios have, however, generally been increasing (see figure 4 below). When raising equity is costly, banks have to resort to other means of improving capital ratios. One way to do this is to keep interest rates high, even when funding rates decrease. Apart from improving profitability, keeping interest rates high also results in lower lending volumes, which helps in the deleveraging process. Indeed, capital ratios may also be improved by reducing the amount of assets on balance sheets. Banks that have lower capital ratios will thus be less inclined to pass-through cuts in funding rates to retail rates.

Hypothesis 2. *A lower capital ratio leads to lower pass-through in the current financial crisis.*

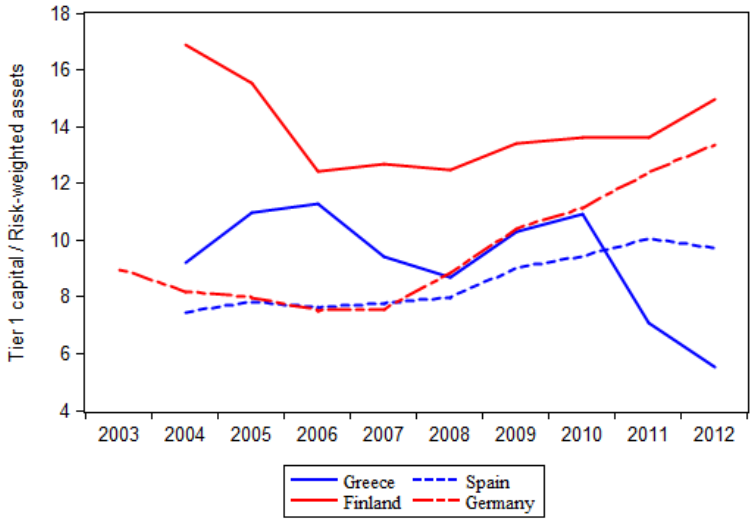


Figure 4: **Tier 1 capital over risk-weighted assets for four selected countries. Source: IMF/Bankscope**

[3]Jansen et al. [2013] show that this happened in the Netherlands.

2.3 Competition

The financial crisis also resulted in a drastic change in the competitive landscape in the Eurozone banking system. Cross-border banking, for example, has reduced significantly across the Eurozone (see table 10 in the appendix). This has caused a transfer in the supply of credit from internationally orientated banks to domestic banks. Mier-y Teran [2012] provides a theoretical framework on how competition alters the pass-through process. His model suggests that markup-values will be closer to zero as the amount of loan suppliers increase, so that the monetary policy rates transmit more fully to retail rates. This suggests that the recent reduction in competitiveness may explain the deterioration in the pass-through process. In their paper, the ACM [2013][4] – apart from finding that banks ration credit to improve their capital-ratios – finds a strong positive correlation between the Herfindahl-index and profit margins for Dutch banks, so that banks have less incentive to fully pass-through changes in funding rates to retail rates. Indeed, figure 5 below shows that – although the trajectory seems very gradual – there has been a reduction in competition. As a proxy for competition, the Herfindahl-index on total assets is used here, where a higher value corresponds to less competition. There are a number of serious limitations to the use of the Herfindahl-index. First, when fierce bank competition forces consolidation as a means of improving efficiency, this will, despite low profit margins, result in a higher Herfindahl-index. Second, a small amount of players in the competitive landscape does not necessarily imply that competition is low. For instance, there's a difference between three banks operating in Luxembourg, and three banks operating in Spain (van Leuvensteijn et al. [2013]).

Hypothesis 3. *Heterogeneity in pass-through can be partly explained by cross-country variation in the Herfindahl-index.*

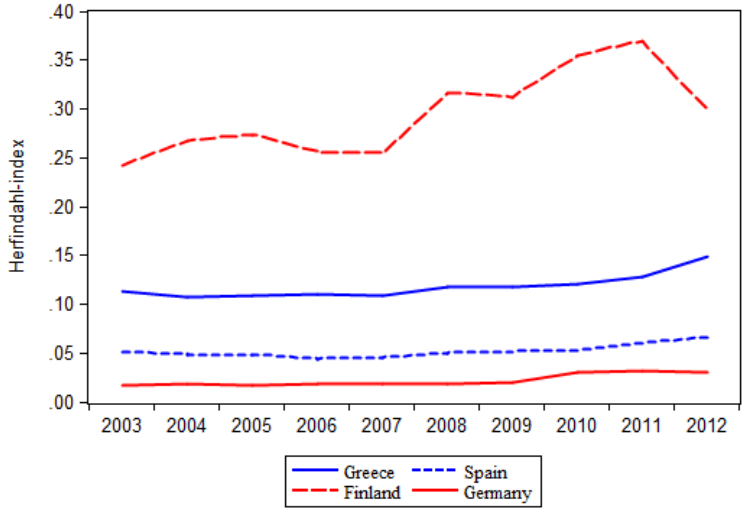


Figure 5: **Herfindahl-index on total bank assets for four selected countries. Source: ECB**

2.4 Non-performing loans

The onset of the financial crisis coincided with an increase in risk-taking by banks. With the expectation of ongoing economic prosperity, banks were eager to supply loans to those in need. Indeed, as Minsky [1992] argues, there will be an increasing tendency to engage in risk-taking activities in times of prolonged prosperity. Minsky argues that the least creditworthy borrowers – the so-called Ponzi units – are only able to meet their debt obligations when asset prices are

[4] Autoriteit consument en markt.

rising. The financial crisis caused a Minsky moment: the least creditworthy borrowers en masse started selling their assets, inducing a deflationary spiral in asset prices. This has caused many of the debtors that took on a loan to be unable or unwilling to meet their debt obligations. As figure 6 shows, the rise in non-performing loans in the periphery – which also took the largest blows in terms of economic growth and unemployment – has been especially overwhelming. With European-wide weak recovery, there is little reason for banks to assume that debtors will repay these non-performing loans. I expect that banks with a large amount of non-performing loans keep interest rates high to accumulate loss provisions. Insofar as the interest elasticity of the demand for bank loans is not perfectly inelastic, this will also result in a reduction in total loans, which may put a downward pressure on profits. There is however another way in which non-performing loans may affect pass-through. The amount of non-performing loans in banks' portfolios may be an indication for the height of risk-premia. After all, when banks tend to supply loans to risky projects, and thereby face the risk of non-performing loans, they will also charge high risk premia to compensate for expected losses. Thus, the mechanism works in two ways: First, when non-performing loans are numerous, banks may be inclined to keep interest rates high so as to accumulate loss provisions. And second, when non-performing loans are numerous, risk premia are high, such that banks have a tendency to keep retail rates high when funding rates are falling. This leads me to the following hypothesis:

Hypothesis 4. *Heterogeneity in pass-through can be partly explained by cross-country variation in non-performing loans.*

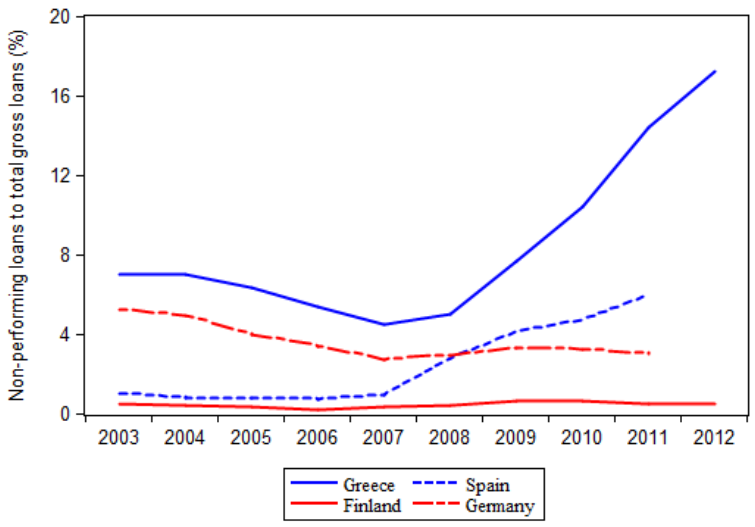


Figure 6: **Non-performing loans to total gross loans in four selected countries. Source: Worldbank**

2.5 Literature review

In a paper by the IMF, Sabarowski and Weber [2013] attempt to identify the determinants of short run interest rate pass-through by means of a panel VAR with interaction terms that include exchange rate flexibility, regulatory quality, financial development, dollarization, inflation, competition, non-performing loans, and the ratio of liquid to total assets. They find that all these variables, with the exception of inflation, are significant in the VAR. Most notably, more fierce competition and the amount of non-performing loans are key determinants of short run pass-through. They also find that higher liquidity leads to lower pass-through, and attributute this to the fact that in high-liquidity environments, adequate investment opportunities do not exist. The main advantage of their methodology stems from the fact that they require

only one estimation technique – a panel VAR – to find determinants of short run pass-through. The main downside is that they are unable to examine the determinants of long run pass-through. Schluter et al. [2012] first estimate an error-correction model, and subsequently regress estimated loan markups and speed of adjustment coefficients on a number of explanatory variables. They find that high liquidity and cost efficiency reduces loan mark-ups, whereas banks with a high share of deposit funding tend to have higher loan markups. In addition, bank size, cost efficiency, and deposit funding have a positive sign in determining the speed of adjustment. In a very recent BIS paper, Illes and Lombardi [2013] show in a two-stage estimation technique that interest rate pass-through has been lower during the financial crisis. They first calculate the pass-through coefficient prior to the crisis, and proceed to estimate fitted values of interest rates for the post-crisis sample had the high pre-crisis pass-through levels prevailed. The fitted values are then subtracted from actual interest rates to find how weak pass-through differs per country. The paper proceeds to conduct a bivariate regression between non-performing loans and weak pass-through, and finds a positive correlation for Italy, Spain, the United States, but not for the United Kingdom and France. Kapan and Minoiu [2013] examine the impact of balance sheet health on loan supply. Their results indicate that banks that relied relatively heavily on market-based funding were more likely to ration credit. In addition, well capitalized banks are less likely to ration credit, and there exists a positive interaction term between liquidity and solvency. In a BIS working paper, Gambacorta and Marques-Ibanez [2011] make a distinction between the determinants of bank lending prior, and during the crisis. Their main results - driven by microdata from over 1000 banks in the US and Europe - suggest that banks with lower capital ratios and larger dependence on market-funding rationed credit more strongly in times of crisis compared to calm economic times. The latter of these two independent variables suggest that the funding gap has played a role in the reduction of the supply of loans. It will be interesting to see if the funding gap also plays a role in interest rate pass-through. van Leuvensteijn et al. [2013] investigate the effects of competition on pass-through using the Boone indicator with a 10-year data sample starting in 1994. The Boone indicator is derived under the assumption that more efficient firms attract more market share. The more competitive the market is, the stronger an incremental improvement in efficiency is on market share. The authors include the Boone indicator in the error-correction estimation and find a negative significant sign in most specifications: more fierce competition leads to lower pass-through. Mojon [2000] finds that banks in competitive environments are characterized by higher estimates of short run pass-through. Similar results are found in Cotterli and Kourelis [1994] and Gigineishvili [2011].

