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Interest rate sensitivity of the banking sector non-maturing deposits

Master's thesis

Programme Applied Economics, specialisation Economic Analysis

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Tallinn 2021

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The document length is 14831 words from the introduction to the end of conclusion.

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ABSTRACT

In this study the author estimates the interest rate sensitivity of the non-maturing deposits of the banking sector in the eurozone countries. The interest rate sensitivity was measured by estimating the relationship between the volumes of the banking sector non-maturing deposits and the general level of the market interest rates in the eurozone.

The author used the autoregressive distributed lags (ARDL) method to identify the possible cointegration between the volumes of the non-maturing deposits and the market rates and the OLS estimator with autoregressive term to assess the short-term relationship between changes in the volumes of the non-maturing deposits and changes in the market interest rates.

No significant link can be detected between the volume of the non-maturing deposits and the market interest rates. Based on this it can be concluded that maturity transformation function provided by the banking sector does not create significant exposure to the interest rate risk and the interest rate risk is not an impediment to the flow of funds from the short-term savings to the long-term lending.

Keywords: interest rate sensitivity of deposits, demand deposits, non-maturing deposits, interest rate risk in the banking book.

INTRODUCTION

The aim of this study is to measure the interest rates sensitivity of the banking sector non-maturing deposits in the eurozone countries.

Banking sector provides the funding maturity transformation service to the economy enabling a more efficient flow of funds from savings to investments. The nature of the maturity transformation involves assuming significant maturity mismatch between the assets and the liabilities of the banking sector since the asset side lending has significantly longer maturities than the average maturity of the liabilities. This gives rise to the liquidity risk and the interest rate risk. These risks attach a certain cost to the maturity transformation function (for example Busch and Memmel (2016) analysed the costs of maturity transformation). If the cost which accompanies the maturity transformation is high, it may have a bearing on the speed and price of the channelling of savings to investments.

The interest rate risk associated with the maturity transformation of the banking sector materializes when the interest rates change differently for the instruments in the assets and liabilities. This may be caused by a general increase of the market interest rates, change of the shape of the market interest rate curve, i.e. short-term interest rates could move differently than the long-term interest rates, or when interest rates on different instruments with similar maturity move differently due to being connected to different indices, the so-called basis risk (EBA 2018). The often-cited example of the interest rate risk case is the US Savings & Loans crisis in 1980s, when savings and loans associations incurred large losses after a sharp increase in the market interest rates (Drechsler et al 2018, p 10).

An important risk factor influencing the interest rate risk of the banking sector is the behaviour of the customer deposits in response to changes in interest rates, or in other words the interest rate sensitivity of the customer deposits. However, the interest rate sensitivity of the customer deposits may not be as easily observable based on the contractual characteristics of such deposits as in case of other instruments. Particularly the interest rate sensitivity of the non-maturing deposits may be difficult to measure. Non-maturing deposits are deposits which do not have a clear contractual time to maturity or have zero contractual maturity and can be withdrawn at any time. One example of non-maturing deposits is a demand deposit, but also some other type of saving deposits can exhibit non-maturing deposits characteristics. Despite having zero maturity the non-maturing deposit behave on aggregate level as stable long-term instrument, which is usually priced below the market rates. The stability and low price make the non-maturing deposits an important and valuable source of funding, which can potentially keep the cost of maturity transformation in the economy low. Despite having these valuable characteristics, the non-maturing deposits remain an instrument with an elusive interest rate sensitivity. Measuring the interest rate sensitivity of the non-maturing deposits is important to understand the true cost of the maturity transformation. Kerbl et al (2019) study shows that banks use varying assumptions regarding the non-maturing deposits and that the assumptions impact the reported interest rate risk level to a great extent.

Customer deposits make up a significant part of the eurozone banking sector funding structure. Customer deposits accounted for 31% of total funding of the banking sector eurozone as of second quarter of 2020. Non-maturing deposits formed majority, 64%, of the total customer deposits. (ECB Statistical Data Warehouse). The non-maturing deposits in the eurozone are priced under normal circumstances at noticeably lower interest rates compared to the market interest rate. The era of the negative market interest rates created an important exception, because the non-maturing deposits interest rates are sticky at zero percent level, while the market interest rates fell into the negative territory. The size and the price of non-maturing deposits make it an important driver of the banking sector profitability.

The issue of the interest rate sensitivity of the non-maturing deposits is two-fold. First, the sensitivity of the <u>interest rates</u> offered on the non-maturing deposits can be measured. One can measure the speed and the degree at what a shock in the market rates is passed through to customer deposit interest rates. There are numerous studies addressing this aspect of the customer deposits behaviour.

The second and more precise way to measure the interest rate sensitivity of the non-maturing deposits is understand how the <u>volume</u> of the non-maturing deposits reacts to changes in both the market interest rates and the rates offered on the non-maturing deposits. This is a less obvious source of the deposits interest rate sensitivity, but it is equally important from the maturity transformation cost perspective. If customers relocate a significant part of the non-maturing deposits to other saving and investment instruments in response to a change of the interest rate the banking sector will have to replace this funding with other instruments. Since the non-maturing deposits are priced below the market rates, it means that the replacement instruments are priced closer to the market rates and a jump-like increase in the cost of funding can happen. An obvious alternative to a non-maturing deposit from a customer perspective is a deposit with agreed maturity (a term deposit) in the same bank. A shift of the balances from the non-maturing deposits to the term deposits has a negative impact on the profitability of a bank, because of the price differences between the two types of the deposits.

Looking at the distribution of the customers deposits between the non-maturing deposits and deposits with agreed maturity, one can see that it is far from stable. Non-maturing deposits volumes in the eurozone fluctuated from 36% of the total customer deposits in December 2003, when the general level of the interest rates was relatively high, to 64% in June 2020, when the interest were at historically lowest level.

The non-maturing deposits can be divided into core-deposits and non-core deposits. The core deposits are the ones the clients keep in the bank for the purpose of managing everyday liquidity and servicing recurring transactions. The core-deposits exhibit extremely stable behaviour and low interest rate sensitivity, because regardless of the level of the interest rates the clients will have to maintain a liquidity buffer for servicing forecasted or potential cash outflows.

The non-core part of the non-maturing deposits is the optional liquidity, the amount of which is optimized by the economical agents based on various factors. One of the important factors driving the size of this liquidity maintained by economic agents is the difference between the interest rate offered by the bank on non-maturing deposits and the yield on alternative investments. If the difference is small the convenience of having liquidity outweighs the advantage of investing in the alternative instruments. If the difference is large the clients are likely to choose to invest in other instruments leading to decreasing non-maturing deposits accounts balances. The decrease of the cheap non-maturing deposits means the banking sector has to rely more on other more expensive sources of funding.

Since the non-maturing deposits form such a large part of the banking sector funding and is a major driver of profitability it is important to measure how sensitive non-maturing deposits react to changes in the general level of the interest rates. If the sensitivity is low the price of funding of the banking sector is stable and depends to a little extent on changes in the market interest rates. If the sensitivity is high, the price of funding of the banking sector reacts quickly to changes in the market rates.

The interest rate sensitivity of non-maturing deposits was the object of several studies in Europe, USA and other regions. However, to the author's knowledge no such publicly available research was undertaken specifically for the eurozone banking sector.

The research questions of this study are:

1) how sensitive is the volume of the banking sector non-maturing deposits to changes in the market interest rates?
2) how does sensitivity on non-maturing deposits compare across different countries?

The author limited the study with eurozone region, because of the better comparability of the reporting. The author used ECB Statistical Data Warehouse and the Eurostat database as the source of the data.

The author used autoregressive distributed lags (ARDL) estimator to identify cointegration presence. For countries and time-series where no cointegration could be found the short-term relationship in the first differences was estimated. The standard tests for breaks was applied to find trend breaking points in the dependent variables time series, which were then used in the regressions.

This study is structured as follows. The first chapter provides justification why the non-maturing deposits interest rate sensitivity problem is important and summarises the literature where the problem of measuring the non-maturing deposits sensitivity was tackled. The second chapter describes the dataset and econometrical methods used. The third chapter describes the results of the regression analysis. The forth chapter interpret the results obtained by the regression analysis. The final chapter concludes the study.

1 ECONOMIC THEORY

1.1 Interest rate risk in the banking sector

The interest rate risk is an important part of the overal risk profile of banking sector. The importance of the interest rate risk in the banking book has been recognised by financial regulators. Basel Committee on Banking Supervision (hereafter referred as BCBS) issued a detailed standard on the management of the interest rate risk in the banking book in April 2016 (BCBS, 2016). The European Banking Authority (hereafter referred as EBA) issued a guidelines on the same topic in July 2018 (EBA, 2018). The interest rate risk in a banking book is defined as a possibility of an adverse impact the changes in the market interest rates can have on earnings or capital of a bank (BCBS, 2016 p. 3).

EBA guidelines states that interest rate risk in the banking book should be regarded as a significant risk and a bank should always assess it explicitly (EBA, 2018 p. 8). BCBS standards stipulate that the interest rate risk in the banking book is a material risk for all banks and must be specifically measured (BCBS, 2016 p. 4).

The interest rate risk in the banking book has a dual nature. It can be measured as an impact on the economic value or the earnings of a bank (BCBS, 2016 p. 3; EBA, 2018 p. 8). The interest rate risk in the banking book from economic value perspective can materialize if unfavourable changes lead to a decrease of the present value of the cash flows of a bank, which in turn will cause the economic value of a bank to diminish. The economic value metrics take into account the impact on all the cash flows up untill the date of the last cash flow of the longest instrument.

The earnings perspective of interest rate risk in the banking book focuses on the impact the changes in the market interest rate can have on the profit of a bank. The earnings metrics have a set horizon, e.g. one, two or three years. (EBA, 2018 p. 6) EBA guidelines require that the earnings risk metrics should include both changes in the net interest income of a bank and changes of the market value of instruments. Depending on an accounting approach used toward a specific balance sheet item the changes of the market value of the instruments can reveal themselves in the profit and loss account of a bank or for instruments measured through the other comprehensive income in reserve items within the own capital of a bank. (EBA, 2018 p. 8)

Both the earnings and economic value risk metrics have its advantages and disadvantages. The economic value approach may be regarded as theoretical. The accounting value of the balance sheet items measured at amortised cost are not impacted by the changes in their present value and therefore a bank will never incur the loss in the present value directly in its profit and loss account. The loss of the economic value will only be revealed if a bank is forced to sell its balance sheet portfolio in an arm-length transaction. The advantage of the economic value approach is its comprehensevness, its ability to quantify all maturity mismatches till the longet maturity of the last remaining cash flow in a concise and easy to understand risk metric.

The earnings perspective has an advantage of measuring the highly relevant indicator – the impact on the profitabilty, which is usually high on banks management's agenda. The disandvantage of the earnings perspective is that it focuses on the relatively short term horizon (one to three years) and may miss the pockets of risk located further down in the maturity ladder.

Focusing only on one of the two interest rate risk in the banking book perspective may lead to increasing the exposure in terms of the remaining perpective. For instance if a bank strives to hedge its risk positions based on the economic value metric by matching the maturity of its assets and liabilities it could assume the risk of earnings volatility. (BCBS, 2016 p. 3) The BCBS and EBA standards require that the banks manage interest rate risk in the banking book both from economic value and the earnings perspective (BCBS, 2016 p. 6; EBA, 2018 p. 8).

1.2 Importance of measuring non-maturing deposits sensitivity

Modeling unobserved characteristics of the non-maturing deposits is an important part of the risk management of interest rate risk in a banking book of a bank. The BCBS standard state that the risk measurement of the interest rate risk in the banking book is impacted signficantly by assumptions made regarding, among other things, the non-maturing deposits (BCBS, 2016 p. 10). EBA guidelines require that modeling assumptions, including those with regard to treatment of balances and interest payments of non-maturing deposits, should be fully understood by the management and well documented (EBA, 2018 p. 27).

The BCBS suggest a standardised approach for measuring the interest rate risk in the banking book as a possible fallback solution for the internal management system. Under the standardized approach banks should identify the stable and non-stable part of the non-maturing deposits based on the last 10 years of observations of the customers behaviour. The stable part of non-maturing deposits should, in turn, be split into core and non-core non-maturing deposits. The non-core non-maturing deposits are assumed to re-price overnight while the core non-maturing deposits can have a re-pricing maturity of up to several years. BCBS standard puts maximum limits on the proportion of non-maturing deposits which can be considered core non-maturing deposits and the re-pricing maturity of the core deposits as shown in the Table 1 below (BCBS, 2016).

Table 1. Limits on proportion and maturity of non-maturing deposits suggested by BCBS

	Cap on proportion of core deposits	Cap on average maturity of core deposits, years
Retail/transactional	90%	5.0
Retail/non/transactional	70%	4.5
Wholesale	50%	4.0

Source: BCBS, 2016, p. 26

Neither BCBS standards nor EBA guidelines prescribe how the core part of the stable deposits and the re-pricing maturity of the core deposits within the limits should be estimated. Therefore it remains for each individual bank to develop a method suited for its individual situation.

The non-maturing deposits make for an important source funding of eurozone banking sector. According to the data published by European Central Bank (hereafter referred as ECB) the non-maturing deposits accounted for 31% of total funding the Eurozone banks as of Q2 2020.

The assumptions regarding the re-pricing maturity can have a drastic impact on the outcome of interest rate risk measurement. Therefore, if one wants to understand the impact of the interest rates have on the profitability of the banking sector, it is of the utmost importance to understand how sensitive the non-maturing deposits are to changes in the interest rates.

Understanding the non-maturing deposits sensitivity to interest rates became more important in the era of the negative market interest rates. Since the beginning of the 2014 many benchmark market interet rates became negative. Banks, for the most part, avoid passing the costs associated with the negative market rates to deposit customers. More importantly, the negative interest rates may have disrupted normal relationships between interest rates and depositors behaviour rendering previous models imprecise as to predicting the impact when market interest rates start returning to positive value.

The volume of non-maturing deposits should negatively correlate with the market interest rates, which is a proxy for a yield of all alternative fixed rate investments. The volume of the non-maturing deposits should positively correlate with the interest rates offered on the non-maturing deposits.

The currently seen relatively high level of the non-maturing deposits reflect the fact that during the period of the negative interest rates the opportunity cost is low or even negative.

1.3 Review of academic literature

The first strain of the academic literature of interest for the purpose of this study is the research regarding the overall level of the interest rate level of the banking sector. Indeed, if the interest rate risk level is low, that could mean either that non-maturity deposits have long behavioural maturity and banks can use them to fund long-term lending without being exposed to maturity mismatch, or that banks hedge the interest rate risk effectively, for instance by means of derivatives.

The existing literature gives mixed evidence on the level of the interest rate risk in the banking sector, probably depending on individual national specificities.

Männasoo (2013) in her study of Estonian banks concluded that volatility of the interest rates have a small impact on the both loans and deposits interest rate spreads. Männasoo (2013) concludes that this could be attributed to prevalence of variable intererst rate loans in the Estonian banking sector.

Busch and Memmel (2016) estimated that maturity transformation function accounted for 37% of the net interest margin of German banks in 2012-2013, while liquidity management and payment services accounted for 47% of the net interest margin. Busch and Memmel described that the liquidity management and payment services provided by the banking sector are not usually covered by direct fees charged for those services, but customers pay for those services indirectly via reduced fees on non-maturing deposits and additional premium added to lending prices. While Busch and Memmel did not analyse the connection between the volumes of non-maturing deposits and interest rates, the proportion of the net interest margin attributed to other non-interest rate related components may provide insight to what degree the depositors are motivated to maintain deposit balances due to other non-yield related factors. This can be thought of as an interest rate sensitivity measure of customer deposits. However, the cumulative estimation of the maturity transformation premium does not answer the question what the contribution of the non-maturity deposits is to the overall transformation premium, as opposed to other instruments the banks have on their balance sheet.

Kerbl et al (2019) gives an overview of a interest rate risk measure in Austrian banks during 2005-2018. By comparing the result of the parallel 200 basis point shift of the interest rate curve to the own funds, they show that the level of the interest rate risk has steadily increased during 2005 to 2018, especially in the large banks when correcting for differences in the assumptions used by banks for the non-maturing deposits (Kerbl et al, 2019, p. 78). Kerbl and Sigmund (2016) find that the changes of the market interest rates impact the net interest margin singificantly while being around zero, but the impact is less prominent when the market rates move farther into the positive territory.

The current low interest rates environment makes the interest rate risk particularly important. Neisen and Schulte-Mattler (2020) point out that the maturity transformatin undertaken by the banking sector is a challenge in the low or negative interest rates and flattened interest rate curve environment. Neisen and Schulte-Mattler (2020) suggest that a signficant interest income can only be earned in this environment by assuming a disporportionally high level of the interest rate risk. (Neisen, Schulte-Mattler, 2020, p. 235)

Memmel (2020) found that the banks are prepared to tolerate a certain level of the interest rate risk arising as banks satisfy their customers' demand for fixed rate loans and do not hedge this risk fully by using interest rate derivatives or interbank loans.