3 Data

Data is collected for 11 countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. For the VECM specification, I extracted data for funding rates and retail rates from various sources. The VECM is estimated in two subperiods: the calm period, with effective monetary transmission, lasts from january 2003, up until august 2007 (2003M01-2007M08), and the crisis period corresponds to 2007M08-2013M03[5]. Retail interest rate data is publicly available from the SDW[6]. Eonia rates can be found on global-rates.com[7], three-month and six-month euribor rates come from euribor-ebf.eu[8], and 5- and 10-year government bond yields were extracted internally at DNB[9]. With respect to the determinants of interest rate pass-through, the main variables are capital ratios, loan to deposit ratios, competition, and non-performing loans. Since the results may vary for different types of the employed capital ratio, I

[5] In august 2007, euribor rates started rising quickly relative to the MRO (main refinancing operation) rate. de Socio [2011] finds that this can be attributed to increased liquidity risk perceptions by banks, initiating the problems in the interbank market. See figure 9 in the appendix for a graphical representation.

[6] Statistical Data Warehouse.

[7] http://www.global-rates.com/interest-rates/eonia/eonia.aspx

[8] http://www.euribor-ebf.eu/euribor-org/euribor-rates.html

[9] de Nederlandsche Bank.

acquired four types of capital ratios. Capital and reserves over total assets was acquired from a database at DNB with a monthly frequency over the entire sample period. Capital and reserves include equity capital, non-distributed benefits or funds, and specific and general provisions against loans, securities and other types of assets. To avoid notational clutter, I will refer to this ratio as simply capital over total assets. Tier 1 + tier 2 capital over total assets is made available from the World Bank with a yearly frequency from 2003 to 2011 or 2012, depending on country. Tier 1 and total regulatory capital over risk-weighted assets is made available by the International Financial Statistics database supplied by the IMF. Unfortunately, the dataset on tier 1 / RWA[10] and total regulatory capital / RWA was largely incomplete – comprising 4 to 7 years out of the 10 years examined, again depending on the country considered. For the years where these data were not reported, I constructed them by summing tier 1 and regulatory capital over total risk weighted assets for the five largest banks in each country, using microdata from Bankscope. Even with the additions from Bankscope, there are still some years where the tier 1– and total regulatory capital ratio could not be reported. For the loan to deposit ratio, loans and deposits to households and non-financial corporations were used. The data on this is made available by the SDW with a monthly frequency. The Herfindahl-index on total assets is extracted from the SDW with a yearly frequency from 2003 to 2012. Data on non-performing loans is available from the worldbank database and lasts from 2003-2011 / 2003-2012 depending on country. Additionally, two control variables are employed. To control for demand, data from the Bank Lending Survey was constructed. The relevant questions here from the BLS were, since my retail rates correspond to loans to households, and loans to firms, the following: "Over the past three months, how has the demand for loans or credit lines to enterprises changed at your bank, apart from normal seasonal fluctuations?" and "Over the past three months, how has the demand for loans to households changed at your bank, apart from normal seasonal fluctuations?". The bank lending survey presents the results in net percentages or as a diffusion index. Unfortunately, the Bank Lending Survey is unpublished for Greece and Finland, so I could not control for demand in those countries. As a general strategy, I used the reported net percentage[11] as a way of measuring demand shifts. However, for three out of the nine surveys examined, only diffusion indexes were available, which were then used to indicate demand shifts. The second employed control variable is HICP[12] inflation (2003-2013). Table 1 presents descriptive statistics on the employed variables. As can already be seen, mean values of pass-through – which will be estimated in section 5 – have fallen in the crisis sample. The capital to total assets ratio and the Herfindahl-index remained roughly the same, whereas Tier 1 and Tier 1 + 2 capital ratios have increased in value. Particularly illustrative of the crisis is the increase in the mean value of NPL - from 2.7 to 5.18. Another interesting descriptive statistic is loan demand, which faced a large drop in mean value. The coinciding movements in pass-through and banking statistics provides the first hint that the two may be interlinked.

[10] Risk-weighted assets.

[11] Here, the net percentage is calculated as $\frac{\sum Responsesincreased - \sum Responsesdecreased}{\sum Allresponses} * 100$, and the diffusion index is calculated as $\frac{\sum Responsesincreasedconsiderably - \sum Responsesincreasedsomewhat}{\sum Allresponses} * 100$ - $\frac{\sum Responsesdecreasedconsiderably - \sum Responsesdecreasedsomewhat}{\sum Allresponses} * 100$

[12] Harmonised index of consumer prices.

Table 1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
$passthrough_{calm}$	57	0.89	0.17	0.34	1.28
$passthrough_{crisis}$	56	0.52	0.34	0	0.93
CA/TA_{calm}	11	6.20	1.76	3.94	8.63
CA/TA_{crisis}	11	6.46	1.52	4.55	8.49
NPL_{calm}	11	2.7	1.89	0.34	6.04
NPL_{crisis}	11	5.18	3.52	0.52	11
$T1/RWA_{calm}$	11	9.11	1.95	7.313	14.387
$T1/RWA_{crisis}$	11	10.65	1.89	8.20	13.62
$(T1+T2)/TA_{calm}$	11	5.61	1.72	3.26	9.42
$(T1+T2)/TA_{crisis}$	11	5.75	1.22	4.37	8.57
$Reg.Cap/TA_{calm}$	11	12.09	1.87	10.14	17.21
$Reg.Cap/TA_{crisis}$	11	13.16	2.34	9.19	17.20
$Herfindahl_{calm}$	11	0.10	0.08	0.02	0.26
$Herfindahl_{crisis}$	11	0.11	0.09	0.03	0.33
$loandep_{calm}$	11	1.38	0.345	0.814	1.968
$loandep_{crisis}$	11	1.39	0.36	0.68	1.99
$inflation_{calm}$	11	2.20	0.68	0.95	3.23
$inflation_{crisis}$	11	2.12	0.53	0.79	2.79
$loandemand_{calm}$	9	4.00	10.18	-10.55	36.19
$loandemand_{crisis}$	9	-18.69	16.15	-53.33	15.95

4 Testing for cointegration: the Johansen method

Standard procedure in modern time-series econometrics is analyzing the stationarity of the variables of interest[13]. When these variables are indeed non-stationary, ordinary least squares will yield spurious results, where t-values may wrongfully suggest a meaningful economic relationship. Consider the following AR(1) process:

$$y_t = \rho y_{t-1} + \varepsilon_t, \tag{4.1}$$

which may be rewritten to:

$$(1 - L\rho)y_t = \varepsilon_t, \tag{4.2}$$

where L is a lag operator and $0 < \rho < 1$. In the case that ρ=1, the equation may be rewritten as:

$$\Delta y_t = \varepsilon_t \tag{4.3}$$

It is now easy to see that the error term translates one-to-one into Δy_t. Hence, shocks in the error term are non-decaying so that a permanent change in variable y_t results. The described situation where the coefficient $\rho = 1$ is called a unit root in the time series literature, which is equivalent to the time series being non-stationary. There are a number of tests to determine whether this is the case or not. The Dickey-Fuller test is obtained when subtracting y_{t-1} from both sides of equation (4.1):

$$\Delta y_t = \alpha y_{t-1} + \varepsilon_t \tag{4.4}$$

Here $\alpha = (\rho - 1)$. However, the Dickey-Fuller test is only valid in case of an AR(1) process. In case the series is characterized by higher significant lag lengths, the white noise assumption of ε is violated. To resolve this, lags are added

[13] In terms of methodology, this section draws upon Harris [1995] and Enders [2004].

to equation (4.4), which leads us to arrive at the following p-th order augmented Dickey-Fuller test equation:

$$\Delta y_t = \alpha y_{t-1} + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + ... + \beta_p \Delta y_{t-p} + \varepsilon_t \tag{4.5}$$

Again, $\alpha = (\rho - 1)$, so that the ADF test amounts to testing whether $\alpha = 0$, or equivalently, $\rho = 1$.
The results (see appendix, table 6) suggest that we are – in all but two cases – dealing with non-stationary variables. In principle, first differences can be taken to restore stationarity. The downside of this, however, is that any long run relationship can no longer be inferred. In case variables are cointegrated, a linear combination of the variables of interest will result in stationary error terms, so that first differencing is unnecessary. Having estimated that most of my time series are indeed $I(1)$, I will now, by following the Johansen procedure, estimate whether a linear combination of my $I(1)$ variables results in stationary $I(0)$ error terms. To determine the amount of lags used in the specification, the following VAR is estimated with the non-stationary variables in levels:

$$r_t = \sum_{k=1}^{n} \alpha_k r_{t-k} + \sum_{k=1}^{n} \beta_k i_{t-k} + \mu_t$$

$$i_t = \sum_{k=1}^{n} \gamma_k i_{t-k} + \sum_{k=1}^{n} \lambda_k r_{t-k} + \epsilon_t$$

Here, i_t denotes the underlying funding interest rate, which can be either a money market rate or a capital market rate, while r_t corresponds to the relevant retail rate. The optimal amount of lags was derived from the Schwarz information criterium[14]. Then, the Johansen procedure was followed in order to identify possible cointegration. In the Johansen procedure, the following vector error-correction model is run, which is effectively the VAR in first-differences plus an error-correction term.

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + ... + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-k} + \varepsilon_t$$

Here, $Z_t = \begin{pmatrix} r_t \\ i_t \end{pmatrix}$, $\Pi = \alpha\beta'$ where α is a vector of speed of adjustment parameters and β is the cointegration vector. In the Johansen cointegration test, the rank of the matrix Π denotes the amount of cointegrating relationships, which is equivalent to the amount of eigenvalues present in matrix Π. A full rank indicates that our variables are $I(0)$, so that there is no error-correction. In that case, the bivariate VECM is inappropriate and a standard VAR should be estimated instead. A rank of zero indicates non-cointegrating $I(1)$ variables, where the appropriate model is one where the variables are cast in first differences. Only when matrix Π has reduced rank, the matrix is separable between the speed of adjustment term and the cointegrating vector, so that we can speak of a cointegrating relationship between r_t, the retail rate and i_t, the funding rate.

Tables 6 to 11 show the test results for the presence of cointegration. The numbers – 0, 1, or 2 – indicate the cointegrating rank as found by the Johansen procedure. As said, a rank of zero indicates non-cointegrating $I(1)$ variables, a rank of one indicates cointegrating $I(1)$ variables, and a rank of two indicates that our variables may be $I(0)$. The numbers in brackets indicate the trace-statistics: a higher value corresponds to a stronger rejection of the null hypothesis that the cointegrating rank is zero. Since there is considerable heterogeneity in long run pass-through between the different types of funding rates, it is important to use the same funding rate in both periods in order to obtain comparable estimates. In principle, combinations of funding rates that yield the highest trace-statistics will be used in the succeeding section to estimate long run pass-through. Sometimes, in spite of the rejection of stationarity by the ADF test, the Johansen procedure will be unable to detect non-stationarity of the time series, yielding a cointegrating rank of two.

[14] As is common in the interest rate pass-through literature. See for example ECB [2009] and Aristei and Gallo [2012].

When encountered with this result I – when possible – will choose a funding rate combination with a cointegrating rank of unity in both subperiods, regardless of the magnitude of the trace-statistics. However, when only an option with two cointegrating relationships is available, adding additional lags in the Johansen test often reduced the cointegrating rank to one. In other cases, the amount of lags dictated by the Schwarz criterion only yielded cointegration in the calm sample, but no longer thereafter. This problem could often be circumvented by reducing the number of lags chosen in the Johansen test. In some cases, it was not possible to find cointegration in the crisis sample: Hence, there is no long run pass-through, so that the reported coefficient in the succeeding section will be set to zero. In other cases, cointegration could not be found in either period, or eye-ball econometrics clearly suggested that retail rates followed an independent trajectory of funding rates. For these cases, I did not report long run pass-through estimates in the succeeding section. The reported asterisks in the tables correspond to the funding rates chosen in the error-correction model in the following section. Table 13 presents – as a robustness check – speed of adjustment parameters by following the Engle-Granger methodology for detecting cointegration. Unfortunately, in some cases the Engle-Granger method was – as opposed to the Johansen method – unable to detect cointegration. This suggests that some of the cointegrating relationships as found by the Johansen procedure using non-optimal lags (as described above) are only weakly cointegrating. This may result in a small bias in the long run pass-through coefficients as calculated in the succeeding section.

5 Error-correction estimates of long run pass-through

In this section, I will present results of the long run relationship between funding rates, and retail rates. The relationship of interest is represented by the following equation:

$$r_t = \beta_0 + \beta_1 i_t + \varepsilon_t \tag{5.1}$$

Here, r_t equals the retail rate, i_t represents a funding rate, and β_1 equals the pass-through coefficient between the two interest rates. $\beta_1 = 1$ will then indicate full pass-through and thus perfect transmission of the funding rate to retail rates, i.e. a unit change of the funding rate translates into a unit change in retail rates. β_0 is a fixed mark-up, which may inter alia include profit margins and monitoring costs. Remember that, since all interest rates are non-stationary, OLS is inappropriate and first differences need to be taken. Doing this for equation (5.1) results in the following:

$$\Delta r_t = \eta_0 + \eta_1 \Delta i_t + \epsilon_t \tag{5.2}$$

In order to find a long run relationship, a VECM can be estimated when the variables are cointegrated. The estimated relationship is given by the following error-correction representation:

$$\Delta r_t = \alpha_0 + \sum_{k=1}^{n} \alpha_k \Delta r_{t-k} + \sum_{k=1}^{n} \theta_k \Delta i_{t-k} + \gamma(r_t - \beta_0 - \beta_1 i_t) \tag{5.3}$$

Note that the term in brackets in equation (5.3) is equivalent to the error term in equation (5.1). The error-correction model allows us to find both short run, long run, and speed of adjustment coefficients. θ_k indicates the pass-through of funding rates to retail rates in the short run, and β_1 provides the long run pass-through estimate, the coefficient we are most interested in. In case $\beta_1 = 1$, pass-through is complete. When $\beta_1 < 1$, pass-through is incomplete. Likewise, when $\beta_1 > 1$, retail rates over- or undershoot. The overshooting of pass-through may, inter alia, be due to banks switching to more risky projects during the examined time frame (de Bondt [2002]). γ indicates the speed at which disequilibria between the two rates are restored to equilibrium. In the absence of a significant estimate, there is no cointegration since no adjustment to equilibrium takes place.

For each respective retail rate, two ECMs are estimated: one for calm economic times, and one for times of crisis. Doing so will yield long run pass-through coefficients for both subperiods, so that we can identify whether pass-through has indeed deteriorated.

The estimated long run pass-through coefficients can be found in table 2. The results are in line with previous literature (Blot and Labondance [2011] Aristei and Gallo [2012]), although somewhat less pronounced. There are at least two reasons why this could be the case. First, monetary policy transmission faced the largest impairment at the beginning of the financial crisis (both authors examined a shorter crisis period subsample), and second, the aforementioned authors solely use eonia and 3-months euribor respectively as proxies for the MRO rate. As expected, the long run pass-through coefficient is lower for the crisis sample than for the calm sample in almost all cases. One of my particularly important results is that pass-through in the crisis sample for firm loans up to 1 million euro's – often attracted by SME's – has faced large deteriorations. In many cases, pass-through is found to be zero. For loans over 1 million euro's – often attracted by larger firms – pass-through has been relatively high in comparison. Pass-through in the mortgage retail market also suffered large blows: pass-through for new mortgage loans roughly halved in Belgium (from 1.117 to 0.539) and the Netherlands (from 0.959 to 0.459), and to a smaller extent in Spain, Germany, France, and Finland. For some countries, the deterioration in pass-through is stronger than in others. Austria, for example, seems relatively unaffected, whereas peripheral countries like Portugal, Spain, Ireland, Italy and Greece faced large impairments in pass-through, often ending up with a pass-through of zero. Another interesting case is Finland, where pass-through in the crisis sample remained quite high for most retail rates, but dropped to zero for firm loans up to 1 million euros. This indicates that the SME financing problem does not merely limit itself to the periphery. For France, long run pass-through has increased for outstanding loans to non-financial corporations with a maturity exceeding five years from 0.341 to 0.433. Unfortunately, both Blot and Labondance [2011] and Aristei and Gallo [2012] limit their analysis to newly issued loans, so that this rather puzzling result cannot be compared with previous literature. Table 12 in the appendix shows whether the differences in pass-through between the two subperiods are significant or not. As is clear, the differences in long run pass-through are significant in almost all cases. The results for Austria and France indicate that the reduction in pass-through has been moderate for these countries. For Austria, only significant differences can be reported for newly issued loans to firms, both up to- and over 1 million euro's. For France, only pass-through to retail rates over 1 million euros to non-financial corporations reports a marginally significant result at the 10% confidence interval.