The studies on how the banking sector customer deposits react to market interest rates can be contingently divided by their focus into several large parts. The first part deals with the relationship between the pricing of customer deposits and the market interest rates (so called pass-through rates), and ignore or makes simplified exogenous assumptions regarding the volume of the deposits. Most recent examples of this branch of the research are Paraschiv (2013), Stanislawska (2015), Hussain and Hannar (2015), Holmes et al (2015). These studies typically find that pass-through of the market rates to deposit rates is slow, incomplete and in some cases asymmetrical. This is direction of the research is most numerous.

A second direction of research, connected to the pass-through mechanism, are studies assessing the value non-maturing deposits and finding ways to manage interest rate risk connected to them. For example Hutchison and Pennacchi (1996) modeled the interest rate paid by a bank on non-maturing deposits as a function of the market rates and several other market variables. The estimated deposit rates are used to value of the future profit stream from deposit issue. By estimating sensitivity of the value of the future profit streams to changes in the market interest rates, which effectively produces a measure of the non-maturing deposits duration. Another example of such research is Dewachter et al. (2006), who proposed a framework for estimating the value non-maturing deposits based on a sample of Belgian banks during 1994-2005. Their framework is based on estimating elasticity of non-maturing deposits premiums, which is a sum of discounted net cash flows a bank earns from a pool of non-maturing deposits. The volume of non-maturing deposits is assumed to be exogenous and the authors tested the model with several exogenous decay rates. Dewachter at al found that the premium component of non-maturing deposits is statistically and economically significant. The authors also found that the value of non-maturing deposits depreciates strongly with rising market interest rates.

Blöchlinger (2015) approaches the problem determening the duration of the non-maturing deposits as an option valuation problem. He highlights the non-linear nature of the non-maturing deposits valuation due to the discretionary pricing by banks and withdrawal right of the depositors. Blöchlinger (2015) shows that the duration of a non-maturing account is far from constant and changes depending on the level of the market interest rates. Particulalry he estimates that in a low interest rate environment the duration of a non-maturing deposit is significantly longer than in normal circumstances.

There is also a direction of research, which aims at managing the interest rate risk connected to non-maturing deposits by creating replicating portfolios. Replicating portfolios in its simplest form is a portfolio of bonds, which replicates as precisely as possible the interest rate payable (level and sensitivity) on non-maturing deposits portfolio. Replicating portfolios is often a tool used by banks for managing non-maturing deposits portfolios. Kalkbrener and Willing (2004) used a replicating portfolio technique.

There is a body of more recent studies which recognize that in addition to the pricing the issue of the relationship between the market interest rates and the volume (or maturity) of non-maturing deposits must also be dealt with. Blöchlinger (2018) wrote that when measuring its interest rate exposure a bank must make assumptions how the customers payments to or from non-maturing deposit accounts vary with changes in the market interest rates. The number of studies pursuing this direction is significantly smaller. K. Nyström wrote in 2008: "In our opinion the literature on the management of the non-maturing assets and liabilities seem surprisingly thin considering its fundamental importance to the banking industry. In fact, only during the past 10-15 years have several authors started to develop approach to the valuation and risk management of the non-maturing assets where both interest rate risk and the problem of undetermined maturity are accounted for." (Nyström (2008), p. 714) Blöchlinger (2015) remarks that determening the valuation of the non-maturing deposits is less studied aread, despite its rising importance, partly because of the increasing regulatory expectations towards the banking sector risk management standards. (Blöchlinger, 2015, p. 35).

The issue of modeling the volume of the deposits is often dealt with by an autoregressive process to account for natural inertia of the deposits, augmented by various explanatory variables, which expected to influence the volume of the deposits (Nyström (2008), p. 716).

O'Brien (2000) developed a system to estimate drivers of the volume and interest rates of NOW and MMDA deposits in 160 USA banks during 1983-1991. O'Brien (2000) does not suggest a full theoretical concept for behavour of the balances of clients' deposits but remarks that the opportunity cost influences deposit demands. O'Brien proceeds to model deposit balances can be modeled in a way similar with the money demand, where the main drivers are the market interest rates, nominal income and the first-order autoregressive term. For the volume deposits he used three explanatory variables: a difference between deposit rate and money market rate, measure of banks client income and an autoregressive term of deposit volume. Brien found that market interest rates have a negative impact on the volume of deposits for most banks, however the most important variable was the autoregressive term (lagged volume of deposits). O'Brien used forecasted deposits rate to deal with simultaneous bias. O'Brien found that rates of deposits adjust slowly to the equilibrium level and the speed of adjustment is asymmetrical: higher for rising and lower for decreasing interest rates.

Frachot (2001) suggests a hypothesis that non-maturiting deposit holders target a certain minimum balance on their account for the purpose of satisfying their liquidity and short-term savings requirements. This target amount depends on the market interest rates. When market rates are close to zero the customers are likely to accumulate more assets on the non-maturing accounts. As the market interest rates rise the customers are motivated to trasnfer their excess liquidity to other higher yield saving products. Frachot suggests a model, where the non-maturing accounts balances steadily increase if the market rates are sufficiently low, because the customers are directing a certain proportion of their savings formed each period to the non-maturing accounts. Once the market rates exceed a certain customer specific strike level, the additional placement of savings to the non-maturing account stop and the balance start to slowly drain to its target level, which is dependent on the liquidity needs of a customer.

Drechsler et al (2018) studied a panel of US banks during 1984-2017. Drechsler et al (2018) concluded that banks are not exposed to the interest rate risk despite having a large maturity mismatch, because banks have pricing power over retail deposits and such deposits are not sensitive to the interest rates. Drechsler et al (2018) referred to large fixed costs, which must be undertaken to retain retail deposits, however, once made the costs are fixed and do not depend on the market rates, therefore the retail deposits assume characteristic of a long-term liability.

Sheehan (2012) made a somewhat unique study based on retention rates of non-maturing deposits of five USA banks. Retention rates are a direct and best way to assess non-maturing deposits behavioral maturity and its drivers. However this data is not publicly observed and require access to confidential client information. Sheehan (2012) used VAR model to forecast retention rates. The model included total NMD balances, retention rates and deposit and market rates as variables. Sheehan found that impact of market rates on retention rates is insignificant, while the impact was visible for total balances of non-maturing deposits. He concluded that changes in the market interest rates have little impact on existing depositors, but a greater impact on new depositors.

Blöchlinger (2018) in his study of Swiss banks assumed that the volume of the non-maturing deposits can be modeled as a supply function dependent on the opportunity cost of maintaining a balance on the non-maturing account. Blöchlinger estimated that changes in the volume of the non-maturing deposits are most adequately estimated by the average difference between customer rate and short term rate during last 12 months and by a 5 year market rate. Blöchlinger remarks that the duration of non-maturing deposits is extremely long in the low interest rate environment because of the zero percent floor embedded in the deposits. In the high interest rates regime the available non-maturing deposits pool is shallower because depositors have other higher yield alternatives (Blöchlinger 2018, p 11).

Castagna, Manenti (2013) split the non-maturing (sight) deposits into the core and the volatile part. The core deposits are not sensitive to the market interest rates, but slowly amortize over a long period of time. The volatile part is withdrawn quickly as it is used to service the clients' liquidity needs. Castagna, Manenti (2013) suggest that the volume non-maturing deposits is driven by liquidity needs, risk appetite of the depositors, and opportunity cost between alternative investment opportunities. If the general level of the market interest rates increase the depositors are inclined to remove cash from their non-maturing deposits and invest in other higher yielding assets. Castagna, Manenti (2013) suggest two different models. A first simpler linear approach models the deposit volume based on four variables: the market interest rates, deposit interest rates, first order autoregressive term and a linear trend. The second model assumes a non-linear relationship between the non-maturing deposits, depositors' regular income, clients' individual interest rate strike level and individual liquidity needs.

The most comprehensive conceptual approach to modelling the non-maturing deposits, as far at the author of this study was able investigate, is suggested by Nyström (2008). Nyström suggests a view of a customer, which receives in his transactional account income cash-flow. The transactional account pays zero or very low interest. The customer aims to keep in his transactional account a certain target amount which is proportional to his regular income cash-flow. This is the amount the customer needs to keep to cover his short-term liquidity needs. The customer's has a number of other alternative investments opportunities, between which to distribute his savings portfolio. The customer rebalances his portfolio to keep in the transactional account the target amount and invest the remnant into other investments opportunities. The customer has an unknown strike level with regard to the market interest rates, which drive the returns on the other investment opportunities. If the market rates exceed the customer's individual strike level, the customer lowers the target level which he desires to keep in the transactional account (expressed as a proportion of the regular income cash-flow). The basic idea behind the Nyström's concept is that when the market interest rates increase, the difference between the returns on alternative investments and the low return on the transaction account also starts to increase, making the alternative investment more attractive for a customer. When this difference exceeds a certain individual trigger level the customer makes decision to re-balance his savings portfolio. In addition, it is assumed that the market interest rates influence the customer's propensity to save. Similarly, when the market interest rates exceed a certain trigger level the customer increases the proportion of its income directed to savings leading to the growth ot the overal savings portfolio of which a transactional deposit is one part. Nyström assumes that the income of the customer increases in time thus causing an exogenous linear growth in transactional deposits volume. (Nyström (2008), pp. 723-725)

The author of this study has a strong view that studies focusing on the pricing of the non-maturing deposits while providing an important insight do not give sufficient information for understanding the true impact of non-maturing deposits behavior on the banking sector. Therefore it is necessary to account for the relationship between the market interest rates and volume (or maturity) of the non-maturing deposits. This relationship seems to be relatively less studied, as many authors concentrate on the pricing the non-maturing deposits instead. To the knowledge of the author no comprehensive studies were undertaken for the panel of European countries to examine the the volumes of the non-maturing deposits as a function of the market interest rates.

2 DATASET AND METHODOLOGY

2.1 Dataset

This study includes 19 eurozone countries for the period from 31 Jan 2003 to 30 June 2020.

All the variables used in the regressions in this thesis were derived from a dataset consisting of the three main blocks:

1. The volume of the non-maturing deposits of households and non-financial companies for the 189eurozone countries from the statistical data warehouse of the European Central Bank (data table codes: *BSI.M.XX.N.A.L21.A.1.U2.2240.Z01.E* and *BSI.M.XX.N.A.L21.A.1.U2.2250.Z01.E*, where XX represents a two-letter country code).
2. The euro sovereign and interbank interest rates obtained from the Eurostat database (Eurostat data table codes *irt_euryld_m* and *irt_st_m*).
3. The interest rates offered by banking sector on non-maturing deposits of households and non-financial companies for the 19 eurozone countries from the statistical data warehouse of the European Central Bank (table codes *MIR.M.XX.B.L21.A.R.A.2250.EUR.N* and *MIR.M.XX.B.L21.A.R.A.2240.EUR.N*).
4. The nominal GDP volumes for the 19 eurozone countries from the Eurostat database (Eurostat data table codes *namq_10_gdp*, filters "Current prices, million euro" and "Gross domestic product at market prices").

The author would wish to use a longer sample period. However, the data on the non-maturing deposit volumes and interest rates was missing for many countries before 31 January 2003.

The data listed in the points 1 to 3 above was with monthly frequency. The data listed in the point 4, the nominal GDP volumes, was with quarterly frequency. The quarterly GDP data was transformed to monthly observations assuming that the GDP did not change within one quarter. As an alternative, a linear interpolation of GDP was used to find GDP changes between the three months in each quarter. The switch from stable GDP within one quarter to linear interpolation did not change the results significantly and the same conclusions can be drawn based on these alternative calculations. The alternative calculations results are not presented in this study, although they are available for the author and can be presented on request.

Traditionally the GDP in real terms, i.e. adjusted for inflation effects, is used in macroeconomic studies. However, for the purpose of this study the nominal GDP should be used, because according to the theoretical concept suggested by the literature, the amounts deposited in the transactional non-maturing deposits are derived from the income cash-flows arriving in the transactional accounts, which are then distributed between different alternative investments by the return maximizing customers. Because the income cash-flows, which customers receive, is, of course, measured in nominal units impacted among other things by inflation (the higher is the inflation the bigger are the cash-flows received by customers, which leads to larger non-maturing deposits balances). The nominal GDP, which includes inflationary impact, is a better proxy for the income cash-flows received by customers for the purpose of this study.

Based on the dataset two dependent variables and four regressor variables were derived.

The following four sections explain briefly what variables were derived from the each of the four blocks and why such variables were chosen while offering illustrative charts of the corresponding time series.

2.1.1 Dependent variables

The purpose of this thesis is to analyse how the volume of the non-maturing deposits react to changes in the market interest rates. The volumes of non-maturing deposits data were available from the statistical data warehouse of the European Central Bank for 19 countries and various counterparties. In this study the dataset was limited to the two types of the counterparties: households and non-financial companies (NFCs). Households and non-financial companies together account for the bulk of the non-maturing deposits and for a significant part of the banking sector funding. The Figure 1 illustrates the original time series of the volume of households and non-financial companies non-maturing deposits, which were used in this study (before taking the natural logarithm and adjusting for seasonality).

The volume of non-maturing deposits is affected by the nominal income earned by a client. Both core and non-core part of the non-maturing deposits are affected by the income. If the nominal income increases a client will divide the additional income between savings and consumption, hence both consumption and savings increase. The growth in consumption contributes to the non-core transactional part of the non-maturing deposits, because a client makes a larger volume of consumption-oriented transactions and has to keep a larger account balance on average between the two inflows of the income.

Figure 1. Households and non-financial companies' non-maturing deposit volumes by countries, billion EUR

The amount of the additional savings received by a client regularly is distributed between various savings opportunities depending on the risk preferences of the client and comparative returns. If the risk preferences of the client and comparative returns on various saving products have not changed the structure of the client's savings portfolio stays the same. Thus, the balances kept as non-maturing deposits grow proportionally to the increase in the volume of the savings portfolio. Similar logic applies to the non-maturing deposits on the non-financial companies.

To account for the nominal income exogenous impact on the non-maturing deposits two different approaches were used in this paper. First, the log of nominal GDP at market prices was added to regressions as a proxy of income of both non-financial companies and households. Alternative models with nominal wages component of from national accounts were tested. Replacing the nominal GDP with nominal wages has not had any noticeable impact on the results of estimations of the models for households, because the two indicators (GDP and wages) are so strongly correlated. As a second option the nominal GDP was dropped from the models and only linear time trends were relied on to account for then natural growth of the deposits in the economy.

The second approach may be less precise from theoretical point of view because the income is an important factor influencing the volume of deposits and it is preferable to include a proxy for it. The only reason why models without nominal GDP variables were estimated to deal with the problem of different observation frequencies. The data on the volume of deposits and interest rates was available on monthly basis, however the GDP measures are only available on quarterly basis.

In econometrics studies the MIDAS approach is used to deal with cases when dependent variable has lower frequency than independent variables (for instance Andreou et al 2010). In our case we have higher frequency of the dependent variable and lower frequency of one independent variable, so that MIDAS approach is not applicable. Since the GDP variable is not the focus of this study and was added to absorb the strong growth trend in the dependent variable, the lower frequency is probably not so important. The main focus of this study is the relationship between the interest rates and the volume of the non-maturing deposits.

Table 2. Dependent variables notations and formulas

Name of the variable	Variable description	Seasonal and other adjustments	Units
log_ddhh_sa	log(households demand deposits)	Adjusted by STL decomposition	log of million EUR
log_ddnfc_sa	log(non-financial companies demand deposits)	Adjusted by STL decomposition	log of million EUR

Source: author’s notations

The two dependent variables, that were used in the regressions, are listed in the Table 2.

Since the non-maturing deposits exhibit strong seasonality all dependent variables were adjusted by EViews STL decomposition method. Unlike TRAMO/SEATS, X-12 and other approaches, STL method is extremely useful for unbalanced panel datasets, because it can deal effectively with missing observations. The Figure 2 shows the seasonal component removed from the dependent variables.

Figure 2. Seasonal components removed from the dependent variables *log_ddhh_sa* and *log_ddnfc_sa*
Source: author's calculations

2.1.2 Variables representing market interest rates

Market interest rates are the main explanatory variables. The market interest rates represent returns on alternative investments opportunities. If the returns on alternative investments increase it should force clients to reallocate their savings to such alternative investments at the expense of the savings in the form of the non-maturing deposits. There is a large number of possible market interest rates for different instruments and different maturities, which all can serve as a measure of returns on alternative investment. The variables considered in this thesis were euro interbank short-term interest rates for maturities between 0 days to 12 months and eurozone sovereign interest rates for maturities between 1 year and 30 years, total of 35 market interest rates. All market interest rates were taken from the Eurostat database.