Table 2: Long run pass-through

Outstanding		Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain
Mortgage Credit	Calm	0.843		1.015				0.975	0.877		0.938	1.186
with maturity	Std. Error	(0.107)		(0.07)				(0.044)	(0.068)		(0.043)	(0.051)
over 5 years	Crisis	0.868		0.862				0	0.698		0.93	0.809
	Std. Error	(0.039)		(0.01)					(0.018)		(0.01)	(0.026)
	Funding rate	eur6m		eur6m				eur3m	eur6m		eur3m	eur6m
Non-financial	Calm	0.786	0.867	0.954	0.723	1.281	0.814	1.037	0.891	0.626	0.743	0.955
corporations	Std. Error	(0.097)	(0.128)	(0.036)	(0.095)	(0.107)	(0.047)	(0.056)	(0.065)	(0.082)	(0.014)	(0.039)
with maturity	Crisis	0.642	0.647	0.703	0.594	0.543	0	0.898	0.667	0.634	0	
1-5 years	Std. Error	(0.009)	(0.014)	(0.008)	(0.025)	(0.018)		(0.018)	(0.042)	(0.037)		
	Funding rate	eur6m	eur3m	eur3m	eur6m	eur6m	eur6m	eonia	eur6m	eur6m	eur6m	eur6m
Non-financial	Calm	0.692		0.846	0.341		0.834	0.926	0.896	0.513	0.755	0.982
corporations	Std. Error	(0.067)		(0.031)	(0.053)		(0.076)	(0.055)	(0.043)	(0.08)	(0.024)	(0.051)
with maturity	Crisis	0.659		0.81	0.433		0.381	0.753	0.799	0.424	0	0.615
over 5 years	Std. Error	(0.007)		(0.005)	(0.02)		(0.055)	(0.02)	(0.025)	(0.009)		(0.03)
	Funding rate	eur6m		eur6m	eur3m		eur3m	eur6m	eur6m	eur6m	eur6m	eur6m
Newly issued												
Mortgage Credit	Calm	0.89	1.117	0.909	1.045	0.833	0.357	0.867	0.904	0.959	0.741	1.008
with maturity	Std. Error	(0.091)	(0.075)	(0.052)	(0.122)	(0.076)	(0.112)	(0.03)	(0.02)	(0.063)	(0.033)	(0.033)
up to 1 year	Crisis	0.858	0.539	0.736	0.824	0.744	0.338	0	0	0.459	0	0.679
	Std. Error	(0.025)	(0.042)	(0.018)	(0.087)	(0.009)	(0.07)			(0.02)		(0.033)
	Funding rate	eur6m	eur3m	eur3m	govbond5y	eur6m	eonia	eur6m	eur3m	eur6m	eur6m	eur3m
Non-financial	Calm	0.988	0.939	0.962		0.885	0.8	1.078	0.881	0.868	0.76	0.98
corporations	Std. Error	(0.086)	(0.037)	(0.042)		(0.036)	(0.048)	(0.048)	(0.047)	(0.032)	(0.032)	(0.059)
up to 1 million	Crisis	0.766	0.835	0		0.751	0	0.658	0	0.595	0	0
1y maturity	Std. Error	(0.009)	(0.017)			(0.01)		(0.051)		(0.012)		
	Funding rate	eur3m	eur3m	eur6m		eur3m	eonia	eur6m	eur3m	eur6m	eur3m	eonia
Non-financial	Calm	0.961	1.092	0.957	0.99	0.943	0.846	1.012	0.814	0.94		1.022
corporations	Std. Error	(0.022)	(0.034)	(0.039)	(0.076)	(0.034)	(0.082)	(0.053)	(0.061)	(0.038)		(0.032)
over 1 million	Crisis	0.762	0.901	0.813	0.84	0.773	0	0.866	0	0.79		0
1y maturity	Std. Error	(0.016)	(0.015)	(0.032)	(0.049)	(0.015)		(0.022)		(0.024)		
	Funding rate	eur3m	eonia	eur6m	eonia	eur6m	eonia	eur3m	eonia	eur3m		eur6m

Numbers correspond with the long run pass-through coefficient (β_1 in equation 5.3) between the reported retail rate and the funding rate. The numbers in brackets are standard errors.

6 Results

In this section, I try to explain cross-sectional heterogeneity in pass-through using capital ratios, a Herfindahl-index, non-performing loans, and loan to deposit ratios as explanatory variables. This section discusses the results in both the sample for calm economic times, and the sample of times of crisis. The equations estimated correspond to the following:

$$passthrough_{calm} = \alpha_0 + \underbrace{\alpha_1}_{0} capratio_{calm} + \underbrace{\alpha_2}_{0} loandep_{calm} + \underbrace{\alpha_3}_{0} herfindahl_{calm} + \underbrace{\alpha_4}_{+} NPL_{calm} + \lambda_i Z_i + \varepsilon \quad (6.1)$$

$$passthrough_{crisis} = \beta_0 + \underbrace{\beta_1}_{+} capratio_{crisis} + \underbrace{\beta_2}_{-} loandep_{crisis} + \underbrace{\beta_3}_{-} herfindahl_{crisis} + \underbrace{\beta_4}_{-} NPL_{crisis} + \gamma_i X_i + \varepsilon \quad (6.2)$$

Here, Z_i and X_i are vectors of control variables as described in the data section. The terms under braces reflect the expected signs on the coefficients, and correspond to the posited hypotheses in section 2. The following paragraph briefly explains the expected signs.

The financial crisis forced banks to improve their capital ratios. This can either be done by rationing credit or improving profit margins. In an attempt to improve capital ratios, banks will be less inclined to pass-through a decrease in market rates. Hence the positive sign on capital ratios for the crisis sample. Since banks were thought to have ample capital positions prior to the crisis, the expected sign for the calm sample equals zero. Due to the absense of functioning markets for securitization, banks will be inclined to keep deposit rates high in an attempt to attract deposits. Hence the expected negative sign on loan to deposits for the crisis subsample. Since markets for securitization boomed prior to the crisis, the expected sign for the calm subsample is zero. Moving on, in an environment of imperfect competition, there is assymetry in the pass-through from funding rates to retail rates over the interest rate cycle: When interest rates are trending up, the increase in funding rates will be passed-through to retail rates. Conversely, when interest rates are trending down, the incentive to pass-through lower funding rates to retail rates will be low in the absense of competition. When competition among banks is fierce, the assymetry dissipates: When interest rates are trending up, banks will be sure to pass-through increases in funding costs to prevent making losses. Likewise, when interest rates are trending down, banks pass-through lower funding costs to avoid losing market share (Mojon [2000]). During the crisis subperiod, when interest rates were trending down, the expected sign is negative: fierce competition among banks increases the incentive to pass-through lower funding rates (a low Herfindahl-index indicates fierce competition among banks). Since interest rates were trending up in the calm subperiod, the expected sign here is 0: regardless of the fierceness of competition, banks will always pass-through rising funding costs. Finally, when non-performing loans are numerous, banks may keep retail rates high in order to cushion the blow when losses need to be taken. Additionally, banks that face an increasing amount of non-performing loans will be driven to increase credit risk margins, thereby affecting pass-through. During the crisis, when interest rates were trending down, banks will keep pass-through low so as to increase the margin. For the same reason, in the calm subsample when interest rates were trending up, banks will more than fully pass-through a rise in funding rates in order to increase the margin. Hence the negative sign for the crisis sample and a positive sign for the calm sample.

The estimation results can be found in table 3 and 4. For every type of capital ratio, two equations are estimated. Model (1) is equivalent to equation (6.1) or (6.2) without Z_i and X_i respectively. Model (2) includes inflation and loan demand as control variables. When inflation is high, the real interest rate is lower and banks will want to keep pass-through high so as to compensate for the loss in return (Cotterli and Kourelis [1994]). Loan demand controls for fluctuations in bargaining positions of banks that may potentially influence pass-through. The amount of control variables in my model may be considered to be too limited. The author has tried to include other control variables such as return on assets, total bank assets to GDP, public debt to GDP, and GDP growth, but they proved unsatisfactory in improving the goodness of

fit. In addition, the aforementioned control variables were unable to turn up significant in any of the specifications, which also reduces the odds of the presence of omitted variable bias.
The regression estimates[15] for the calm sub-period are given in table 3, estimates of the crisis sample are projected in table 4.

The calm subsample Because inflation and loan demand turn out to be insignificant controls, only the results for the baseline estimation are reported. As expected, the fit of the models is very poor, with adjusted R^2 statistics ranging between 0.066 and 0.082. Indeed, capital ratios, the funding gap and competition play an insignificant role in determining long run pass-through. A somewhat surprising result is that non-performing loans turn out significantly negative in three out of four regression specifications. This result was only to be expected in the crisis sample when interest rates are trending down. The significant negative result indicates that when funding rates are increasing, banks with high non-performing loans tend to less than fully pass-through an increase in funding rates to retail rates. Unfortunately there is no theoretical mechanism that could explain why this is the case. The low fit of the model, however, indicates that the significance may be the result of omitted variable bias.

The crisis subsample Table 4 provides the estimates for the crisis sample. Interesting to note here is that the Adjusted R^2 values are higher in all regression specifications compared to the estimates for the calm subsample. This at least partly confirms the hypothesis that capital ratios, loan to deposit ratios, competition, and non-performing loans are better able to explain cross-country heterogeneity in pass-through in times of crisis. In the baseline estimation without control variables, the capital over total assets ratio has a negative significant sign. However, when the risk-weighted tier 1, or risk-weighted total regulatory capital ratio is used, the sign reverses, is significant, and as expected according to the posited hypothesis: in times of crisis, banks that are below regulatory capital requirements are more likely to keep interest rates high. Because the regulatory framework of Basel III is aimed at safeguarding capital over risk-weighted (and thus not gross) assets, the positive significant sign here confirms my hypothesis. Nonetheless, the sign reversal between the capital ratios remains somewhat of a mystery and may deserve some attention in future research[16]. The funding gap does not turn out to be significantly negatively related with pass-through[17]. Apparently, there is no European-wide tendency for banks to keep interest rates high in order to attract funding. Nonetheless, there may be a role for the funding gap for specific retail markets or specific countries. The limited amount of calculated long run pass-through observations makes this a difficult exercise to uncover. In four of the specifications, the sign on the Herfindahl-index gets the expected negative sign and is significant: a higher Herfindahl-index results in lower pass-through. However, due to the serious shortcomings of the Herfindahl-index as discussed in subsection 2.3, the significant result here should only serve as a hint for future research. These limitations not withstanding, the results on competition are in line with findings by e.g. Sabarowski and Weber [2013], Mojon [2000] and van Leuvensteijn et al. [2013]. The high importance of non-performing loans as a determinant found in Illes and Lombardi [2013] and Sabarowski and Weber [2013] is not confirmed by my results: Non-performing loans turn out to be insignificant in most specifications. Indeed, only in two specifications, there is a significantly negative association between pass-through and non-performing loans, while five other specifications show an insignificant negative sign. It seems that capital is the main driver of pass-through heterogeneity.

[15] In some cases, robust standard errors are used when heteroskedasticity was found to be present.
[16] Figure 8 provides a graphical representation of the association between pass-through and capital ratios. The graphs confirm that there is a strong fit in times of crisis in opposing directions for the two capital ratios depicted.
[17] Figure 7 shows that there is a negative association between average long run pass-through and loan to deposits in the crisis sample. Upon investigation, the reader may identify Greece and Portugal as problematic outliers. Leaving them out of the regression specification, however, does not lead to higher significance of the loan to deposit variable.

Table 3: Regression results equation 12: calm sample

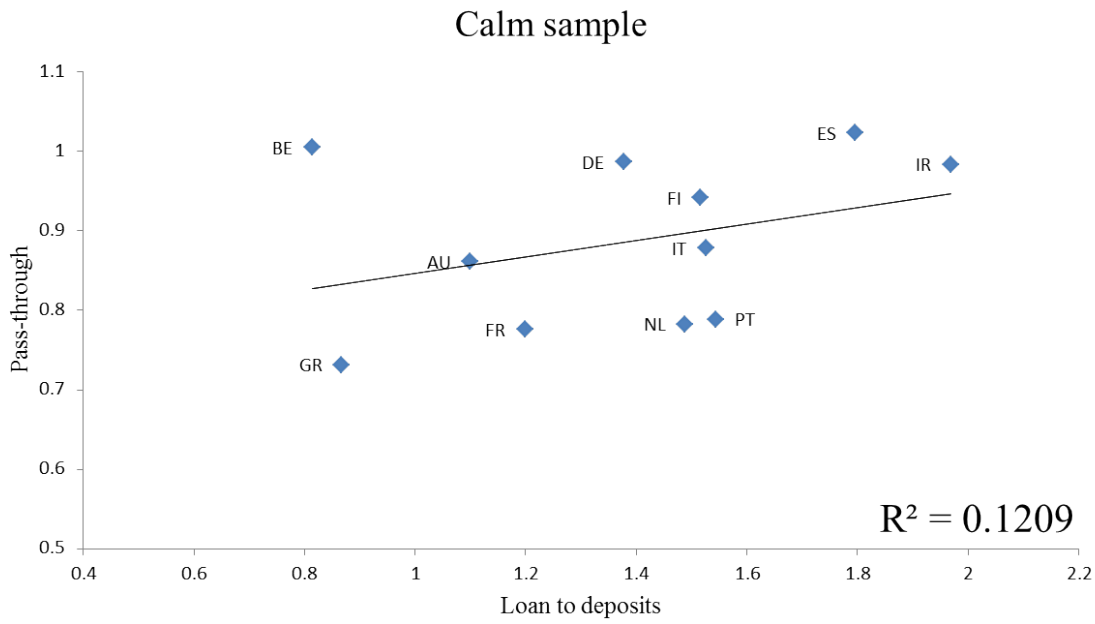
	Capital / assets		Tier 1+2 / assets		Tier 1 / RWA		Regulatory capital / RWA	
Parameters	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
$\alpha_1$capratio	−0.008		0.008		0.021		0.012	
$\alpha_2$loandep	0.035		−0.015		−0.017		0.000	
$\alpha_3$herfindahl	−0.332		−0.544		−0.991		−0.628	
$\alpha_4$non-performing loans	−0.028		−0.036**		−0.037***		−0.032**	
λ_1Loan demand								
$\lambda_2$inflation								
Constant	0.993***		1.016***		0.915***		0.893***	
Adj R^2	0.066		0.066		0.082		0.073	
Robust Std. Errors?	no		yes		yes		yes	
Observations	57		57		57		57	

*** ** and * indicates significance at the 99%, 95% and 90% respectively.

Table 4: OLS regression results equation 13: crisis sample

	Capital / assets		Tier 1+2 / assets		Tier 1 / RWA		Regulatory capital / RWA	
Parameters	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
$\beta_1$capratio	−0.114**	−0.167***	−0.026	0.031	0.098***	0.120***	0.067***	0.097***
$\beta_2$loandep	0.090	−0.131	−0.024	−0.232	0.029	−0.157	0.034	−0.073
$\beta_3$herfindahl	−0.773*	−2.886***	−0.563	0.018	−1.209**	−2.213**	−0.323	−1.526
$\beta_4$non-performing loans	−0.016	0.007	−0.040***	−0.049***	−0.019	−0.011	−0.019	−0.017
$\gamma_1$loan demand		−0.009**				−0.008*		−0.009**
$\gamma_2$inflation				−0.237*				
Constant	1.305***	1.848***	0.982***	1.426***	−0.321	−0.401	−0.278	−0.600
Adj R^2	0.244	0.258	0.133	0.187	0.282	0.254	0.265	0.240
Robust Std. Errors?	yes	no	no	yes	yes	no	no	no
Observations	56	45	56	56	56	45	56	45