Instead of choosing one variable over the other the author used the principal component analysis to condense the information in all market interest rates into fewer uncorrelated variables. The principal component analysis transforms original observations into a few orthogonal vectors, each consisting of several underlying variables. From the Table 4 it can be seen that the first two principal components capture 99.4% of the variance in the original population. Thus, it is possible to use instead of 35 market interest rates just the two composite variables, which capture most of the information in the market rates sample.

Since the market interest rates and the principal component scores contain negative values, it is not possible to take log the respective times series. The principal component scores were normalized so that regression coefficient would be better comparable with other variables. Market rates variables notations are shown in the Table 3. There are no missing values for the market rates time series for the whole period of 2003m1 to 2020m6.

The Figure 3 compares the original 35 market rates time series and the two principal components calculated based on those 35 original times series.

Table 3. Variables representing market interest rates

Name of the variable	Variable description	Adjustments	Units
pc1	First principal components of the 35 market interest rates time series	Adjusted by the formula: $pc1 = \frac{pc1 - \text{mean}(pc1)}{\text{standard deviation}(pc1)}$	Normalized to 0 mean and standard deviation = 1
pc2	Second principal components of the 35 market interest rates time series	Adjusted by the formula: $pc2 = \frac{pc2 - \text{mean}(pc2)}{\text{standard deviation}(pc2)}$	Normalized to 0 mean and standard deviation = 1

Source: author’s notations

Table 4. Eigenvalues and loading of the first 4 components for the dataset for of 35 market interest rates

Eigenvalues

Number	Value	Difference	Proportion	Cumulative value	Cumulative proportion
1	32.241	29.699	0.921	32.241	0.921
2	2.542	2.418	0.073	34.784	0.994
3	0.124	0.069	0.004	34.908	0.997
4	0.055	0.036	0.002	34.963	0.999

Eigenvectors (loadings)

Variable	PC 1	PC 2	PC 3	PC 4
R10Y	0.17516	-0.056838	-0.09683	-0.144121
R11Y	0.17482	-0.069801	-0.070766	-0.155363
R12M	0.15143	0.31414	0.068958	-0.253727
R12Y	0.17449	-0.080141	-0.047455	-0.161119
R13Y	0.17418	-0.088634	-0.027243	-0.162949
R14Y	0.17391	-0.095482	-0.00822	-0.159365
R15Y	0.17367	-0.101098	0.007845	-0.149288
R16Y	0.17347	-0.105675	0.022803	-0.136175
R17Y	0.17333	-0.108964	0.03613	-0.117009
R18Y	0.17318	-0.112075	0.048322	-0.096844
R19Y	0.17309	-0.114047	0.060026	-0.071945
R1M	0.14348	0.356562	0.29886	0.001043
R1Y	0.15602	0.276559	-0.20284	0.434284
R20Y	0.17301	-0.115713	0.072292	-0.045701
R21Y	0.17293	-0.117021	0.082101	-0.014416
R22Y	0.17288	-0.117717	0.092168	0.016671
R23Y	0.17283	-0.118102	0.101506	0.051354
R24Y	0.17278	-0.118211	0.109559	0.086663
...	...	...	...	...

Variable	PC 1	PC 2	PC 3	PC 4
...	...	...	...	...
R25Y	0.172743	-0.117738	0.118093	0.12294
R26Y	0.172685	-0.117367	0.12509	0.16059
R27Y	0.172633	-0.116496	0.132807	0.19814
R28Y	0.172561	-0.115633	0.139117	0.23756
R29Y	0.172472	-0.114592	0.145749	0.27779
R2Y	0.163756	0.215774	-0.316458	0.26352
R30Y	0.17238	-0.113342	0.150428	0.31672
R3M	0.145652	0.346793	0.251319	-0.164
R3Y	0.168724	0.163023	-0.323279	0.1263
R4Y	0.172023	0.114175	-0.302846	0.04033
R5Y	0.174069	0.070732	-0.270836	-0.0151
R6M	0.148432	0.332532	0.163629	-0.2406
R6Y	0.175165	0.03368	-0.233793	-0.0538
R7Y	0.175605	0.003479	-0.1957	-0.0828
R8Y	0.175642	-0.021159	-0.159642	-0.1074
R9Y	0.175456	-0.040956	-0.126072	-0.1278
RDTD	0.141052	0.364225	0.303796	0.13657

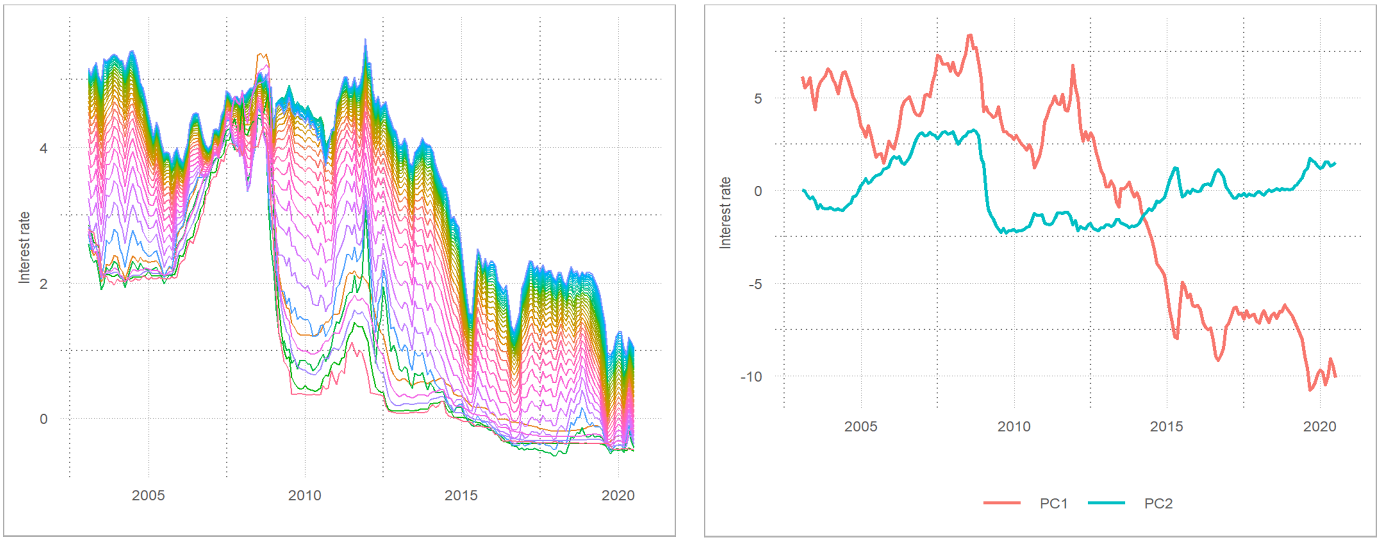

Figure 3. 35 market interest rates time series (maturities 1 day to 30 years) and two first principle component scores
Source: Eurostat, author's calculations

2.1.3 Variables representing returns on non-maturing deposits

Another important independent variable is the difference between the market rate and interest paid to customer on a non-maturing deposit. This is essentially a reverse of the convenience premium which client pays to have money on a demand deposit account or how much banks earns interest income from the non-maturing deposits.

Figure 4. Variables *rdtd_irddhh* and *rdtd_irddnfc* time series by countries
source: ECB Statistical Data Warehouse, Eurostat, author's calculations

The bigger is difference between the market interest rate and the interest which the clients receive on the non-maturing deposits balance the more clients are motivated to reallocate the assets from non-maturing deposits to other instruments.

The interest rates paid offered to clients on the non-maturing deposits were compared with euro interbank day-to-day rate (rdtd). The day-to-day rate is the market rate is for the shortest maturity (one day), therefor it suits the best to compare with interest rates paid on non-maturing deposits which can be withdrawn at any moment. The time series reflecting the difference between the data-to-date market rate and the interest rates paid on non-maturing deposits are depicted in the Figure 4.

The notations for the variables describing the difference between the market interest rate and the interest paid to customers on the non-maturing deposits balance are summarised in Table 5.

Table 5. Variables representing differences between market interest rates and interest rates on non-maturing deposits

Name of the variable	Variable description	Adjustments	Units
rdtd_irddhh	Euro interbank day-to-day interest rate – interest rate paid on demand deposits of households.	No adjustments	%
rdtd_irddnfc	Euro interbank day-to-day interest rate – interest rate paid on demand deposits of non-financial companies	No adjustments	%

Source: author's notations

2.1.4 Dummy and trend variables

For the purpose of testing for the breaks in the regression coefficients it was necessary to introduce time trend dummy variables.

Table 6. Breaks dummy variables

Name of the variable	Variable description	Units
b2008	dummy variable equal to 1 for all dates before 2008m5 and 0 otherwise	0;1
a2008	dummy variable equal to 1 for all dates after 2008m6 and 0 otherwise	0;1
a2008_2014	dummy variable equal to 1 for all dates between 2008m6 and 2014m6 and 0 otherwise	0;1
a2014	dummy variable equal to 1 for all dates after 2014m7 and 0 otherwise	0;1
b2014	dummy variable equal to 0 for all dates after 2014m7 and 1 otherwise	0;1
b2008_trend	b2008 * time trend, time trend variable between 2003m1 and 2008m5 and equal to 0 outside that period	0;time trend
a2008_2014_trend	a2008_2014 * time trend, time trend variable between 2008m6 and 2014m6 and equal to 0 outside that period	0;time trend
a2014_trend	a2014 x time trend, time trend variable between 2014m6 and equal to 0 outside that period	0;time trend

Source: author's notations

To achieve this the three dummy variables were used for the period before 2008m5, for the period between 2008m6 and 2014m6 and the period after 2014m7. By multiplying the said dummies with the time trend, the time trend breaks variables were introduced. The Table 6 specifies the notations used for the dummy variables and time trend dummy variables. The Figure 5 illustrates the time trend dummies used to capture the breaks in the time trend.

The dual dummies for 2008 and 2014 breaks (symmetrical dummies for before and after the break) were introduced for the purpose of the more convenient interpretation of the interaction of the break dummies with the independent variables.

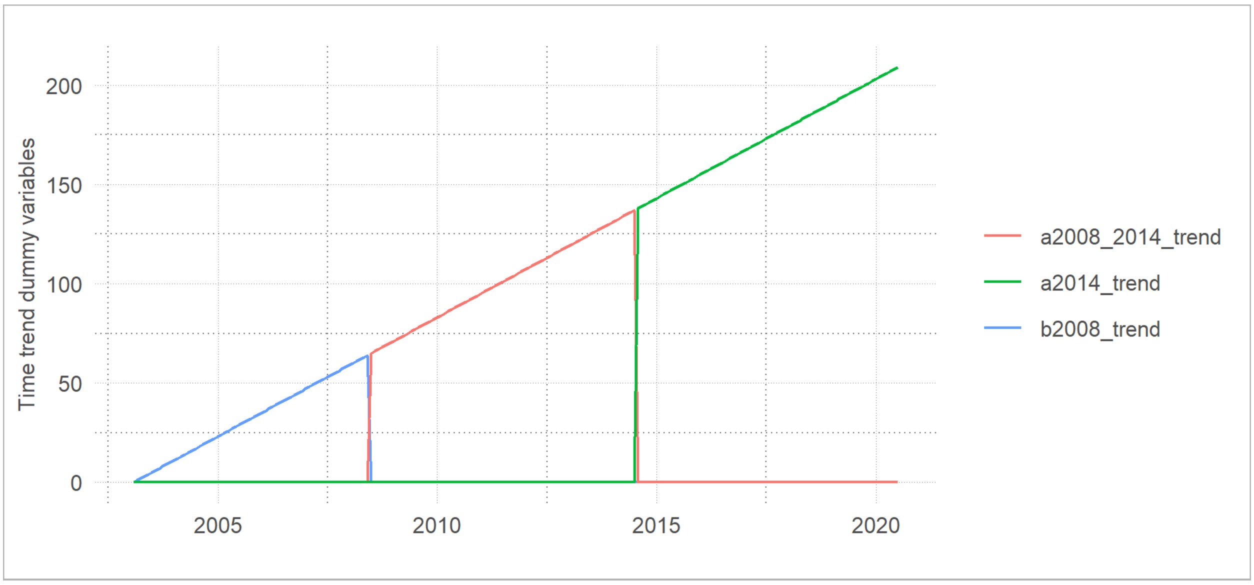

Figure 5. Time trend dummy variables

The break point 2008m6 was chosen because the fincial crisis, which started in the Q3 of 2008, could have introduced an innovation shock to the relevant time series. The break point 2014m6 was chosen due to the fact that around that time for the first time in history the euro money market interest rates became negative. This event could also change the underlying economic relations of interest for this study.

2.1.5 Number of observations and missing data

The panel consists of 18 countries and 7 variables for the period January 2003 to June 2020. The panel is unbalanced because for the 6 countries the information for two dependent variables is missing in the beginning of the observation period. For remaining 13 countries there are no missing data and for each variable there is 210 observations. The total number of available observations is 27500. The Table 7 bellow summarises which variable how many observations are available for each country.

Table 7. Number of observations for each variable

	Variables						
Country	log_ddhh_sa	log_ddnfc_sa	rdtd_irddhh	rdtd_irddnfc	pc1	pc2	log_gdpnom_sa
Austria	210	210	210	210	210	210	210
Belgium	210	210	165	165	210	210	210
Cyprus	176	176	150	149	210	210	210
Estonia	210	210	208	208	210	210	210
Finland	210	210	210	210	210	210	210
France	210	210	210	210	210	210	210
Germany	210	210	210	210	210	210	210
Greece	210	210	210	210	210	210	210
Ireland	210	210	156	210	210	210	210
Italy	210	210	210	210	210	210	210
Latvia	118	118	198	198	210	210	210
Lithuania	193	193	184	184	210	210	210
Luxembourg	210	210	210	210	210	210	210
Malta	186	186	156	156	210	210	210
Netherlands	210	210	210	210	210	210	210
Portugal	210	210	210	210	210	210	210
Slovakia	174	174	150	150	210	210	210
Slovenia	198	198	182	182	210	210	210
Spain	210	210	210	210	210	210	210

2.2 Statistical methods

The main statistical method used in this thesis is autoregressive distributed lag cointegration estimation method (hereafter referred as ARDL) described in Pesaran, Shin and Smith 2001 seminal work (Pesaran, et al., 2001). ARDL is a single equation cointegration estimation method.

The attractivity of the ARDL method is that it allows in the cointegration regression both variables integrated of order one and stationary variables and therefore does not depend on unit root tests, which can be imprecise. The ARDL technique does not allow I(2) variables in the equation, therefore some unit-roots pretesting is still necessary to ensure that no I(2) variables are included in the regression. (Nkoro, Uko, 2016)

The ARDL method estimates regression which includes both lagged dependent and contemporaneous and lagged independent variables on the right-hand side. The base regression equation of ARDL(p, q, q,...,q) model looks like follows (Hassler, Wolters 2006; Kripfganz, S., Schneider, D.C., 2018):

$$\begin{aligned} y_t = c_0 + c_1 t + \theta_1 y_{t-1} + \cdots + \theta_p y_{t-p} + \\ + \beta_1^1 x_t^1 + \cdots + \beta_q^1 x_{t-q}^1 + \\ \ldots \\ + \beta_1^k x_t^k + \cdots + \beta_q^k x_{t-q}^k + u_t \end{aligned} \quad (2.1)$$

where p is number of lags of dependent variable
q is number of lags of independent variables
k is number of independent variables

The equation 2.1 can be transformed into an error correction form (Hassler, Wolters 2006; Kripfganz, S., Schneider, D.C., 2018):

$$\Delta y_t = c_0 + c_1 t - \alpha(y_{t-1} - \theta' x_t) + \sum_{i=1}^{p-1} \varphi_{yi} \Delta y_{t-i} + \sum_{i=0}^{q-1} \varphi'_{xi} \Delta x_{t-i} + u_t \quad (2.2)$$

where x_t is a vector of k independent variables.

Alternatively, the 2.2 can be written as:

$$\Delta y_t = c_0 + c_1 t - \alpha(y_{t-1} - \theta' x_{t-1}) + \sum_{i=1}^{p-1} \varphi_{yi} \Delta y_{t-i} + \sum_{i=1}^{q-1} \varphi'_{xi} \Delta x_{t-i} + \omega' \Delta x_t + u_t \quad (2.3)$$

Pesaran, Shin and Smith 2001 described five different variations of the model:

1. Case I: Model without intercept (constant) and trend.
2. Case II: Model with restricted intercepts and unrestricted trend (denoted as *rcut*).
3. Case III: Model with unrestricted intercepts and no trend (*uc*).
4. Case IV: Model with unrestricted intercepts and restricted trend (*ucrt*).
5. Case V: Model with unrestricted intercept and unrestricted trend (*ucut*).

The terms “restricted intercept” and “restricted trend” refers to cases when the intercept or the trend is included in the long-term relation part in the equation 2.2 above. The term “unrestricted” refers to cases when intercept and trend were included in the short-term relation part of the equation 2.2 and 2.3.

In this study the main focus was on the Case V specification of the ARDL model. This is due to the presence of a strong time trend in the deposit volumes, the dependent variable. The Case V was chosen over the Case IV due to the fact that according to Pesaran, Shin and Smith 2001, the t-test for the Case IV is absorbed by Case V (Pesaran, et al., 2001 lk 299), thus Case V provides for a simpler interpretation of the results.

The Pesaran, Shin and Smith 2001 suggested two significancy tests, the so-called bounds tests. The f-statistics bound test checks the null hypothesis that all θs in the equation 2.2 above are jointly equal to zero. The t-statistics bound test checks the null hypothesis that $\theta_1 = 0$.

If f-statistics exceeds the upper critical value boundary suggested in Pesaran, Shin and Smith 2001, we can conclude that the variables may be cointegrated. If the f-statistics is below the lower boundary suggested by Pesaran, Shin and Smith 2001, we can conclude that all variables are stationary. If the f-statistic is between the lower and upper boundary then the test is inconclusive. If the f-test is passed, one should proceed to the t-test and check if the speed of adjustment is different from 0 and negative. After the t-test is passed one should look at the significance of the coefficients in the long-run part of the regression.

If the f-test and t-test reject the presence of the cointegration relationship the short-term relationship was estimated using ordinary OLS regressor with lags.

In addition to the regressions performed for individual countries the pooled mean group estimator suggested in Pesaran, Shin, Smith 1999 was used. The pooled mean group estimator allows for the individual cross-sectional intercepts and short-term relationship coefficients and forces only the coefficient of the variables in the long-term relationship to be the same across the panel. This approach may be a suitable compromise, which allows to identify both commonalities between countries while allowing national specificities.

2.3 Unit roots testing

Although the ARDL procedure does not require that all series should be integrated of order 1 or be stationary, we still need to make sure that no series are integrated of order 2. Also, if some of the key variables prove to be stationary in the standard unit-root testing it could provide additional insight in interpreting ARDL regression results.

Table 8. Unit root testing of households' non-maturing deposit volumes time series

Variable = log of households NMT deposit volumes (*log_ddhh_sa*)								
	Individual ADF results for levels, with intercept and linear trend				Individual ADF results for fist differences, with intercept and linear trend			
Country	Prob.	Lag	Max Lag	Obs.	Prob.	Lag	Max Lag	Obs.
Austria	0.5196	3	14	206	0.0000	2	14	206
Belgium	0.9530	1	14	208	0.0000	0	14	208
Cyprus	1.0000	0	13	175	0.0000	0	13	174
Germany	0.1381	3	14	206	0.0121	2	14	206
Estonia	0.4765	3	14	206	0.0013	2	14	206
Spain	0.4330	0	14	209	0.0000	0	14	208
Finland	0.9690	1	14	208	0.0000	0	14	208
France	1.0000	7	14	202	0.0000	6	14	202
Greece	0.9334	3	14	206	0.0008	2	14	206
Ireland	0.5459	0	14	209	0.0000	0	14	208
Italy	0.9099	0	14	209	0.0000	0	14	208
Lithuania	0.4392	3	14	189	0.0010	2	14	189
Luxembourg	0.2605	4	14	205	0.0003	2	14	206
Latvia	0.8462	0	12	117	0.0000	0	12	116
Malta	0.2445	1	14	184	0.0000	0	14	184
Netherlands	0.9980	0	14	209	0.0000	0	14	208
Portugal	1.0000	1	14	208	0.0000	0	14	208
Slovenia	0.4728	13	14	184	0.4457	11	14	185
Slovakia	0.9768	0	13	173	0.0000	0	13	172

As it could be seen from Table 8, all households' non-maturing deposits volumes are not stationary and become stationary after taking first differences with the exception of the Slovenia time series, which seems to be integrated of order 2 based on ADF test. The alternative Phillips-Perron unit-root test indicate that Slovenia time series are also stationary in first differences and thus are integrated of order one.

Table 25, Table 26 and Table 27 in Appendix 5 summarize unit root test results for other cross-sectional variables: log of volumes of non-financial companies' non-maturing deposits and interest premium paid on non-maturing deposits over the interbank day-to-day interest rate. It is possible to see that all variables are non-stationary in levels and become stationary in the first differences, with minor exceptions. The risk premium variables for Slovakia and Cyprus seem to be stationary in levels according to ADF unit root test. Using alternative Phillips-Perron unit root test Slovakia and Cyprus risk premium variables are integrated of order 1 at 1% confidence level by stationary at 5% confidence level. The ARDL model, which allows to combine stationary and non-stationary variables, is the perfect fit for time series with such borderline inconclusive unit root test results.

The non-cross-sectional variables, the two first principal components of the 35 market interest rates time series (*pc1* and *pc2*), are also integrated of order 1 (see Table 28 in the Appendix 5).

Table 9. Possible breaks in the dependent variable time series

Country	Households' NMT deposit volumes *log_ddhh_sa*	Non-financial companies' NMT deposit volumes *log_ddnfc_sa*
Spain	2005m05	2015m01
Slovenia	2014m01	2014m03
Slovakia	2013m09	2013m07
Portugal	2015m07	2015m03
Netherlands	2016m03	2014m05
Malta	2014m03	2009m04
Luxembourg	2008m12	2003m12
Lithuania	2013m07	2009m10
Latvia	2011m11	2018m11
Italy	2014m01	2014m07
Ireland	2014m07	2013m11
Greece	2010m01	2015m06
Germany	2008m09	2008m08
France	2003m05	2014m10
Finland	2008m11	2020m02
Estonia	2009m08	2010m01
Cyprus	2017m06	2015m08
Belgium	2014m07	2011m11
Austria	2014m09	2008m09

As Vogelsang and Perron (1998) put it, macroeconomics deal with time series fluctuating around a broken trend. The unit roots test may provide false evidence of a unit root presence in the time series if the time series includes a structural break. A number of methods were developed to identify a possible structural break. Hansen (2001) gives an overview the relevant methods. Among others Vogelsang and Perron (1998) suggested two methods for selecting a break data endogenously by testing all possible breaks and choosing the date that suggests the most evidence against the presence of a unit root (for instance minimizing ADF test statistics).

Performing the unit root test with an innovational outlier break on the dependent variable series suggested that the breaks may exist in the data series as summarized in the Table 9. It can be seen that many of the suggested breaks happen around 2008-2009 financial crisis and 2014 when due to extraordinary monetary policy measures of the European Central Bank the market interest rates entered negative territory for the first time.

The identified cross-sectional break dates were used in the two additional ARDL regressions to test for possible break in the trend.

3 RESULTS OF REGRESSION ANALYSIS

3.1 ARDL regression with interacted dummies

In total 12 ARDL regressions were estimated for each of the 19 individual countries: 6 models for households' deposits and 6 models for non-financial companies' deposits. The variables used in each regression are summarized in the Table 10 below. The models 1 and 6 are the baseline models, which do not include any dummies controlling for possible breaks in the time series. All other models include a dummy *a2008* and *a2014* interacted with *rdtd* variables representing premium paid on non-maturing deposits compared to the market rate and *pc1*, which is the first principal component of the 35 market interest rates. Models 1-3 and 7-9 included log of nominal GDP to control for income growth impact on the deposit volumes. The models 4-6 and 10-12 did not include GDP measure and rely only on the linear time trend variable to control for the strong exogenous trend in the deposit volumes.

The number of lags for variables was chosen for each country individually using Akaike information criteria from the maximum lag number of 12, because the data is with monthly frequency.

$$\Delta y_t = c_0 + c_1 t - \alpha(y_{t-1} - \theta x_t) + \sum_{i=1}^{p-1} \varphi_{yi} \Delta y_{t-i} + \sum_{i=0}^{q-1} \varphi'_{xi} \Delta x_{t-i} + u_t \tag{3.1}$$

The regression equation of the form 3.1 was used, where y_t were dependent variables are taken from the Table 10 and x_t is a vector of independent variables from the same table. The sign of θ coefficients is expected to be negative for variables *pc1*, *rdtd_irddhh* and *rdtd_irddnfc.* An increase in the general level of the interest rates increases attractiveness of alternative investments and should motivate customers to re-allocate some assets away from the non-maturing deposit accounts. Likewise, if the premiums which clients pay for the convenience to keep savings at the immediately callable non-maturing deposits increase, the customers are motivated to keep less at the non-maturing accounts and seek alternative instruments to invest their savings into. The sign for the variable *log_gdpnom_sa* should be positive, as an increase in income leads ceteris paribus to an increase in the NMT deposits balances. The sign of α should be negative for dependent variable to converge over time to its long-term equilibrium. The coefficients φ_{xi} describe the short-term relationship between y_t and x_t and should have the same sign as θ. The coefficients φ_{yi} are the coefficients of the autoregressive terms of y_t. Because the Δy_t variables are stationary as we have seen from the unit root tests in the section 2.3, we expect φ_{yi} to be smaller than 1.

Table 10. Variables used in the estimated ARDL regressions with interacted dummies

Model number	Group	Dependent variable	Independent variable with lags
1	Households	log_ddhh_sa	rdtd_irddhh, pc1, pc2, log_gdpnom_sa
2	Households	log_ddhh_sa	rdtd_irddhh, pc1, pc2, log_gdpnom_sa, a2014×pc1, a2014×rdtd_irddhh
3	Households	log_ddhh_sa	rdtd_irddhh, pc1, pc2, log_gdpnom_sa, a2008×pc1, a2008×rdtd_irddhh
4	Households	log_ddhh_sa	rdtd_irddhh, pc1, pc2
5	Households	log_ddhh_sa	rdtd_irddhh, pc1, pc2, a2008×pc1, a2008×rdtd_irddhh
6	Households	log_ddhh_sa	rdtd_irddhh, pc1, pc2, a2014×pc1, a2014×rdtd_irddhh
7	Non-financial companies	log_ddnfc_sa	rdtd_irddnfc, pc1, pc2, log_gdpnom_sa
8	Non-financial companies	log_ddnfc_sa	rdtd_irddnfc, pc1, pc2, log_gdpnom_sa, a2014×pc1, a2014×rdtd_irddnfc
9	Non-financial companies	log_ddnfc_sa	rdtd_irddnfc, pc1, pc2, log_gdpnom_sa, a2008×pc1, a2008×rdtd_irddnfc
10	Non-financial companies	log_ddnfc_sa	rdtd_irddnfc, pc1, pc2
11	Non-financial companies	log_ddnfc_sa	rdtd_irddnfc, pc1, pc2, a2008×pc1, a2008×rdtd_irddnfc
12	Non-financial companies	log_ddnfc_sa	rdtd_irddnfc, pc1, pc2, a2014×pc1, a2014×rdtd_irddnfc

Source: author's notations

The Figure 6 summarizes the f- bounds test and t- bounds test results of all 12 models. The horizontal axis in the Figure 6 identify the number of the regression model using the models' numeration from Table 10. The circles in the Figure 6 depict p-values of the f-test statistics and the triangles the p-values of the t-test statistics for upper bound test. The colours are used to identify results for each country. If both the f-test and t-test p-value for a country is below the 5% critical value level for the upper bound test. the cointegration presence is not rejected and further testing should be done. For the models with p-values for either f-test or t-test statistics above 5% critical level the cointegration presence is rejected.

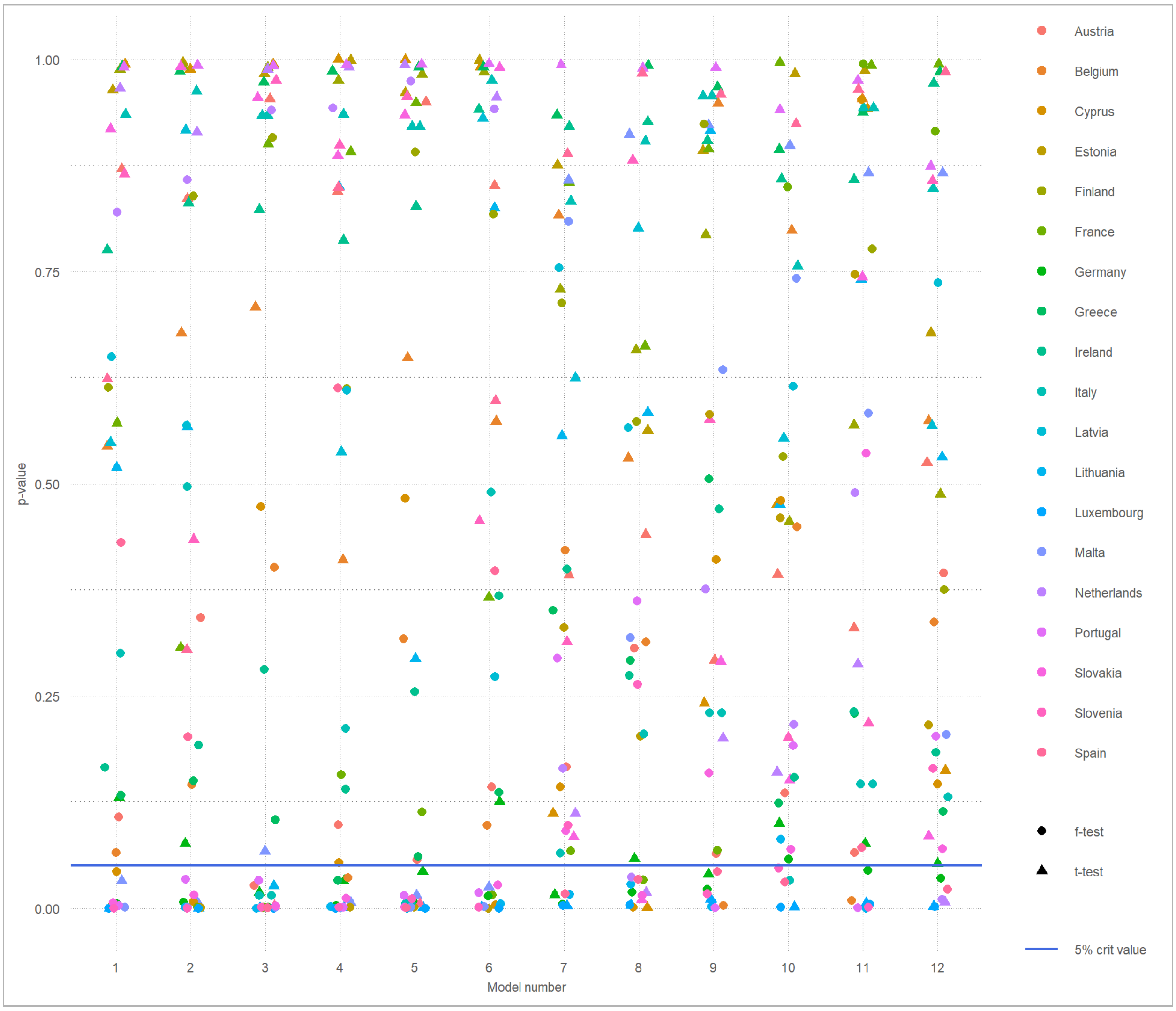

Figure 6. The p-values of ARDL models f- ja t- bounds tests for unrestricted constant and unrestricted linear trend (ucut)

It can be seen that only in a few cases both f- and t-bound test statistics exceeded the upper bound. The number of countries, for which each regression resulted in passing of both f- and t-bound test upper bound limit, can be better seen on the Figure 7. The Figure 7 uses exactly the same notations as Figure 6, but zooms on the results below the 5% critical value level line.

Passing of f- and t-test upper bound does not yet guarantee that time series are cointegrated. We must look further whether the sign of the error correction term is negative, indicating convergence to the long-term equilibrium, and whether the coefficients of variables inside the error correction term are statistically significant.