*** ** and * indicates significance at the 99%, 95% and 90% respectively.



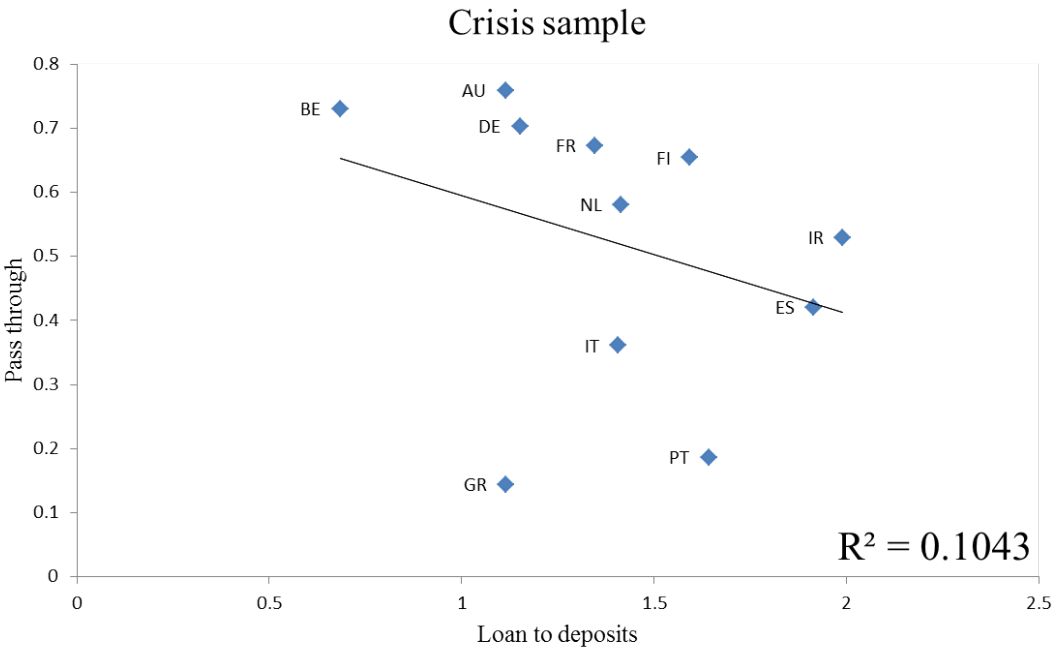


Figure 7: Loan to deposits and average pass-through

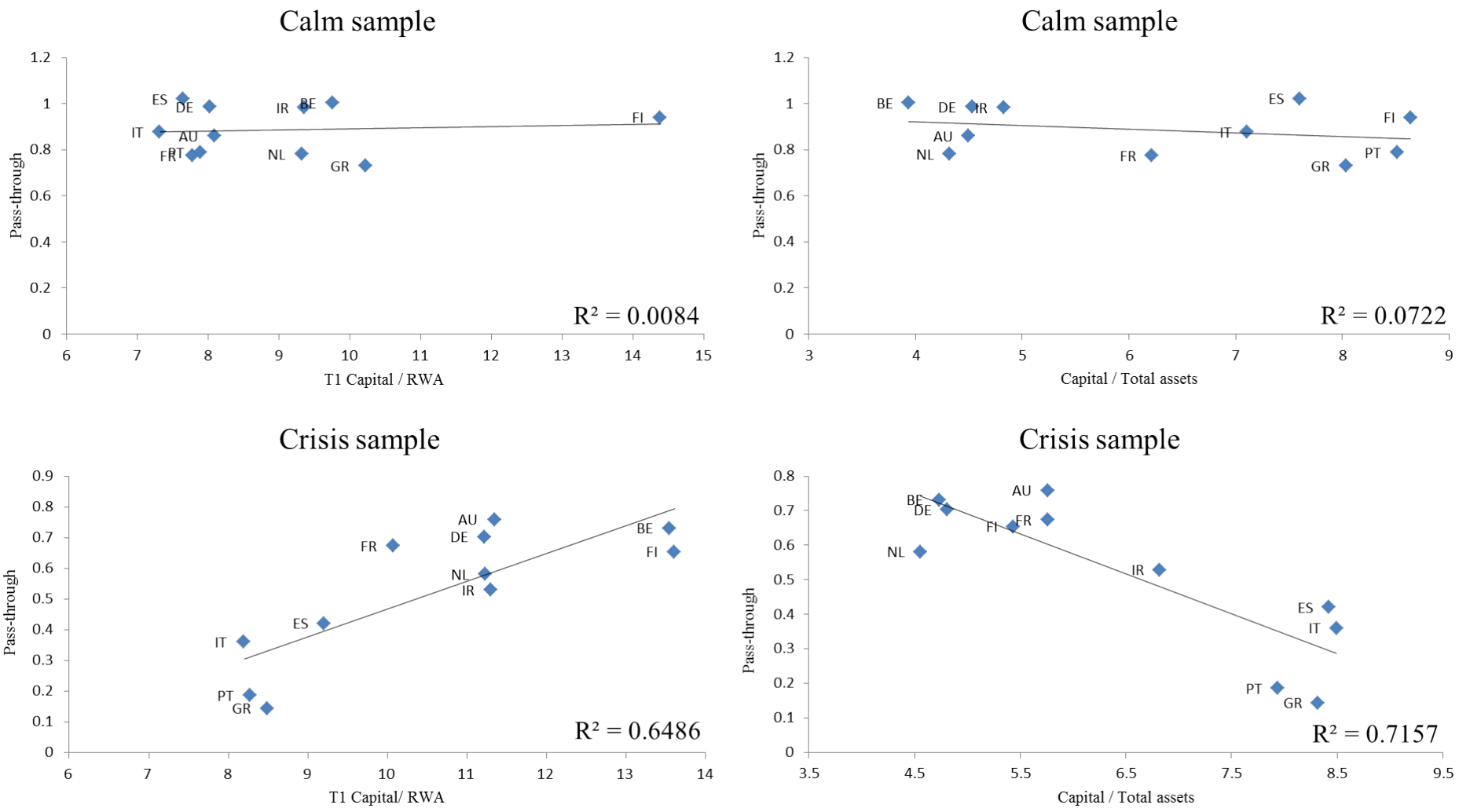


Figure 8: Capital ratios and average pass-through

7 Conclusion

The financial crisis resulted in large consequences for the effectiveness of monetary policy transmission. This thesis was written in an attempt to uncover why interest rate pass-through has been so weak since the onset of the financial crisis. To answer this question, a two step estimation technique was used. First, long run pass-through from funding rates to retail rates was estimated using an error-correction model. The results indicated that the crisis indeed resulted in significantly lower pass-through, with particularly strong effects in the periphery. Second, I regressed long run pass-through estimates with capital ratios, loan to deposit ratios, non-performing loans, and competition to find if these variables are able to explain why some countries had stronger pass-through during the crisis than others. The main result is that banks with higher regulatory capital ratios tend to have higher pass-through estimates. The absense of significant estimates for the loan to deposit ratio suggests that the funding gap does not play a significant role for the examined retail rates. In addition, I find a negative association between the Herfindahl-index and pass-through estimates that is quite robust across the different specifications. However, considering the serious limitations of the Herfindahl-index as a measure for competition, the result should, in spite of being in line with theory, be interpreted with care. More numerous non-performing loans result in significantly lower pass-through in two specifications. Five other specifications report a negative but insignificant estimate. The main policy implication is as follows and in line with other literature (e.g. van Horen and de Haan [2013], Kapan and Minoiu [2013], Gambacorta and Marques-Ibanez [2011]): Since regulatory capital ratios are significantly positively related to long run pass-through across specifications, banks should be recapitalized so as to improve pass-through, thereby repairing part of the monetary transmission mechanism. Adequate financial means to recapitalize banks following the asset-quality review are therefore of high importance.

There are a number of suggestions for future research. First, research may be dedicated to calculating pass-through for a larger range of countries, such that the distinction between retail markets can more easily be made. Second, the poor quality of the Herfindahl-index makes it an unrealiable measure for competition, such that policy implications can not directly be taken. For that reason, future research may focus on using more sophisticated measures of competition, such as the Boone indicator or a Lerner-index.

8 Appendix

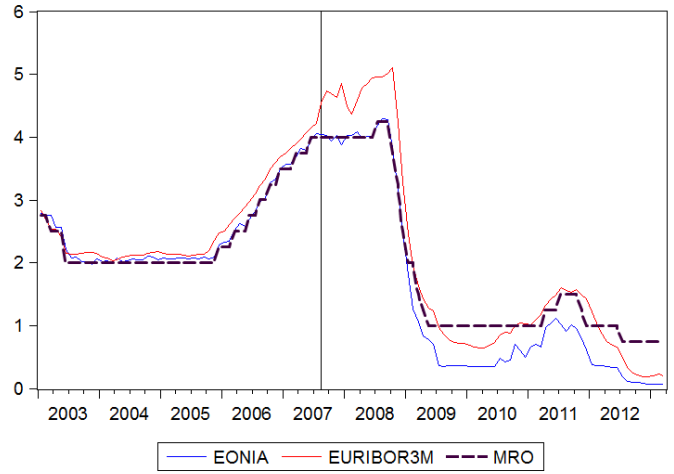


Figure 9: **Eonia, 3-months Euribor, and the MRO rate. 2003M01-2013M03. Source: ECB, global-rates.com, euribor-ebf.eu**

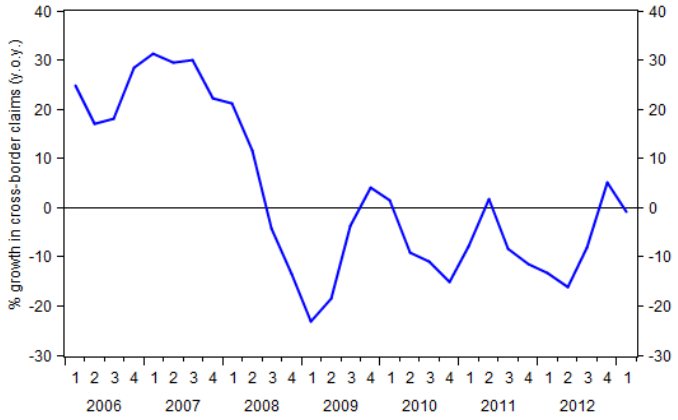


Figure 10: **Eurozone cross-border banking. 2005Q1-2013Q1 y.o.y. growth. Source: BIS**

Table 5: Unit root p-values

	Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	the Netherlands	Portugal	Spain	
Funding rates												
EONIA												0.6887
3-month EURIBOR												0.5459
6-month EURIBOR												0.6658
Gov. Bond 5y	0.7708	0.7284	0.6153	0.5824	0.4852		0.3527	0.5824	0.6016	0.0528	0.0385	
Gov. Bond 10y	0.7632	0.7608	0.7069	0.5154	0.4846	0.3517	0.4856	0.5154	0.6296	0.3068	0.1744	
Outstanding retail rates												
Mortgage Credit >5y	0.3807	0.338	0.414	0.157	0.5673	0.5219	0.3455	0.659	0.0502	0.1812	0.1775	
NFC 1-5y	0.272	0.7343	0.2824	0.9368	0.2831	0.2269	0.3739	0.2684	0.227	0.1753	0.1358	
NFC >5y	0.1887	0.2315	0.6018	0.4055	0.5833	0.1419	0.4015	0.484	0.1973	0.2759	0.1555	
Newly issued retail rates												
Mortgage Credit 1y	0.4958	0.1778	0.3186	0.3555	0.3992	0.2777	0.2478	0.2495	0.3509	0.2591	0.2386	
NFC <1mln 1y	0.3941	0.6992	0.6024	0.3803	0.3803	0.2321	0.2496	0.3312	0.5589	0.0697	0.1636	
NFC over 1mln 1y	0.5664	0.2454	0.7369	0.8858	0.8858	0.456	0.8267	0.5458	0.7871	0.5439	0.431	

Table 6: Cointegrating rank and trace statistics for rate on outstanding mortgage rates with maturity greater than 5 years

	Calm					Crisis				
Country	eonia	euribor3m	euribor6m	gov bond 5y	gov bond 10y	eonia	euribor3m	euribor6m	gov bond 5y	gov bond 10y
Austria	2 [40.41]	1 [27.44]	1 [32.77]*	1 [24.41]	0 [20.21]	1 [25.13]	1 [33.57]	1 [34.47]*	0 [13.22]	0 [06.05]
Belgium	2 [32.89]	2 [26.29]	2 [27.88]	2 [27.18]	1 [25.42]	0 [08.24]	0 [09.93]	0 [10.41]	1 [19.54]	0 [07.62]
Finland	2 [18.68]	2 [29.24]	2 [72.64]*	0 [07.69]	0 [07.89]	0 [10.42]	1 [14.96]	1 [34.01]*	0 [06.92]	0 [12.82]
France	1 [30.52]	1 [20.11]	1 [17.11]	0 [08.27]	0 [07.98]	1 [15.39]	1 [13.89]	1 [14.54]	0 [13.11]	0 [11.03]
Germany	2 [42.72]	2 [29.15]	2 [27.09]	1 [23.59]	1 [23.01]	1 [21.24]	1 [22.64]	1 [23.37]	2 [40.84]	2 [36.51]
Greece	1 [22.00]	1 [21.85]	1 [24.69]	-	1 [19.01]	0 [10.07]	0 [09.58]	0 [09.99]	-	0 [03.53]
Ireland	2 [24.72]	1 [31.34]*	2 [50.66]	0 [13.38]	0 [08.71]	0 [05.94]	0 [05.39]	0 [05.11]	0 [07.71]	0 [06.06]
Italy	2 [22.82]	1 [21.89]	1 [35.28]*	1 [18.85]	1 [13.60]	1 [26.28]	1 [21.39]	1 [35.82]*	0 [11.03]	0 [09.11]
the Netherlands	2 [14.83]	1 [30.02]	2 [31.06]	1 [39.32]	2 [29.70]	1 [16.84]	1 [21.80]	1 [16.15]	1 [19.77]	1 [14.45]
Portugal	0 [11.80]	1 [27.18]*	1 [25.55]	0 [12.24]	0 [08.73]	2 [24.91]	1 [41.71]	1 [36.16]*	0 [11.68]	0 [09.53]
Spain	2 [29.78]	1 [37.31]	1 [41.34]*	1 [16.27]	2 [16.99]	2 [23.98]	1 [26.97]	1 [26.03]*	0 [12.90]	0 [10.86]