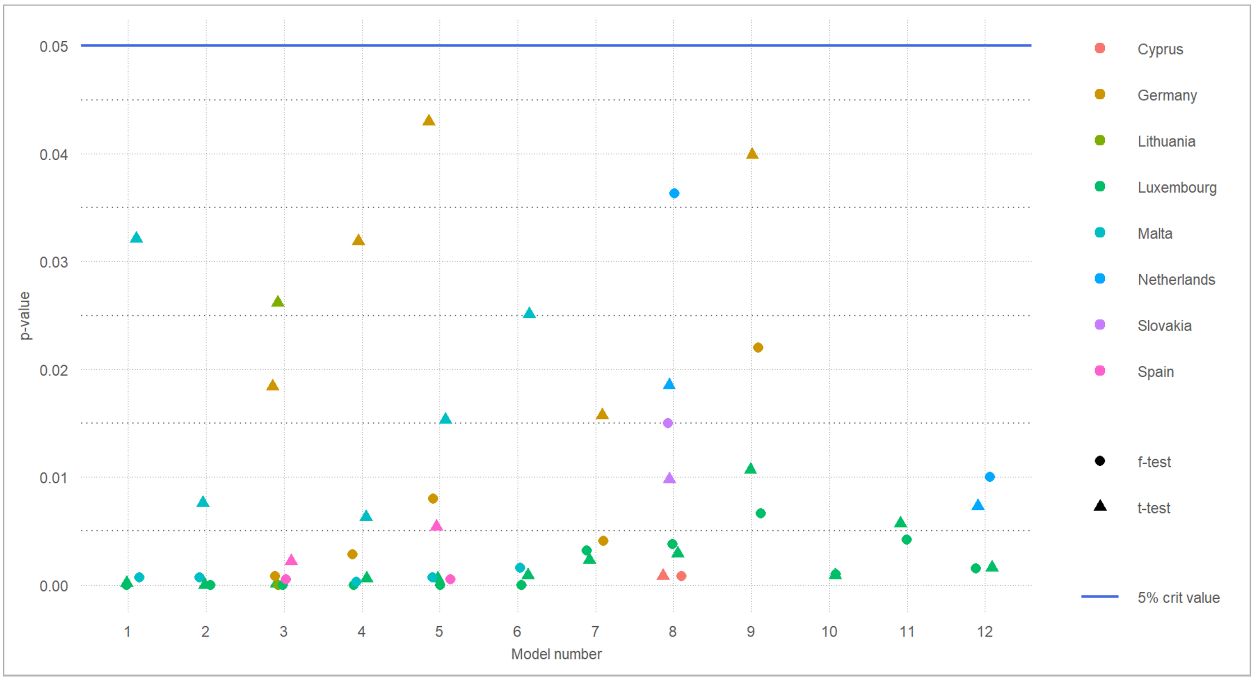

Figure 7. The p-values of ARDL f- ja t-bounds tests for unrestricted constant and unrestricited linear trend (ucut), which passed both f- and t-test upper bound for 5% critical value.

Because the ARDL model is sensitive to the assumption that residuals are not serially correlated (Pesaran, et al., 2001 lk 308), the serial correlation LM tests must be performed on residuals to ensure that serial correlation was properly removed from the residuals, because 12 lags may not be enough to do this and increasing lags beyond 12 was not computationally reasonable (for example EViews software does not allow more lags than 12). The models, for which serial correlation test was not passed, were removed. The Breusch-Pagan-Godfrey test showed significant heteroskedasticity, therefore HAC (Newey-West) covariance matrix was used to adjust the t-statistics.

The Table 11 below summarizes the results of ARDL models which passed all the tests, i.e.:

- f-upper bound test;
- t-upper bound test;
- have negative ECM term coefficient (speed of adjustment);
- have at least one variable inside the ECM term which is significant at least at the 5% critical level;
- passed serial correlation LM test.

The Table 12 summarises the coefficients of the long-term relationship of all the models which passed all the above tests. The full results of the estimation results for those models can be found in the section 8.1 of the Appendix 1.

Table 11. Models indicating cointegration after passing f-test, t-test, serial correlation test with at least one variable coefficient in the ECM term significant at least at 5% critical level

Model number	Country	Model	Lags	f-test (ucut) statistic	f-test (ucut) p-value	t-test (ucut) statistic	t-test (ucut) p-value	ECM term coefficient	Variables significancy inside ECM term
M.8	Cyprus	log_ddnfc_sa = b2014*rdtd_irddnfc + b2014*pc1 + pc2 + log_gdpnom_sa + a2014*pc1 + a2014*rdtd_irddnfc + trend	7-0-7-0-5-0-1	6.3739	0.0008	-6.1837	0.0008	-0.3831	Only *log_gdpnom* significant (at 1%)
M.4	Germany	log_ddhh_sa = rdtd_irddhh + pc1 + pc2 + trend	4-0-8-6	7.2631	0.0028	-4.3139	0.0319	-0.1480	*pc1* and *pc2* significant at 1%
M.3	Lithuania	log_ddhh_sa = b2008*rdtd_irddhh + b2008*pc1 + pc2 + log_gdpnom_sa + a2008*pc1 + a2008*rdtd_irddhh + trend	1-11-10-2-10-10-12	11.3333	0.0000	-4.9544	0.0262	-0.2918	All but *pc2* significant at 1%
M.1	Luxembourg	log_ddhh_sa = rdtd_irddhh + pc1 + pc2 + log_gdpnom_sa + trend	6-3-0-4-10	13.9095	0.0000	-6.4238	0.0002	-0.1064	Only *rdtd_irddhh* is significant at 1%
M.2	Luxembourg	log_ddhh_sa = b2014*rdtd_irddhh + b2014*pc1 + pc2 + log_gdpnom_sa + a2014*pc1 + a2014*rdtd_irddhh + trend	6-3-0-9-4-0-0	14.4957	0.0000	-7.3757	0.0000	-0.1601	*b2014*rdtd_irddhh, a2014*pc1, a2014*rdtd_irddhh* are significant at 1%
M.4	Luxembourg	log_ddhh_sa = rdtd_irddhh + pc1 + pc2 + trend	6-1-4-0	18.3712	0.0000	-5.7940	0.0006	-0.1163	Only *rdtd_irddhh* is significant at 1%
M.6	Luxembourg	log_ddhh_sa = b2014*rdtd_irddhh + b2014*pc1 + pc2 + a2014*pc1 + a2014*rdtd_irddhh + trend	6-3-0-9-0-1	12.6328	0.0000	-5.9690	0.0009	-0.1617	All *b2014*pc1* are significant at 1%
M.10	Luxembourg	log_ddnfc_sa = rdtd_irddnfc + pc1 + pc2 + trend	2-11-10-11	8.0194	0.0010	-5.4904	0.0009	-0.4095	Only *pc2* significant, at 5%
M.3	Spain	log_ddhh_sa = b2008*rdtd_irddhh + b2008*pc1 + pc2 + log_gdpnom_sa + a2008*pc1 + a2008*rdtd_irddhh + trend	1-4-4-1-9-0-1	7.2741	0.0005	-5.7742	0.0022	-0.2869	*b2008*rdtd_irddhh, b2008*pc1* and *log_gdpnom* are significant at 1%
M.5	Spain	log_ddhh_sa = b2008*rdtd_irddhh + b2008*pc1 + pc2 + a2008*pc1 + a2008*rdtd_irddhh + trend	1-4-4-4-0-1	7.5873	0.0005	-5.3363	0.0054	-0.1951	*b2008*rdtd_irddhh* and *b2008*pc1* significant at 1%

The number of countries with models which passed the tests described above was 5. Out of those five countries the model for Cyprus showed a cointegration of deposit volumes only with GDP variable. In case of four countries it was possible to find a long-term relationship between the deposit volume and the market interest rates and/or premium paid on the non-maturing deposits. In case of three countries (Germany, Spain and Lithuania) the cointegration existed only for households' non-maturing deposits but not for non-financial companies' non-maturing deposits. For one country, Luxembourg, the long-term relationship could be found both for households and non-financial companies.

The speed of adjustment was relatively high for all identified long-term relationships varying between 0.10 and 0.40. The sign of the *pc1* variable was negative and consistent with theory for Germany, Lithuania and Spain. The increase of market interest rates makes alternative investments more attractive and thus decrease the volume of non-invested non-maturing deposits. For Cyprus and Luxembourg the sign of the *pc1* variable was positive for several models, especially before the break at year 2014, which is inconsistent with the theory.

The sign of the premium paid on non-maturing deposits over the market rates was not consistent with the theoretical assumptions for Spain and Lithuania and in some instances for Luxembourg. The sign of the premium was correct for Cyprus.

Table 12. Coefficients variables in the identified long-term relationships (variables of the error correction term)

Germany, model 4				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
log_ddhh_sa	Dependent variable			
RDTD_IRDDHH	-0.0290	0.0195	-1.4903	0.1379
PC1	-0.0780	0.0099	-7.9196	0.0000
PC2	-0.0306	0.0102	-2.9874	0.0032

Lithuania, model 3				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
log_ddhh_sa	Dependent variable			
B2008_RDTD_IRDDHH	0.3972	0.0561	7.0855	0.0000
B2008_PC1	-0.3724	0.1359	-2.7403	0.0072
PC2	-0.0383	0.0202	-1.8998	0.0601
LOG_GDPNOM_SA	-1.4696	0.4270	-3.4419	0.0008
A2008_PC1	-0.0754	0.0199	-3.7960	0.0002
A2008_RDTD_IRDDHH	0.1831	0.0497	3.6823	0.0004

Spain, model 3				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
log_ddhh_sa	Dependent variable			
B2008_RDTD_IRDDHH	0.6633	0.1922	3.4508	0.0007
B2008_PC1	-1.6028	0.2609	-6.1431	0.0000
PC2	-0.1936	0.1407	-1.3759	0.1706
LOG_GDPNOM_SA	2.5159	0.3984	6.3158	0.0000
A2008_PC1	-0.3375	0.1882	-1.7930	0.0747
A2008_RDTD_IRDDHH	0.2245	0.2058	1.0912	0.2767

Spain, model 5				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
log_ddhh_sa	Dependent variable			
B2008_RDTD_IRDDHH	0.4795	0.1966	2.4392	0.0157
B2008_PC1	-1.5116	0.2853	-5.2989	0.0000
PC2	0.1032	0.1277	0.8079	0.4202
A2008_PC1	-0.0189	0.1566	-0.1208	0.9040
A2008_RDTD_IRDDHH	0.0510	0.2113	0.2411	0.8097

Cyprus, model 8				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
log_ddnfc_sa	Dependent variable			
B2014_RDTD_IRDDNFC	-0.0839	0.1677	-0.5001	0.6179
B2014_PC1	0.2246	0.1269	1.7703	0.0792
PC2	-0.0616	0.1371	-0.4489	0.6543
LOG_GDPNOM_SA	2.4611	0.3459	7.1158	0.0000
A2014_PC1	-0.0513	0.2463	-0.2084	0.8352
A2014_RDTD_IRDDNFC	-0.1095	0.3964	-0.2761	0.7830

Luxembourg, model 1				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
log_ddhh_sa	Dependent variable			
RDTD_IRDDHH	-0.2225	0.0824	-2.7016	0.0076
PC1	0.0155	0.0481	0.3222	0.7477
PC2	-0.0088	0.0409	-0.2156	0.8296
LOG_GDPNOM_SA	-0.2377	0.5808	-0.4092	0.6829

Luxembourg, model 2				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
log_ddhh_sa	Dependent variable			
B2014_RDTD_IRDDHH	-0.1514	0.0561	-2.6987	0.0077
B2014_PC1	0.0457	0.0334	1.3695	0.1726
PC2	-0.0269	0.0339	-0.7939	0.4283
LOG_GDPNOM_SA	-0.7973	0.4345	-1.8352	0.0682
A2014_PC1	-0.2046	0.0576	-3.5511	0.0005
A2014_RDTD_IRDDHH	0.5439	0.1515	3.5887	0.0004

Luxembourg, model 4				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
log_ddhh_sa	Dependent variable			
RDTD_IRDDHH	-0.1768	0.0667	-2.6519	0.0087
PC1	-0.0132	0.0246	-0.5364	0.5923
PC2	-0.0382	0.0269	-1.4193	0.1575

Luxembourg, model 6				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
log_ddhh_sa	Dependent variable			
B2014_RDTD_IRDDHH	-0.12434	0.04777	-2.6031	0.01
B2014_PC1	0.005164	0.03016	0.1712	0.8643
PC2	-0.06087	0.02061	-2.95299	0.0036
A2014_PC1	-0.22902	0.05587	-4.09895	0.0001
A2014_RDTD_IRDDHH	0.458347	0.15401	2.97616	0.0033

Luxembourg, model 10				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
log_ddnfc_sa	Dependent variable			
RDTD_IRDDNFC	-0.2457	0.27693	-0.88725	0.3763
PC1	0.045084	0.1085	0.41552	0.6783
PC2	0.214208	0.08445	2.53657	0.0122

Interacting break dummy with the main independent variables *pc1* and premium variables proved to be useful. For Lithuania, Spain and Cyprus the models without breaks did not show cointegration, while adding 2008 and 2014 breaks enabled to identify the cointegration.

3.2 ARDL regression including breaks in the linear trend

As an alternative to interacting breaks dummies with independent variables one can try adding breaks dummies to the linear trend in the ARDL regression. Two types of linear breaks were generated. First, universal breaks to the trend at the years 2008 and 2014 were added. The corresponding dummy variables were added to the baseline models 1, 4, 7 and 10 from Table 10 as exogenous non-lagged variables. As a second type of breaks the individual breaks described in Table 9 above were used, as identified by unit roots with breaks procedure. The models 1, 4, 7 and 10 then used the variables listed in the Table 13. Again, the number of lags for variables was chosen for each country individually using Akaike information criteria from the maximum lag number of 12.

The regression equation is of the form 3.1, with y_t being dependent variables from the Table 13 and x_t is a vector of independent variables from the same table.

$$\Delta y_t = c_0 + c_1 t + c_2 break\_dummy * t - \alpha(y_{t-1} - \theta x_t) + \sum_{i=1}^{p-1} \varphi_{yi} \Delta y_{t-i} + \sum_{i=0}^{q-1} \varphi'_{xi} \Delta x_{t-i} + u_t \qquad (3.2)$$

Replacing dummies interacted with independent variables in with the breaks in linear trends has not produced results significantly different for the ones described in the section 3.1 above.

The Figure 8 shows f- and t- tests p-values for all the regressions, which simultaneously exceeded upper bounds for at least 5% confidence level. The horizontal axis in the Figure 8 identify the number of the regression model using the models' numeration from Table 13. The circles in the Figure 8 depict p-values of the f-test statistics and the triangles the p-values of the t-test statistics for upper bound test. The colours are used to identify results for each country. If both the f-test and t-test p-value for a country is below the 5% critical value level for the upper bound test the cointegration presence is not rejected and further testing should be done.

If we compare the models inside each rectangular in the Figure 8, we will easily notice that adding breaks to trend does not increase the number of regressions passing f- and t- bounds test significantly.

Comparing the Figure 7 in the section 3.1 above with the Figure 8 below the number of countries with models which passed f- and t- upper bound test is smaller when using models with the breaks in trends than in case of models with interacted dummies.

Table 13. Variables used in the estimated ARDL regressions with linear time breaks

Model number	Group	Dependent variable	Independent variable with lags	Non-lagged trend variables
Model_1 2008-2014	Households	log_ddhh_sa	rdtd_irddhh, pc1, pc2, log_gdpnom_sa	trend, a2008_2014×trend, a2014×trend
Model_1 individual breaks	Households	log_ddhh_sa	rdtd_irddhh, pc1, pc2, log_gdpnom_sa	trend, individual breaks × trend
Model_4 2008-2014	Households	log_ddhh_sa	rdtd_irddhh, pc1, pc2	trend, a2008_2014×trend, a2014×trend
Model_4 individual breaks	Households	log_ddhh_sa	rdtd_irddhh, pc1, pc2	trend, individual break × trend
Model_7 2008-2014	Non-financial companies	log_ddnfc_sa	rdtd_irddnfc, pc1, pc2, log_gdpnom_sa	trend, a2008_2014×trend, a2014×trend
Model_7 individual breaks	Non-financial companies	log_ddnfc_sa	rdtd_irddnfc, pc1, pc2, log_gdpnom_sa	trend, individual breaks × trend
Model_10 2008-2014	Non-financial companies	log_ddnfc_sa	rdtd_irddnfc, pc1, pc2	trend, a2008_2014×trend, a2014×trend
Model_10 individual breaks	Non-financial companies	log_ddnfc_sa	rdtd_irddnfc, pc1, pc2	trend, individual break × trend

All the countries from Figure 7 are present Figure 8 as well. Changing the form of the regressions has not identified additional cointegration candidates. The exogenous linear time trend breaks and directional proxies did not add much explanatory power to the regressions. We can conclude that the regressions interacted dummies produced very similar or slightly superior results than regressions with linear break dummies.