Note: * indicates the chosen funding rate in the VECM specification

Table 7: Cointegrating rank and trace statistics for rate on outstanding loans to NFC with maturity between one and five years

	Calm					Crisis				
Country	eonia	euribor3m	euribor6m	gov bond 5y	gov bond 10y	eonia	euribor3m	euribor6m	gov bond 5y	gov bond 10y
Austria	2 [16.64]	1 [17.94]	1 [29.59]*	0 [10.55]	0 [12.83]	2 [42.60]	2 [46.20]	1 [24.75]*	0 [07.22]	0 [04.06]
Belgium	2 [32.04]	2 [24.12]*	2 [110.19]	1 [17.41]	0 [08.31]	2 [25.21]	1 [23.78]*	1 [24.81]	0 [06.62]	0 [03.96]
Finland	1 [13.64]	1 [35.33]*	1 [32.10]	0 [05.88]	0 [05.54]	2 [14.65]	1 [20.82]*	1 [20.93]	0 [07.73]	0 [07.35]
France	1 [22.55]	1 [18.77]	1 [22.81]*	1 [20.86]	0 [09.93]	2 [18.76]	1 [18.28]	1 [19.27]*	1 [18.47]	0 [09.83]
Germany	2 [41.06]	2 [32.70]	2 [31.75]*	1 [31.40]	0 [11.41]	2 [14.14]	0 [09.59]	0 [11.24]*	0 [11.75]	0 [10.00]
Greece	1 [22.09]	1 [27.94]	1 [27.94]*	-	0 [07.23]	0 [04.79]	0 [04.45]	0 [06.20]	-	0 [08.58]
Ireland	1 [43.62]*	1 [47.86]	1 [47.73]	1 [25.57]	0 [06.75]	1 [30.92]*	2 [43.19]	1 [24.15]*	0 [06.99]	0 [05.55]
Italy	1 [20.88]	1 [25.05]	1 [30.89]*	0 [06.68]	0 [08.12]	0 [06.46]	0 [04.27]	0 [03.82]*	0 [05.13]	0 [05.98]
the Netherlands	1 [22.30]	1 [16.65]	1 [21.62]*	1 [20.93]	0 [09.51]	0 [07.51]	0 [04.30]	0 [04.30]*	0 [06.10]	0 [05.50]
Portugal	0 [08.60]	2 [39.07]	1 [43.49]*	0 [08.95]	0 [03.67]	0 [05.30]	0 [09.06]	0 [13.06]	0 [11.44]	0 [11.00]
Spain	1 [20.06]	1 [26.51]	1 [30.93]*	0 [07.80]	0 [05.41]	2 [18.52]	0 [10.22]	0 [06.30]	0 [09.20]	0 [07.86]

Note: * indicates the chosen funding rate in the VECM specification

Table 8: Cointegrating rank and trace statistics for rate on outstanding loans to NFC with maturity exceeding 5 years

	Calm					Crisis				
Country	eonia	euribor3m	euribor6m	gov bond 5y	gov bond 10y	eonia	euribor3m	euribor6m	gov bond 5y	gov bond 10y
Austria	2 [20.38]	1 [16.63]	1 [32.39]*	0 [12.18]	0 [11.83]	2 [46.77]	1 [36.26]	1 [31.96]*	0 [06.58]	0 [03.86]
Belgium	0 [08.27]	0 [11.19]	0 [09.16]	0 [11.53]	0 [12.74]	0 [12.30]	0 [11.75]	0 [11.40]	0 [10.22]	0 [06.48]
Finland	0 [09.91]	1 [28.69]*	1 [34.15]	0 [11.88]	0 [06.10]	2 [22.54]	2 [48.08]*	1 [45.31]	0 [07.92]	0 [07.54]
France	1 [26.51]	1 [23.69]*	1 [21.84]	1 [16.62]	0 [12.54]	2 [32.77]	1 [27.91]*	1 [25.78]	1 [17.78]	0 [08.30]
Germany	2 [38.00]	2 [25.83]	2 [29.54]	1 [38.01]	1 [35.28]	1 [14.64]	1 [14.64]	0 [08.52]	0 [10.97]	0 [08.62]
Greece	1 [20.19]	1 [21.96]*	1 [17.20]	-	0 [09.86]	0 [06.38]	0 [03.84]*	0 [03.48]	-	0 [07.07]
Ireland	2 [24.96]	1 [31.21]	1 [34.00]*	1 [20.02]	0 [07.44]	2 [15.42]	0 [06.59]	0 [04.26]*	0 [06.56]	0 [05.14]
Italy	1 [23.84]	1 [23.90]	1 [36.70]*	0 [07.13]	0 [09.25]	2 [37.12]	2 [21.37]	0 [07.99]*	0 [07.37]	0 [07.41]
the Netherlands	2 [32.51]	1 [24.44]	1 [29.21]*	1 [39.47]	0 [10.64]	2 [14.00]	0 [12.21]	1 [15.82]*	0 [08.36]	0 [06.22]
Portugal	0 [06.53]	2 [20.51]	1 [24.63]*	0 [08.94]	0 [08.61]	0 [06.52]	0 [04.60]	0 [08.11]	0 [08.33]	0 [07.91]
Spain	1 [17.70]	1 [22.94]	1 [25.90]*	0 [08.69]	0 [06.24]	2 [16.81]	2 [14.73]	0 [07.30]*	0 [10.98]	0 [08.46]

Note: * indicates the chosen funding rate in the VECM specification

Table 9: Cointegrating rank and trace statistics for rate on newly issued mortgage loans with maturity smaller than one year

	Calm					Crisis				
Country	eonia	euribor3m	euribor6m	gov bond 5y	gov bond 10y	eonia	euribor3m	euribor6m	gov bond 5y	gov bond 10y
Austria	1 [23.90]	1 [17.97]	1 [26.93]*	1 [32.78]	0 [08.63]	2 [28.03]	1 [27.14]	1 [20.95]*	0 [06.34]	0 [03.37]
Belgium	0 [04.99]	0 [09.96]*	0 [07.71]	0 [12.49]	0 [06.39]	2 [14.64]	0 [10.40]*	0 [08.59]	0 [05.90]	0 [05.47]
Finland	0 [08.74]	1 [17.66]*	1 [17.94]	0 [05.93]	0 [06.89]	2 [22.87]	1 [14.32]*	0 [06.61]	0 [05.05]	0 [05.31]
France	1 [33.10]	1 [18.91]	1 [21.64]	1 [32.75]*	0 [09.25]	2 [25.33]	2 [42.79]	2 [26.47]	1 [17.83]	0 [10.10]
Germany	1 [16.15]	1 [15.90]	1 [18.19]*	0 [09.41]	0 [06.95]	2 [17.80]	2 [24.69]	1 [27.70]*	0 [05.80]	0 [04.29]
Greece	1 [16.24]	1 [21.26]*	0 [11.81]	-	2 [18.76]	0 [08.12]	0 [08.32]*	0 [07.64]	-	0 [06.31]
Ireland	1 [14.55]	1 [30.55]	1 [41.95]*	0 [12.55]	0 [10.67]	0 [11.11]	0 [06.37]	0 [05.38]	0 [07.81]	0 [06.27]
Italy	0 [10.23]	1 [24.71]*	1 [62.37]	0 [10.76]	0 [05.38]	0 [05.53]	0 [04.52]	1 [04.51]	0 [05.27]	0 [05.38]
the Netherlands	0 [04.12]	0 [12.86]	1 [13.51]*	0 [06.93]	0 [06.64]	2 [18.33]	1 [20.50]	1 [19.85]*	0 [11.48]	0 [08.35]
Portugal	0 [03.91]	2 [22.68]	1 [31.47]*	1 [17.75]	0 [08.99]	0 [06.99]	0 [04.10]	0 [03.99]	0 [07.63]	0 [07.68]
Spain	0 [09.84]	0 [05.59]*	1 [23.38]	0 [08.48]	0 [06.35]	0 [06.27]	0 [12.91]*	0 [06.25]	0 [06.72]	0 [07.10]

Note: * indicates the chosen funding rate in the VECM specification

Table 10: Cointegrating rank and trace statistics for rate on newly issued loans to NFC up to 1 million euros

	Calm					Crisis				
Country	eonia	euribor3m	euribor6m	gov bond 5y	gov bond 10y	eonia	euribor3m	euribor6m	gov bond 5y	gov bond 10y
Austria	1 [17.52]	1 [18.82]*	2 [77.47]	1 [19.49]	1 [19.49]	2 [29.92]	0 [04.99]*	0 [03.07]	0 [06.21]	0 [05.98]
Belgium	0 [09.84]	1 [14.31]*	1 [17.49]	0 [12.29]	0 [11.40]	2 [22.31]	1 [16.62]*	0 [13.27]	0 [05.63]	0 [04.23]
Finland	0 [07.82]	0 [11.70]	0 [12.06]*	1 [15.17]	0 [11.21]	0 [12.08]	0 [05.34]	0 [04.63]	0 [04.62]	0 [04.58]
France	1 [16.59]	0 [10.99]	0 [07.75]	0 [12.10]	0 [08.38]	2 [16.42]	0 [12.72]	0 [09.72]	0 [09.71]	0 [07.67]
Germany	1 [15.56]	1 [21.85]*	1 [20.66]	0 [11.67]	0 [07.53]	0 [10.84]	2 [23.71]*	2 [24.56]	0 [05.33]	0 [05.68]
Greece	1 [16.48]*	2 [15.49]	2 [15.89]	-	0 [09.51]	0 [11.00]	0 [11.63]	0 [10.99]	-	0 [05.16]
Ireland	1 [19.08]	1 [20.92]	1 [31.80]*	0 [11.38]	0 [12.38]	0 [09.50]	0 [04.88]	0 [05.31]*	0 [05.92]	0 [04.66]
Italy	1 [19.96]	1 [20.12]*	1 [16.32]	1 [14.40]	0 [11.43]	0 [05.28]	0 [02.95]	0 [02.91]	0 [04.49]	0 [04.12]
the Netherlands	0 [12.72]	2 [18.24]	1 [25.15]*	1 [15.22]	0 [09.61]	2 [24.17]	1 [22.05]	1 [21.37]*	0 [09.01]	0 [04.51]
Portugal	1 [24.38]	1 [33.78]*	1 [25.43]	1 [14.46]	0 [06.49]	0 [06.94]	0 [04.42]	0 [04.38]	0 [04.99]	0 [04.70]
Spain	1 [20.36]*	2 [19.98]	1 [56.45]	2 [15.57]	1 [14.93]	0 [09.02]	0 [04.68]	0 [04.01]	0 [08.47]	0 [05.48]