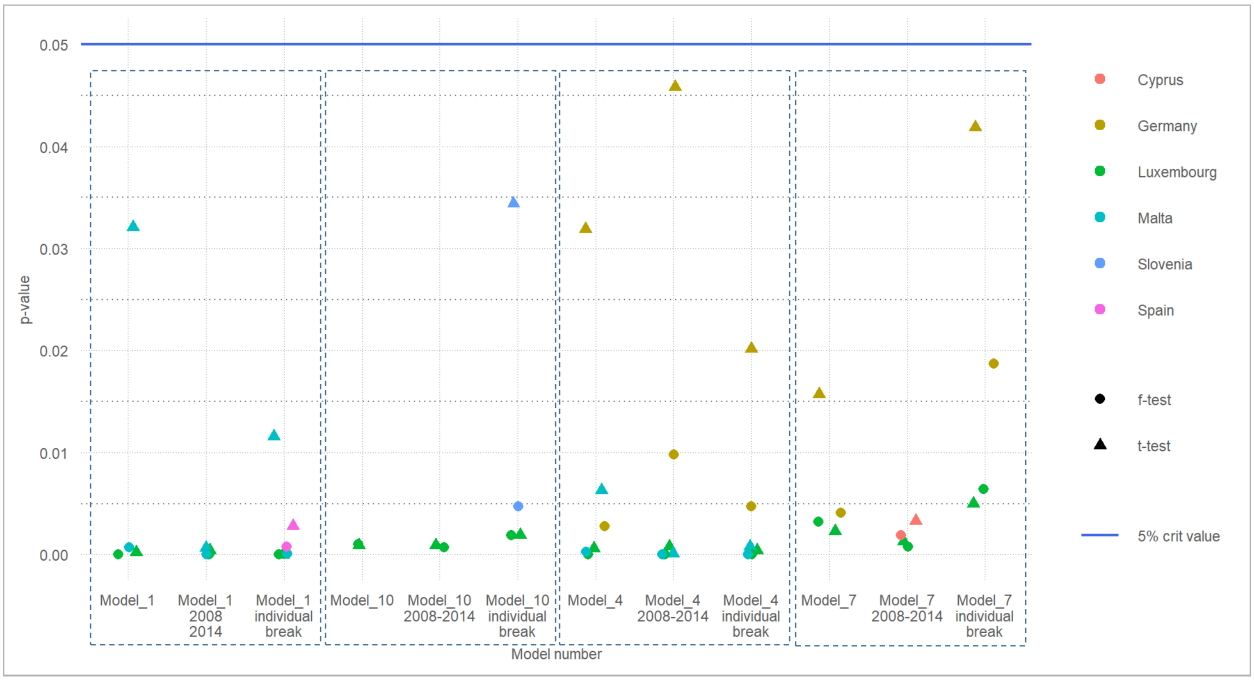

Figure 8. The p-values of ARDL f- ja t-bounds tests for unrestricted constant and unrestricited linear trend (ucut), which passed both f- and t-test upper bound for 5% critical value; models with added breaks in linear trends

3.3 Regression with first differences

As shown above cointegration presence and the long-term relationship between the variables of interest could not be found for majority of countries. As we have shown in the section 3.1, only for four countries, Germany, Lithuania, Luxembourg and Spain, out of the 19 eurozone countries a cointegration can be found between the volume of the deposits and the level of the interest rates. In the absence of the cointegration there can still be a short-run relationship.

To estimate the short-run relationship we need to make sure that all variables entering the regression are stationary. As we have seen in the section 2.3 all the main variables of interest for this study have unit root in levels and become stationary in the first differences. Thus, it is possible to test for a short-term relationship by taking the first differences of both the dependent and independent variables.

The similar notations are used as for the variables in the ARDL regressions above (see Table 14). We are interested in the two dependent variables *d(log_ddhh_sa)* and *d(log_ddnfc_sa)*, which denote a one month change of logs of the volumes of households' and non-financial companies' non-maturing deposits respectively. The independent variables were *d(pc1)* and *d(pc2)*, measure of the change of the market rates, *d(rdtd_irddhh)* and *d(rdtd_irddnfc)*, change of difference between demand deposit interest and the market rate interest, and *d(log_gdpnom)*, change of nominal GDP.

Table 14. Variables used in the estimated short-run relationship regressions

Variable	Type	Description
d(log_ddhh_sa)	dependent variable	change of log of volumes of households' demand deposits
d(log_ddnfc_sa)	dependent variable	change of log of volumes of non-financial companies' demand deposits
d(pc1)	independent variable	change of the first principal component of the 35 market interest rates
d(pc2)	independent variable	change of the second principal component of the 35 market interest rates
d(rdtd_irddhh)	independent variable	change of the difference between the interest paid on households' demand deposits and day-to-day euro interbank interest rate
d(rdtd_irddnfc)	independent variable	change of the difference between the interest paid on non-financial companies' demand deposits and day-to-day euro interbank interest rate
d(log_gdpnom_sa)	independent variable	change of the log of the nominal GDP

Because obviously the simple list of the independent variables like this do not capture all possible factors influencing the volume of the non-maturing deposits, it was necessary to add the lags of the dependent variables to control for possible serial correlation. It reasonable to assume that changes in the market rates may not impact clients' behaviour immediately, but it may take some time for clients to notice the change and make changes in their assets allocation. For this reason, the variables *d(pc1)*, *d(pc2)* and *d(rdtd_irddhh)* and *d(rdtd_irddnfc)* were added with one lag, thus giving households and companies one months to react. The variable *log_gdpnom_sa* was not added with a lag but only contemporaneously, assuming that changes in income impacts the level of deposits immediately.

The number of lags for dependent variable was chosen to be 6 for all countries, because of the strong autocorrelation present the dependent variables. Despite the large number of lags the homoskedasticity and autocorrelation tests were still failed for some countries, therefore HAC (Newey-West) adjustment was used to calculate correct t-statistics.

Using notations of variables from Table 14 above the two baseline regressions described in Table 15 were estimated. The results of the regressions are presented in the Table 16 and Table 17 below.

Table 15. Regressions equations used to estimate the short-term relationship

Model nr	Equation
1	$d(\log\_ddhh\_sa_t) = \alpha_1 d(\log\_ddhh\_sa_{t-1}) \dots \alpha_6 d(\log\_ddhh\_sa_{t-6}) +$ $\beta_1^1 d(pc1_{t-1}) + \beta_1^2 d(pc2_{t-1}) + \beta_1^3 d(rdtd\_irddhh_{t-1}) + \beta_0^4 d(log\_gdpnom\_sa_t)$
2	$d(\log\_ddnfc\_sa_t) = \alpha_1 d(\log\_ddnfc\_sa_{t-1}) \dots \alpha_6 d(\log\_ddnfc\_sa_{t-6}) +$ $\beta_1^1 d(pc1_{t-1}) + \beta_1^2 d(pc2_{t-1}) + \beta_1^3 d(rdtd\_irddnfc_{t-1}) + \beta_0^4 d(log\_gdpnom\_sa_t)$

Table 16. Estimation results for the short-term relationship Model 1 (households' deposits)

	Dependent variable: d_log_ddhh_sa																		
	Austria	Belgium	Cyprus	Estonia	Finland	France	Germany	Greece	Ireland	Italy	Latvia	Lithuania	Luxembourg	Malta	Netherlands	Portugal	Slovakia	Slovenia	Spain
d_log_ddhh_sa_Lag1	-0.35***	-0.25***	0.20**	0.30***	-0.18	-0.05	-0.10	0.12**	-0.05	-0.07	-0.06	0.16	0.15*	-0.22**	-0.12**	-0.13**	-0.06	-0.15**	0.02**
	(0.13)	(0.08)	(0.08)	(0.07)	(0.13)	(0.04)	(0.13)	(0.05)	(0.09)	(0.10)	(0.08)	(0.12)	(0.09)	(0.10)	(0.05)	(0.06)	(0.10)	(0.06)	(0.01)
d_log_ddhh_sa_Lag2	-0.07	0.13	0.001	0.07	-0.09*	-0.11***	-0.10*	0.22***	-0.08	0.03	0.005	0.11	0.10	0.12*	-0.11	0.12*	0.08	0.05	-0.01
	(0.07)	(0.08)	(0.12)	(0.07)	(0.05)	(0.03)	(0.06)	(0.04)	(0.12)	(0.12)	(0.05)	(0.08)	(0.07)	(0.06)	(0.07)	(0.07)	(0.08)	(0.04)	(0.01)
d_log_ddhh_sa_Lag3	0.19***	0.04	0.22***	0.22***	0.20*	0.15***	0.39***	0.18**	0.03	0.06	0.09	0.19**	0.21***	0.17**	0.04	0.23***	0.12	0.16**	0.02
	(0.06)	(0.08)	(0.06)	(0.05)	(0.11)	(0.05)	(0.08)	(0.08)	(0.06)	(0.09)	(0.10)	(0.08)	(0.08)	(0.07)	(0.09)	(0.04)	(0.09)	(0.07)	(0.01)
d_log_ddhh_sa_Lag4	-0.02	0.04	0.04	-0.15	0.05	0.04	0.02	0.09**	-0.07	-0.09	0.10	-0.12	0.08	-0.03	0.03	0.03	0.08	-0.03	0.01
	(0.10)	(0.08)	(0.05)	(0.10)	(0.07)	(0.03)	(0.10)	(0.05)	(0.06)	(0.07)	(0.08)	(0.09)	(0.06)	(0.09)	(0.05)	(0.08)	(0.06)	(0.06)	(0.01)
d_log_ddhh_sa_Lag5	0.05	-0.01	-0.04	0.11	0.12**	-0.04	0.14**	-0.08	0.02	0.14**	0.12	0.07	0.14	0.06	0.14*	0.12**	0.16***	0.06	0.01**
	(0.06)	(0.10)	(0.07)	(0.07)	(0.05)	(0.03)	(0.05)	(0.07)	(0.05)	(0.06)	(0.13)	(0.05)	(0.09)	(0.07)	(0.08)	(0.05)	(0.05)	(0.06)	(0.01)
d_log_ddhh_sa_Lag6	0.11	-0.03	0.13*	0.11	0.06	0.21***	0.09**	0.18*	0.02	0.21***	0.07	-0.03	-0.05	0.25***	0.13**	0.12*	0.12	0.37***	-0.001
	(0.10)	(0.06)	(0.06)	(0.07)	(0.05)	(0.07)	(0.05)	(0.09)	(0.06)	(0.05)	(0.11)	(0.08)	(0.09)	(0.07)	(0.06)	(0.07)	(0.13)	(0.12)	(0.01)
d_rdtd_irddhh_Lag1	-0.03	-0.03*	0.02	-0.002	-0.02**	-0.02	-0.01***	-0.001	-0.06*	-0.02*	-0.05**	0.02	-0.03***	-0.01	-0.02	-0.03**	-0.01	-0.001	-0.02
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.004)	(0.01)	(0.03)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
d_pc1_Lag1	0.01	-0.02	-0.01	-0.0005	-0.003	0.02	-0.02***	0.01	-0.05	-0.01	0.03	0.02	-0.03**	-0.01	0.02**	0.03*	-0.01	0.02	-0.03
	(0.03)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.004)	(0.01)	(0.04)	(0.01)	(0.03)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.03)	(0.05)
d_pc2_Lag1	-0.003	0.01	-0.02	0.003	-0.01	0.02**	-0.01***	-0.01	-0.01	0.002	0.01	0.01	-0.002	-0.005	0.02***	0.02*	-0.01	0.01	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.004)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
d_log_gdpnom_sa	0.12*	-0.04	0.08	0.06	-0.02	-0.08***	-0.15**	0.02	-0.16	0.01	-0.02	0.03	-0.07	0.01	-0.24***	-0.06	0.15*	-0.01	-0.01
	(0.07)	(0.07)	(0.09)	(0.09)	(0.11)	(0.02)	(0.06)	(0.04)	(0.11)	(0.03)	(0.06)	(0.07)	(0.11)	(0.07)	(0.07)	(0.04)	(0.07)	(0.09)	(0.06)
Constant	0.01***	0.01***	0.003*	0.003	0.004***	0.004***	0.004***	0.001	0.01**	0.003*	0.01**	0.01**	0.002	0.01***	0.004**	0.003**	0.004	0.005**	0.01**
	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.002)	(0.003)	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)	(0.003)	(0.002)	(0.005)
Note:	*p<0.1; **p<0.05; ***p<0.01																		

It can be seen that for a few countries the coefficients of the independent variables of interest to our study, *d(pc1)*, *d(rdtd_irddhh)*, *d(rdtd_irddnfc)*, were statistically significant. The Table 18 provides a summary of models, where the coefficient of the variables *d(pc1)*, *d(rdtd_irddhh)* and *d(rdtd_irddnfc)* were statistically significant at least at 5% confidence level. It is also possible to notice that the estimated coefficient values in the are not always consistent in sign. We should expect negative sign for *d(pc1)* since rising the market rates make alternative investments more attractive and clients should reduce balances on the non-maturing deposits. The sign of the variables *d(rdtd_irddhh)* and *d(rdtd_irddnfc)* should also be negative, because the when the interest paid to clients on the deposits is lower than the market day-to-day interest rate the client has more motivation to move deposits to more productive investment. However, we can observe the positive sign 2 cases out of 7 for variable *d(pc1)* and in 2 cases out of 8 for variables *d(rdtd_irddhh)* and *d(rdtd_irddnfc)* (see Table 18). The number of countries, for which the coefficients have the correct sign, is small. The sign of coefficient of *d(pc1)* is negative for two countries for models with households' deposits (Germany, Luxembourg) and three for models with non-financial companies (Austria, Germany, Greece). The size of the coefficient of *d(pc1)* is of small size compared to the coefficients of the autoregressive terms indicating a relatively weak relation.

Table 17. Estimation results for the short-term relationship Model 2 (non-financial companies' deposits)

	Dependent variable: d_log_ddnfc_sa																		
	Austria	Belgium	Cyprus	Estonia	Finland	France	Germany	Greece	Ireland	Italy	Latvia	Lithuania	Luxembourg	Malta	Netherlands	Portugal	Slovakia	Slovenia	Spain
d_log_ddnfc_sa_Lag1	-0.07	-0.40***	0.11	-0.03	-0.40***	-0.28***	-0.24***	-0.33***	-0.06	-0.62***	-0.39***	-0.20**	-0.46***	-0.17*	-0.16***	-0.53***	-0.29***	-0.41***	-0.29***
	(0.15)	(0.09)	(0.11)	(0.08)	(0.08)	(0.10)	(0.08)	(0.08)	(0.05)	(0.07)	(0.10)	(0.09)	(0.09)	(0.09)	(0.04)	(0.09)	(0.07)	(0.08)	(0.08)
d_log_ddnfc_sa_Lag2	-0.12*	-0.23***	-0.13***	0.08	-0.23**	-0.06	-0.16**	-0.18**	0.02	-0.36***	-0.15	-0.12	-0.18*	-0.12*	-0.09***	-0.22**	-0.23***	-0.12	-0.002
	(0.07)	(0.08)	(0.05)	(0.06)	(0.10)	(0.13)	(0.06)	(0.09)	(0.06)	(0.09)	(0.11)	(0.12)	(0.11)	(0.07)	(0.03)	(0.09)	(0.05)	(0.08)	(0.08)
d_log_ddnfc_sa_Lag3	0.003	-0.01	0.06	0.07	0.16**	0.16**	0.15**	-0.01	0.10	0.14	0.14	-0.08	-0.26***	-0.02	0.02	0.002	0.02	0.07	0.24***
	(0.07)	(0.09)	(0.10)	(0.06)	(0.07)	(0.07)	(0.07)	(0.09)	(0.07)	(0.09)	(0.12)	(0.09)	(0.10)	(0.06)	(0.04)	(0.12)	(0.06)	(0.10)	(0.07)
d_log_ddnfc_sa_Lag4	-0.04	0.03	-0.08	0.02	-0.13*	0.04	0.05	0.09	0.12*	0.08	0.11	0.09	-0.17	0.07	0.02	0.01	-0.16*	0.06	0.04
	(0.05)	(0.08)	(0.10)	(0.07)	(0.07)	(0.08)	(0.07)	(0.10)	(0.07)	(0.08)	(0.08)	(0.07)	(0.11)	(0.06)	(0.03)	(0.13)	(0.09)	(0.08)	(0.06)
d_log_ddnfc_sa_Lag5	0.002	0.08	0.04	0.09	-0.14*	-0.13	0.11	0.07	0.01	0.06	0.08	0.03	-0.02	0.01	0.002	0.08	-0.06	0.04	0.08
	(0.05)	(0.09)	(0.06)	(0.08)	(0.08)	(0.11)	(0.08)	(0.09)	(0.06)	(0.10)	(0.10)	(0.07)	(0.08)	(0.09)	(0.04)	(0.07)	(0.08)	(0.08)	(0.07)
d_log_ddnfc_sa_Lag6	0.02	0.19**	0.15*	0.02	-0.02	0.08	0.001	-0.03	0.18***	0.13*	0.01	0.06	-0.12	0.03	0.04	0.15*	0.11***	0.11	0.07
	(0.08)	(0.09)	(0.08)	(0.07)	(0.06)	(0.06)	(0.07)	(0.09)	(0.05)	(0.07)	(0.06)	(0.07)	(0.08)	(0.07)	(0.05)	(0.09)	(0.04)	(0.10)	(0.05)
d_rdtd_irddnfc_Lag1	0.01	-0.04*	-0.11	-0.01	0.10***	0.01	0.01	0.09**	0.01	-0.01	0.11	0.06*	0.19*	-0.02	-0.03	-0.07***	-0.02	0.002	0.01
	(0.03)	(0.03)	(0.10)	(0.02)	(0.03)	(0.02)	(0.01)	(0.04)	(0.02)	(0.02)	(0.07)	(0.03)	(0.10)	(0.02)	(0.02)	(0.03)	(0.04)	(0.03)	(0.02)
d_pc1_Lag1	-0.06***	0.02	0.18	0.01	-0.05*	-0.002	-0.03**	-0.10**	-0.02	0.01	-0.08	0.03	-0.04	0.05**	0.01	0.05*	0.01	0.01	0.01
	(0.02)	(0.03)	(0.15)	(0.02)	(0.03)	(0.02)	(0.01)	(0.04)	(0.02)	(0.02)	(0.06)	(0.03)	(0.10)	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.02)
d_pc2_Lag1	-0.04***	0.01	0.11	0.005	-0.06***	0.02	-0.02**	-0.08***	-0.01	0.01	-0.06	0.01	-0.02	0.02	0.04**	0.03	0.03*	0.02	0.02*
	(0.01)	(0.02)	(0.09)	(0.01)	(0.02)	(0.02)	(0.01)	(0.03)	(0.01)	(0.01)	(0.04)	(0.02)	(0.06)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.01)
d_log_gdpnom_sa	-0.16	-0.32**	0.16	-0.06	-0.34	-0.56***	-0.22**	0.16	0.13**	0.12*	-0.01	-0.19**	-0.04	-0.05	-0.31**	-0.26**	0.03	-0.11	-0.23*
	(0.12)	(0.13)	(0.23)	(0.12)	(0.27)	(0.12)	(0.09)	(0.16)	(0.06)	(0.06)	(0.16)	(0.09)	(0.66)	(0.12)	(0.13)	(0.13)	(0.10)	(0.12)	(0.12)
Constant	0.01***	0.01***	0.01	0.01**	0.01***	0.01***	0.01***	0.01*	0.004	0.01***	0.01**	0.01***	0.01	0.01***	0.01**	0.01**	0.01***	0.01***	0.01***
	(0.002)	(0.003)	(0.01)	(0.003)	(0.003)	(0.002)	(0.001)	(0.004)	(0.002)	(0.003)	(0.004)	(0.003)	(0.01)	(0.004)	(0.003)	(0.004)	(0.002)	(0.003)	(0.002)

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

The sign of coefficients for variables *d(rdtd_irddhh)* and *d(rdtd_irddnfc)* was negative for 5 countries (Finland, Germany, Latvia, Luxembourg, Portugal) for models with households' deposits and one country (Portugal) for models with non-financial companies' deposits. The coefficients were also rather small compared to the coefficients of the autoregressive terms.

To conclude the regression in the first differences, which were used to identify a possible short-term relationship between the volume of the non-maturing deposits and the level of the market rates, failed to show the existence of relationship. Only for a few countries the independent variables of interest showed statistically significant relationship and even then, the size of the coefficients was small compared to the autoregressive terms.

Table 18. The estimates and significance of the coefficients of the variables *d(pc1), d(rdtd_irddhh)* and *d(rdtd_irddnfc)*, which were statistically significant at least at 5% confidence level

Model nr	Group	Country	Dependent variable	Independent variable	Coef. estimate	Signi-ficance
Model 1	households	Germany	d_log_ddhh_sa	d_pc1_Lag1	-0.02	***
Model 1	households	Luxembourg	d_log_ddhh_sa	d_pc1_Lag1	-0.03	**
Model 1	households	Netherlands	d_log_ddhh_sa	d_pc1_Lag1	0.02	**
Model 1	households	Finland	d_log_ddhh_sa	d_rdtd_irddhh_Lag1	-0.02	**
Model 1	households	Germany	d_log_ddhh_sa	d_rdtd_irddhh_Lag1	-0.01	***
Model 1	households	Latvia	d_log_ddhh_sa	d_rdtd_irddhh_Lag1	-0.05	**
Model 1	households	Luxembourg	d_log_ddhh_sa	d_rdtd_irddhh_Lag1	-0.03	***
Model 1	households	Portugal	d_log_ddhh_sa	d_rdtd_irddhh_Lag1	-0.03	**
Model 2	non-financial companies	Austria	d_log_ddnfc_sa	d_pc1_Lag1	-0.06	***
Model 2	non-financial companies	Germany	d_log_ddnfc_sa	d_pc1_Lag1	-0.03	**
Model 2	non-financial companies	Greece	d_log_ddnfc_sa	d_pc1_Lag1	-0.1	**
Model 2	non-financial companies	Malta	d_log_ddnfc_sa	d_pc1_Lag1	0.05	**
Model 2	non-financial companies	Finland	d_log_ddnfc_sa	d_rdtd_irddnfc_Lag1	0.1	***
Model 2	non-financial companies	Greece	d_log_ddnfc_sa	d_rdtd_irddnfc_Lag1	0.09	**
Model 2	non-financial companies	Portugal	d_log_ddnfc_sa	d_rdtd_irddnfc_Lag1	-0.07	***

*p<0.1; **p<0.05; ***p<0.01

For several countries, where the coefficients were statistically different from zero, the sign of the coefficients was not consistent with what should be observed for rationally behaving agent. This probably could point to a possibility that significance is derived by accidental specification of the model and the relationship does not really exist.

3.4 Pooled mean group estimator

As explained above the ARDL modification, the pooled mean group estimator, suggested in Pesaran, Shin, Smith 1999 can be used for the panel setting. The model takes the form (3.3):

$$\Delta y_t^n = c_0^n + c_1^n t - \alpha^n (y_{t-1}^n - \theta^n x_t^n) + \sum_{i=1}^{p-1} \varphi_{yi}^n \Delta y_{t-i}^n + \sum_{i=0}^{q-1} \varphi_{xi}^{n\prime} \Delta x_{t-i}^n + u_t^n \quad (3.3)$$

In the equation 3.3 *n* is the cross-sectional identificator (country *n*), *y* is the dependent variable from the Table 19 below and *x* is a vector of independent variables from the same table.

The pooled mean group estimator allows the intercepts c_0^n, the error correction term coefficient α^n (speed of adjustment) and the short-term relationship coefficients φ_{yi}^n and $\varphi_{xi}^{n\prime}$ to be different cross-sectionally and enforces only the long-term variables coefficients, θ^n, to be the same across the panel. The coefficients c_1^n for time trend are also included in the short-term relationship and therefore allowed be different across countries to better capture possible national specificities in clients' behaviour.

Six different models were tested by means of the pooled mean group estimator: three for households' deposits and three for non-financial companies' deposits. Because the interacted breaks performed better than time linear breaks in the ARDL models for individual countries only the interacted breaks were tested. The individual linear trend was added to all the four models. The number of lags for each variable was chosen automatically based on the Akaike information criterium.

Table 19. Variables used in the estimated ARDL/pooled mean group regressions

Model number	Group	Dependent variable	Independent variable with lags	Non-lagged trend variables
Model_1 - no breaks	Households	log_ddhh_sa	rdtd_irddhh, pc1, pc2, log_gdpnom_sa	trend
Model_1 - 2008 break	Households	log_ddhh_sa	rdtd_irddhh, pc1, pc2, log_gdpnom_sa	trend
Model_1 - 2014 break	Households	log_ddhh_sa	b2014×rdtd_irddhh, b2014×pc1, b2014×log_gdpnom_sa, a2014×rdtd_irddhh, a2014×pc1, a2014×log_gdpnom_sa, pc2	trend
Model_2 - no breaks	Non-financial companies	log_ddnfc_sa	rdtd_irddnfc, pc1, pc2, log_gdpnom_sa	trend
Model_2 - 2008 break	Non-financial companies	log_ddnfc_sa	rdtd_irddnfc, pc1, pc2, log_gdpnom_sa	trend
Model_2 - 2014 break	Non-financial companies	log_ddnfc_sa	b2014×rdtd_irddnfc, b2014×pc1, log_gdpnom_sa, a2014×rdtd_irddnfc, a2014×pc1, a2014×log_gdpnom_sa, pc2	trend

Pesaran, Shin, Smith (1999) say that the pooled mean group estimator relies on the assumption that errors are independent between different groups. However, cross-sectional errors correlation is often observed as a result of omitting common factors affecting all groups. Pesaran, Shin, Smith

(1999) suggest that one way to deal with the cross-sectional correlation is to de-mean all variables for each period by cross-sectional mean of the respective each period. (Pesaran, Shin, Smith, 1999, p 622)

Testing of the data set used in this study showed that the residuals are correlated. Therefore, it was necessary to apply the de-meaning procedure suggested by Pesaran, Shin, Smith (1999) before estimating the regressions. De-meaning was only performed for the variables which differ cross-sectionally: *log_ddhh_sa*, *log_ddnfc_sa*, *rdtd_irddhh*, *rdtd_irdhhnfc* and *log_gdpnom_sa*. The variables *pc1* and *pc2* were not de-meaned, because these are based on the eurozone wide interest rates, which are the same for all countries.

The results for the estimation are summarized in Table 20. It can be seen that the panel PMG estimator performed better than ARDL estimator for individual countries. For base models without breaks the coefficient of key *pc1* variable in the long-term relationship term has the sign consistent with the theoretical assumptions and statistically strongly significant. The premium variable *rdtd_irddhh* coefficient in the regression for the households, although statistically significant at 1% confidence level, has positive value, which is not consistent with the theory. The coefficient *rdtd_irddnfc* in the regression for non-financial companies is not significant. The error correction term coefficient is negative and statistically significant for all countries in the panel.

The results for regressions which allow for a break in the coefficients at 2014 provided somewhat different results. Firstly, for households the coefficient of the main interest rates variable *pc1* is significant only before 2014. The coefficient of the premium variable *rdtd_irddhh* became statistically strongly significant but has positive sign, which is inconsistent with the theoretical assumption.

Secondly, for non-financial companies' the coefficient of the variable *pc1* is statistically significant and has correct sign only before 2014, as in the case of households. The coefficient of the premium variable *rdtd_irddnfc* is statistically significant and has correct sign both before and after 2014.

The error correction term coefficient in the households' regression was negative and statistically significant for all countries in the panel and for all four models.

Table 20. Results of estimation of regressions by the pooled mean group estimator

Model 1 - no breaks				
Dependent Variable: D(LOG_DDHH_SA)				
Selected Model: ARDL(2, 1, 1, 1, 1)				
Long Run Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
RDTD_IRDDHH	0.244	0.075	3.241	0.001
PC1	-0.088	0.026	-3.372	0.001
PC2	-0.013	0.011	-1.204	0.229
LOG_GDPNOM_SA	1.730	0.262	6.597	0.000

Model 1 - 2014 break				
Dependent Variable: D(LOG_DDHH_SA)				
Selected Model: ARDL(2, 1, 1, 1, 1, 1, 1, 1)				
Long Run Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
B2014*RDTD_IRDDHH	0.162	0.063	2.560	0.011
A2014*RDTD_IRDDHH	0.651	0.217	2.995	0.003
B2014*PC1	-0.127	0.029	-4.324	0.000
A2014*PC1	0.046	0.033	1.368	0.171
B2014*LOG_GDPNOM_SA	1.508	0.231	6.519	0.000
A2014*LOG_GDPNOM_SA	1.497	0.232	6.446	0.000
PC2	0.026	0.012	2.243	0.025

Error correction term coefficient (average of cross-sectional)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
COINTEQ01	-0.040	0.005	-7.867	0.000

Error correction term coefficient (average of cross-sectional)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
COINTEQ01	-0.011	0.013	-0.890	0.374

Countries for which the cointegration term is negative and statistically significant at least 5% confidence level
All countries in panel

Countries for which the cointegration term is negative and statistically significant at least 5% confidence level
All countries in panel

Model 2 - no breaks				
Dependent Variable: D(LOG_DDNFC_SA)				
Selected Model: ARDL(3, 1, 1, 1, 1)				
Long Run Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
RDTD_IRDDNFC	-0.084	0.075	-1.120	0.263
PC1	-0.100	0.036	-2.771	0.006
PC2	-0.016	0.014	-1.137	0.256
LOG_GDPNOM_SA	1.061	0.349	3.044	0.002

Model 2 - 2014 break				
Dependent Variable: D(LOG_DDNFC_SA)				
Selected Model: ARDL(3, 1, 1, 1, 1, 1, 1, 1)				
Long Run Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
B2014*RDTD_IRDDNFC	-0.121	0.064	-1.874	0.061
A2014*RDTD_IRDDNFC	-1.020	0.334	-3.054	0.002
B2014*PC1	-0.095	0.029	-3.227	0.001
A2014*PC1	0.013	0.032	0.407	0.684
B2014*LOG_GDPNOM_SA	0.989	0.267	3.704	0.000
A2014*LOG_GDPNOM_SA	0.907	0.264	3.442	0.001
PC2	-0.002	0.010	-0.215	0.830

Error correction term coefficient (average of cross-sectional)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
COINTEQ01	-0.052	0.007	-7.407	0.000

Error correction term coefficient (average of cross-sectional)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
COINTEQ01	-0.058	0.012	-4.784	0.000

Countries for which the cointegration term is negative and statistically significant at least 5% confidence level
All countries in panel

Countries for which the cointegration term is negative and statistically significant at least 5% confidence level
All countries in panel

4 INTERPRETATION OF THE REGRESSION RESULTS

Three different regression estimation methods were used in this study: the ARDL estimator for individual cross-sections, the first differences OLS estimator with autoregressive terms for individual cross-sections and PMG (Pooled Mean Group) estimator in the panel settings.

Based on the individual regressions for majority of countries no cointegration could be identified. The cointegration presence could be established for a small number of countries with mixed signals between different variables. Essentially only Germany, Lithuania, Spain and Luxembourg showed somewhat convincing results for households' deposits and only Luxembourg for non-financial companies' deposits. The cointegration could be not be detected even after adding a break dummy, which divided the observation period into two part, before 2014 and after 2014. The market interest rate volatility was significantly higher before 2014 as compared to after 2014, when the market interest rates were relatively stable around the zero boundary. Nevertheless, checking for this structural change has not changed regressions results so much that to alter the overall conclusions of this study.

The panel PMG estimator performed significantly better and showed significant common cointegration presence for majority of countries. The cointegration, however, seems to be very dependent on whether or not the breaks are present in the model. The long-term relationship took different form with and without breaks. More importantly the relationship between volume of deposits and the general level of the interest rates broke after adding the break at year 2014 and only the premium paid to non-maturity deposits holders became significant. The broken connection with the market interest rates casts doubts on whether the conclusions regarding the non-maturing deposits interest rate sensitivity can be reliably made.

To summarise, no convincing presence of cointegration could be identified neither for individual cross-section nor for the panel settings. Based on the dataset collected for this study there is no long-term relationship between the volumes of the non-maturing deposits and the general level of the market interest rates.

Also, no significant short-term relationship could be identified between the short-term changes in the market interest rates and the volume of the non-maturing deposits. The short-term relationship could be identified for only 5 countries out of 19 for households deposits and for 4 countries for non-financial companies deposits. Even then the relationship was relatively weak. The changes of the volume of the non-maturing deposits were predominantly explained by the autoregressive term, which indicates that factors not captured by the model are driving the dynamics of the non-maturing deposits.

We can conclude that the non-maturing deposits are not affected significantly by changes in the interest rates. The majority of the non-maturing deposits balances seem to be kept based on other considerations rather than the optimisation of the yield on the customers' asset portfolios. One possible reason for this could be that customers do not allow significant uninvested assets to accumulate on the non-maturing deposits accounts but rather seek to invest the excess balances into other instruments within a certain time frame regardless of the general level of the market rates. Even in the current extremely low interest rates environment there is no excess funds on the non-maturing accounts which can evaporate with the rise of the interest rates. Consequently, the balances observed at non-maturing accounts at any given moment of time can be regarded as a stable long-term funding, at least from the interest rate risk point of view.

In terms on theoretical concepts the missing or weak relationship between the market interest rates and the volume of the non-maturing deposits indicate that the individual strikes for the difference between the market interest rate and the rates offered on the non-maturing deposits are located relatively high and were not triggered during the observation period used in this study. According to the theoretical model suggested by Farchot (2001), if the individual interest rate strike of a customer is not triggered then his non-maturing deposit balance continue to linearly grow because the customer puts aside each period a certain proportion of his income to savings, out of which a part is left to accumulate in the transactional non-maturing deposits. According to the theory suggested by Nyström (2008) if the individual interest rate strike of a customer is not triggered than his target liquidity buffer, expressed as a proportion of the customer's regular income, is maintained. The non-maturing deposits continue to exogenously grow as customers' regular income grow.