Note: * indicates the chosen funding rate in the VECM specification

Table 11: Cointegrating rank and trace statistics for rate on newly issued loans to NFC over 1 million euros

	Calm					Crisis				
Country	eonia	euribor3m	euribor6m	gov bond 5y	gov bond 10y	eonia	euribor3m	euribor6m	gov bond 5y	gov bond 10y
Austria	1 [32.47]	2 [27.84]*	1 [29.02]	1 [14.58]	0 [08.02]	2 [20.56]	0 [10.11]*	0 [06.56]	0 [04.32]	0 [03.49]
Belgium	0 [10.97]*	1 [20.79]	1 [23.80]	0 [12.88]	0 [10.70]	0 [10.49]*	0 [05.82]	0 [06.08]	0 [06.30]	0 [04.92]
Finland	1 [17.06]	2 [27.34]	1 [26.55]*	1 [14.80]	0 [07.45]	2 [16.13]	0 [12.99]	0 [10.79]*	0 [05.79]	0 [03.39]
France	1 [15.77]*	1 [17.77]	1 [20.70]	0 [11.49]	0 [05.82]	0 [12.52]*	0 [06.75]	0 [06.12]	0 [05.62]	0 [04.53]
Germany	1 [22.42]	2 [29.99]	1 [24.76]*	0 [12.29]	0 [07.58]	0 [08.93]	0 [11.34]	1 [15.57]*	0 [06.48]	0 [07.00]
Greece	1 [18.84]*	2 [23.64]	2 [21.47]	-	0 [05.13]	0 [06.13]	0 [04.47]	0 [04.32]	-	0 [04.89]
Ireland	0 [07.33]	1 [18.25]*	1 [20.91]	0 [12.33]	0 [06.53]	0 [23.19]	1 [14.68]*	0 [11.98]	0 [05.13]	0 [04.03]
Italy	1 [13.71]*	2 [18.69]	2 [16.14]	0 [08.46]	0 [07.62]	0 [05.11]	0 [03.07]	0 [03.01]	0 [03.32]	0 [03.22]
the Netherlands	1 [28.21]	2 [23.93]*	2 [84.41]	0 [10.26]	0 [08.57]	0 [13.04]	0 [13.00]*	0 [10.50]	0 [05.53]	0 [03.42]
Portugal	0 [11.97]	2 [18.23]	2 [19.88]	0 [10.21]	0 [07.18]	0 [07.36]	0 [03.99]	0 [03.92]	0 [04.61]	0 [04.66]
Spain	2 [20.36]	2 [19.98]	1 [19.96]*	2 [15.58]	1 [14.93]	0 [09.02]	0 [04.68]	0 [04.01]	0 [08.47]	0 [05.48]

Note: * indicates the chosen funding rate in the VECM specification

Table 12: Z-test for significantly different coefficients

	Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain
Outstanding											
Mortgage Credit 5y mat.	-0.220	n.a.	2.164**	n.a.	n.a.	n.a.	n.a.	2.545**	n.a.	0.181	6.586***
NFC 1-5y mat.	1.478	1.709***	6.806***	1.313	6.802***	n.a.	2.363**	2.895***	-0.089	n.a.	n.a.
NFC >5y mat.	0.490	n.a.	1.146	-1.624	n.a.	4.829***	2.956***	1.950*	1.106	n.a.	6.203***
Newly issued											
Mortgage Credit 1y mat.	0.339	6.724***	3.144***	1.475	1.163	0.144	n.a.	n.a.	7.564***	n.a.	7.050***
NFC <1mln 1y mat.	2.567***	2.554**	n.a.	n.a.	3.586***	n.a.	5.997***	n.a.	7.988***	n.a.	n.a.
NFC >1mln 1y mat.	7.315***	5.140***	2.854***	1.659*	4.575***	n.a.	2.544**	n.a.	3.337***	n.a.	n.a.

Note: *** ** and * indicates significance at the 99%, 95% and 90% CI respectively. Calculation of the z-statistic is done with the following formula $\frac{b_1 - b_2}{\sqrt{(SEb_1^2 + SEb_2^2)}}$

Table 13: Engle-granger speed of adjustment parameters

Outstanding		Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain
Mortgage Credit	Pre-crisis	-0.035		-0.093^{**}				-0.134	-0.070		-0.166^{***}	-0.283^{***}
with maturity	(Std. Error)	(0.027)		(0.026)				(0.051)	(0.024)		(0.031)	(0.047)
over 5 years	Crisis	-0.117^{***}		-0.271^{***}					-0.166^{***}		-0.301^{***}	-0.173^{**}
	(Std. Error)	(0.019)		(0.020)					(0.021)		(0.018)	(0.050)
	Funding rate	eur6m		eur6m				eur3m	eur6m		eur3m	eur6m
Non-financial	Pre-crisis	-0.071	-0.014	-0.106^{**}	-0.092	-0.019	-0.235^{*}	-0.159^{*}	-0.136^{*}		-0.252^{***}	
corporations	(Std. Error)	(0.029)	(0.034)	(0.030)	(0.050)	(0.026)	(0.072)	(0.048)	(0.040)		(0.041)	
with maturity	Crisis	-0.547^{***}	-0.259^{***}	-0.500^{***}	-0.290^{***}	-0.269^{***}		-0.439^{***}	-0.071			
1-5 years	(Std. Error)	(0.069)	(0.042)	(0.048)	(0.053)	(0.047)		(0.048)	(0.037)			
	Funding rate	eur6m	eur3m	eur3m	eur6m	eur6m	eur6m	eonia	eur6m		eur6m	
Non-financial	Pre-crisis	-0.083		-0.108^{**}	-0.157^{***}		-0.079	-0.150^{***}	-0.124^{**}	-0.026	-0.241^{***}	-0.097^{*}
corporations	(Std. Error)	(0.032)		(0.028)	(0.073)		(0.035)	(0.040)	(0.035)	(0.017)	(0.049)	(0.029)
with maturity	Crisis	-0.415^{***}		-0.310^{***}	-0.209^{***}		-0.052	-0.162^{**}	-0.292^{***}	-0.318^{***}		-0.209^{***}
over 5 years	(Std. Error)	(0.051)		(0.019)	(0.044)		(0.037)	(0.043)	(0.033)	(0.037)		(0.028)
	Funding rate	eur6m		eur6m	eur6m		eur3m	eur6m	eur6m	eur6m	eur6m	eur6m
Newly issued												
Mortgage Credit	Pre-crisis	-0.119	-0.120	-0.124	-0.121^{***}	-0.182	-0.098	-0.245^{**}	-0.310^{***}	-0.159^{*}	-0.211^{***}	-0.318^{***}
with maturity	(Std. Error)	(0.053)	(0.050)	(0.057)	(0.039)	(0.072)	(0.077)	(0.063)	(0.065)	(0.046)	(0.050)	(0.060)
up to 1 year	Crisis	-0.266^{***}	-0.070	-0.147	-0.135^{***}	-0.665^{***}	-0.067			-0.263		-0.174^{*}
	(Std. Error)	(0.050)	(0.044)	(0.076)	(0.030)	(0.077)	(0.052)			(0.085)		(0.051)
	Funding rate	eur6m	eur3m	eur3m	govbond5y	eur6m	eonia	eur6m	eur3m	eur6m	eur6m	eur3m
Non-financial	Pre-crisis	-0.121	-0.354^{**}	-0.213			-0.645^{***}	-0.197	-0.119	-0.228	-0.284^{***}	-0.263^{***}
corporations	(Std. Error)	(0.051)	(0.099)	(0.084)			(0.133)	(0.066)	(0.055)	(0.091)	(0.086)	(0.057)
up to 1 million	Crisis	-0.344^{**}	-0.369^{***}					-0.409^{**}		-0.666^{***}		
1y maturity	(Std. Error)	(0.088)	(0.083)					(0.104)		(0.122)		
	Funding rate	eur3m	eur3m	eur6m				eur6m	eur3m	eur6m	eur3m	eonia
Non-financial	Pre-crisis	-0.368^{**}	-0.453^{***}	-0.213	-0.413^{***}	-0.366^{**}	-0.612^{***}	-0.530^{**}	-0.472^{***}	-0.780^{***}		-0.425^{***}
corporations	(Std. Error)	(0.094)	(0.110)	(0.084)	(0.114)	(0.096)	(0.132)	(0.129)	(0.121)	(0.136)		(0.094)
over 1 million	Crisis	-0.609^{***}	-0.516^{***}	-0.132	-0.246	-0.686^{***}		-0.659^{***}		-0.494^{***}		
1y maturity	(Std. Error)	(0.121)	(0.091)	(0.073)	(0.081)	(0.119)		(0.116)		(0.107)		
	Funding rate	eur3m	eonia	eur6m	eonia	eur6m	eonia	eur3m	eonia	eur3m		eur6m

*** ** and * indicates significance at the 99%, 95% and 90% CI respectively, using Engle-Granger critical values.

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