We can conclude that the maturity transformation does not create in the banking sector a significant exposure to the interest rate risk, which is costly to manage and mitigate. Among other costs, which can be avoided, is that one banking sector should not put aside significant capital buffers to cover the interest rate risk arising from the non-maturing deposits. The banking sector seems to have ability to summon through the provision of payment and other convenience services a stable predictable pool of funding at low interest cost. It means that the banking sector has a capability to facilitate the flow of funds from short-term savings to the long-term lending without charging significant premium for the interest rate risk.

Low interest rate sensitivity of the non-maturing deposits does not necessarily mean that the deposits are stable from the liquidity management point of view. There could be other non-interest rate factors driving the changes in the non-maturing deposits. But at least there is one impediment less to the flow of funds from savings to lending.

The results of this study could be influenced by the fact that for a large part of the observation period included in the dataset the market interest rates were declining. If depositors' reaction is asymmetrical to increases and decreases of the market interest rates this asymmetry could be missed due to the specific market developments during the observation period. It would be beneficial to repeat the study for the observation period, which includes intervals both of rising and declining interest rates.

5 CONCLUSION

The non-maturing deposits is an important part of the eurozone banking sector funding. The degree to which the non-maturing deposits react to the changes in market interest rates is therefore an important determinant of the cost of the maturity transformation provided by banking sector. The interest rate sensitivity of the non-maturity deposits remains an elusive matter. While providing clients with a possibility to withdraw the deposit balance at a short notice and, thus having a very short contractual maturity, a certain proportion of the non-maturity deposit exhibit characteristics of a stable long-term funding relatively insensitive to fluctuations in the market interest rates.

The aim of this study was to measure the interest rate sensitivity of the non-maturing deposits in the eurozone countries during the period from January 2003 to June 2020. The interest rate sensitivity was measured by estimating the relationship between the volumes of the households' and non-financial companies' non-maturing deposits and the general level of the market interest rates in the eurozone.

The author used the autoregressive distributed lags (ARDL) method to identify the possible cointegration between the volumes of the non-maturing deposits and the market rates and regular OLS with autoregressive term to estimate the short-term relationship between changes in the volumes of the non-maturing deposits and changes in the market rates separately for each individual eurozone country. Additionally, the pooled mean group (PMG) was used to estimate the cointegration using the panel settings.

A weak and periodical cointegration was identified for a small number of the countries (Germany, Lithuania, Spain, Luxembourg households' deposits). For the majority of the eurozone countries the existence of the cointegration could not be confirmed. The regression in the first differences revealed a weak relationship between the changes of the deposit volumes and changes in the interest rates for a small number countries (in Finland, Germany, Latvia, Luxembourg, Portugal for households deposits and in Austria, Germany, Greece, Portugal for non-financial companies deposits). The short-term relationship was largely driven by the autoregressive terms, which were strongly significant for almost all countries. The autoregressive terms summarize in this case all factors driving the changes in the non-maturing deposits, which are non-interest rates related.

The PMG estimator provided at first some interesting results. However, after performing testing for breaks the coefficients proved to behave inconsistently, so that the identified long-term relationships should probably be dismissed as spurious.

The relationship between the market interest rates and the volume of non-maturing deposits could be not be detected even after adding a break dummy, which divided the observation period into two part, before 2014 and after 2014. The market interest rate volatility was significantly higher before 2014 as compared to after 2014, when the market interest rates were relatively stable around the zero boundary.

In terms on theoretical concepts the missing or weak relationship between the market interest rates and the volume of the non-maturing deposits indicate that the individual strikes for the difference between the market interest rate and the rates offered on the non-maturing deposits are located relatively high and were not triggered during the observation period used in this study. According to the theoretical concept suggested in the literature if the individual interest rate strikes of customers are not triggered then their target liquidity buffer, expressed as a proportion of the customers' regular income, is maintained. The non-maturing deposits continue to exogenously grow as customers' regular income grow.

Since no significant link can be detected between the volume of the non-maturing deposits and the market interest rates, one can conclude that maturity transformation function provided by the banking sector does not create significant exposure to the interest rate risk. It means that the banking sector has the ability to facilitate the flow of funds from the short-term deposits to the long-term lending without charging a premium for the interest risk component of the maturity transformation.

This is possible that the results of this study were influenced by the choice of the observation period. During the observation period the interest rate exhibited mainly a declining trend, which could be the reason that possible asymmetric reactions of depositors to falling and to rising interest rates could be missed. It would be beneficial to repeat the study for the observation period, which includes both the intervals of rising and declining interest rates.

6 KOKKUVÕTE

Nõudmiseni klientide hoiused moodustavad olulise osa euroala pangandussektori kogu finantseerimisest. Nõudmiseni hoiuste intressitundlikkus ehk see, millisel määral reageerivad nõudmiseni hoiuste maht ja hind turuintressimäärade muutustele, määrab kui suured kulud kaasnevad pangandussektorile varade ja kohustuste tähtaegade mittekattuvusest tulenevate riskide maandamisega. Juhul, kui nõudmiseni hoiuste intressimäärade tundlikkus on kõrge, võivad kõikumised turuintressimäärades oluliselt mõjutada pangandussektori finantseerimise hinda. Juhul kui pangandussektori varade ja kohustuste tähtaegade mittekattuvusest tulenev risk on kõrge, siis suureneb pangandussektorile riskimaandamisega kaasnev kulu ja see omakorda mõjutab negatiivselt reaalmajanduse finantseerimishinda.

Nõudmiseni hoiuste intressitundlikkuse hindamine on oluliselt keerukam ülesanne kui paljude muude pangandussektori finantseerimisinstrumentide puhul. Ühelt poolt võimaldab nõudmiseni hoiuse olemus kliendil hoiuse jäägi koheselt või lühikese etteteatamisajaga täies mahus tagasi nõuda ja lepinguliselt on tegemist väga lühiajalise instrumendiga. Teiselt poolt, nõudmiseni hoiuste kogu jäägis võib tuvastada osa, mis on äärmiselt püsiva iseloomuga ja ei reageeri kasvavale erinevusele nõudmiseni hoiustele pakutava intressimäära ja kättesaadavate alternatiivsete investeerimisvõimaluste tulukuse vahel. Teisisõnu vaatamata lühikesele lepingulisele tähtajale käitub teatud osa nõudmiseni hoiuste kui pikaajaline ressurss, mis reageerib väga aeglaselt turuintressimäärade muutustele. Selle ressursi tegelik käitumuslik tähtaeg on määrava tähtsusega pangandussektori omandatava intressiriski hindamisel.

Käesoleva uurimuse eesmärk on hinnata nõudmiseni hoiuste intressitundlikkus euroala riikides perioodil 31.01.2003 kuni 30.06.2020. Autor hindas statistilist seost kodumajapidamiste ja mittefinantsettevõtete nõudmiseni hoiuste mahu ja turuintressimäärade üldise taseme vahel. Autor kasutas autoregressiivset jaotatud viitajaga (ARDL) meetodit, et tuvastada võimaliku kointegratsiooni ehk pikaajalise tasakaalu seose hoiuste mahu ja turuintressimäärade taseme vahel individuaalselt igas euroala riigis. Autor kasutas täiendavalt lineaarregressiooni meetodit esimest järku diferentsidega autoregressiivsete liikmetega, et hinnata lühiajalist seost hoiuste mahu muutuste ja intressimäärade muutuste vahel igas euroala riigis. Lisaks, kasutas autor PMG (*pooled mean group*) meetodit, et hinnata võimaliku kointegratsiooni olemasolu paneeluuringu tingimustes.

Nõrk ja episoodiline kointegratsioon oli tuvastatud väikese arvu riikide jaoks paneeluuringus (Saksamaa, Leedu, Hispaania ja Luksemburgi kodumajapidamiste hoiuste jaoks). Enamiku euroala riikide jaoks ei saanud kointegratsiooni olemasolu kinnitust. Esimest järku diferentside autoregressiivsete liikmetega regressiooni hindamine tuvastas nõrga lühiajalise seose nõudmiseni hoiuste mahu muutuste ja turuintressimäärade muutuste vahel väikese arvu riikide jaoks (Soome, Saksamaa, Läti, Luksemburg, Portugali kodumajapidamiste ja Portugali mittefinantsettevõtete jaoks). Esimeste järku diferentside regressioonis olid suurima selgitava jõuga autoregressiivsetel liikmetel, mille koefitsiendid olid statistiliselt olulised kõrge usaldusniivooga enamiku riikide jaoks paneeluuringus. Autoregressiivsed liikmed olid lisatud regressiooni selleks, et summeerida kõikide tegurite mõju, mis ei ole seotud turuintressimääradega. Autoregressiivsete liikmete suur selgitav jõud viitab sellele, et nõudmiseni hoiuste mahtu mõjutavad enim muud tegurid kui turuintressimäärad.

Paneelregressioon PMG meetodiga läbiviidud hindamine tuvastas esmases spetsifikatsioonis kointegratsiooni olemasolu hoiuste mahu ja intressimäärade üldise taseme vahel. Edasine testimine ja trendimurdumist kajastavate dühotoomsete fiktiivsete muutujate lisamine näitas, et pikaajalise seose koefitsiendid kointegratsiooni vektoris ei käitu järjepidevalt vastavuses teoreetiliste eeldustega. Autor järeldas, et PMG regressiooni tulemused ei ole usaldusväärsed ja tuginedes nendele ei saa teha järeldusi uuritava seose kohta.

Kuna seose olemasolu nõudmiseni hoiuste mahu ja turuintressimäärade üldise taseme vahel ei saanud kinnitust, võib järeldada, et nõudmiseni hoiustega finantseerimisega kaasnev varade ja kohustuste tähtaegade mittekattuvus ei tekita pangandussektori jaoks olulist intressiriski. Muuhulgas võib järeldada, et isegi tänases erakorraliselt madalate intressimäärade keskkonnas ei ole nõudmiseni hoiustel paigutatud vahendeid, mis võidakse ümber paigutada teistesse instrumentidesse intressimäärade üldise tõusu korral. Vaatamata lühiajaliste nõudmiseni hoiuste suure osakaalule euroala pangandussektori finantseerimises ei ole see takistuseks pikaajaliste laenude väljastamiseks ja pikaajaliste laenude väljastamisel ei ole vajalik riskipreemia lisamine laenuhinnale nõudmiseni hoiuste lühiajalisusest tuleneva intressiriski eest.

7 LIST OF REFERENCES

Andreou, E., Ghysels, E. and Kourtellos, A. (2010). Regression models with mixed sampling frequencies. Journal of Econometrics, 158(2), pp.246-261.

Blöchlinger, A. (2015). Identifying, valuing and hedging of embedded options in non-maturity deposits. Journal of Banking & Finance, 50, 34-51.

Blöchlinger, A. (2018). Interest Rate Risk of Non-Maturity Bank Accounts: From the Marketing to the Hedging Strategy. Available at SSRN 3181163.

Busch, R., & Memmel, C. (2016). Quantifying the components of the banks' net interest margin. Financial Markets and Portfolio Management, 30(4), 371-396.

Castagna, A., & Manenti, F. (2013). Sight Deposit and Non-Maturing Liability Modelling. Argo, 1, 7-18.

Dewachter, H., Lyrio, M., & Maes, S. (2006). A multi-factor model for the valuation and risk managment of demand deposits. National Bank of Belgium working paper, (83).

Drechsler, I., Savov, A., & Schnabl, P. (2018). Banking on deposits: Maturity transformation without interest rate risk (No. w24582). National Bureau of Economic Research.

Entrop, O., Wilkens, M., & Zeisler, A. (2009). Quantifying the interest rate risk of banks: assumptions do matter. European financial management, 15(5), 1001-1018.

Frachot, A. (2001). A Note on Behavioral Models for Managing Optionality in Banking Books. Groupe de Recherche Opérationnelle. Lyon: Crédit Lyonnais.

Frauendorfer, K., & Schürle, M. (2003). Management of non-maturing deposits by multistage stochastic programming. European Journal of Operational Research, 151(3), 602-616.

Frauendorfer, K., & Schürle, M. (2007). Dynamic modeling and optimization of non-maturing accounts. Liquidity risk: Measurement and management. Singapore: John Wiley and Sons, 327-359.

Guidelines on the management of interest rate risk arising from non-trading book activities. (2018). European Banking Authority. [Online] https://eba.europa.eu/regulation-and-policy/supervisory-review/guidelines-on-technical-aspects-of-the-management-of-interest-rate-risk-arising-from-non-trading-activities-under-the-supervisory-review-process 03.08.2020

Hansen, B. E. (2001). The new econometrics of structural change: dating breaks in US labour productivity. Journal of Economic perspectives, 15(4), 117-128.

Hassler, U., Wolters, J. (2006). Autoregressive distributed lag models and cointegration. Modern econometric analysis (pp. 57-72). Springer, Berlin, Heidelberg.

Holmes, M. J., Iregui, A. M., & Otero, J. (2015). Interest rate pass through and asymmetries in retail deposit and lending rates: An analysis using data from Colombian banks. Economic Modelling, 49, 270-277.

Hutchison, D., & Pennacchi, G. (1996). Measuring Rents and Interest Rate Risk in Imperfect Financial Markets: The Case of Retail Bank Deposits. Journal of Financial and Quantitative Analysis, 31(3), 399-417.

Hussain, M. N., & Nahar, B. (2016). Interest rate volatility and retail interest rate pass-through in the case of the Malaysian economy. The Journal of Developing Areas, 50(5), 277-294.

Interest rate risk in the banking book. Standards. (2016). Basel Committee on Banking Supervision. [Online] https://www.bis.org/bcbs/publ/d368.htm 02.08.2020

Nkoro, E., Uko, A. K. (2016). Autoregressive Distributed Lag (ARDL) cointegration technique: application and interpretation. Journal of Statistical and Econometric Methods, 5(4), 63-91.

Kalkbrener, M., & Willing, J. (2004). Risk management of non-maturing liabilities. Journal of Banking & Finance, 28(7), 1547-1568.

Kerbl, S., & Sigmund, M. (2016). From low to negative rates: an asymmetric dilemma. Financial stability report, 32, 120-135.

Kerbl, S., Simunovic, B., & Wolf, A. (2019). Quantifying interest rate risk and the effect of model assumptions behind sight deposits. Financial Stability Report, 37, 73-75.

Kripfganz, S., Schneider, D.C., (2018). Estimating autoregressive distributed lag and equilibrium correction models. London Stata Conference, September 7, 2018

Lopez, J. A., Rose, A. K., & Spiegel, M. M. (2018). Why have negative nominal interest rates had such a small effect on bank performance? cross country evidence (No. w25004). National Bureau of Economic Research.

Maes, K., & Timmermans, T. (2005). Measuring the interest rate risk of Belgian regulated savings deposits. NBB Financial Stability review, 136-151.

Männasoo, K. (2013). Determinants of bank interest spreads in Estonia. Eastern European Economics, 51(1), 36-60.

Memmel, C. (2018). Why Do Banks Bear Interest Rate Risk?. Schmalenbach Business Review, 70(3), 231-253.

Memmel, C. (2020). What drives the short-term fluctuations of banks' exposure to interest rate risk? Review of Financial Economics, 38(4), 674-686.

Neisen, M., Schulte-Mattler, H. (2020). CRD V/CRR II: A comprehensive synopsis of the first European step towards implementing Basel IV (Part II). Journal of Risk Management in Financial Institutions, 13(3), 224-241.

Nyström, K. (2008). On deposit volumes and the valuation of non-maturing liabilities. Journal of Economic Dynamics and Control, 32(3), 709-756.

O'Brien, J. (2000). Estimating the value and interest rate risk of interest-bearing transactions deposits. Board of Governors of the Federal Reserve System. Finance and Economics Discussion Paper, (46).

Paraschiv, F. (2013). Adjustment policy of deposit rates in the case of Swiss non-maturing savings accounts. Journal of Applied Finance & Banking, 3(3), 271-323.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. Journal of the American statistical Association, 94(446), 621-634.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of applied econometrics, 16(3), 289-326.

Sheehan, R. G. (2013). Valuing core deposits. Journal of Financial Services Research, 43(2), 197-220.

Stanisławska, E. (2015). Interest rate pass-through in poland: evidence from individual bank data. Eastern European Economics, 53(1), 3-24.

Vogelsang, T. J., & Perron, P. (1998). Additional tests for a unit root allowing for a break in the trend function at an unknown time. International Economic Review, 1073-1100.

Zijderveld, R. V. (2017). BCBS IRRBB pillar 2: The new standard for the banking industry. Journal of Risk Management in Financial Institutions, 10(3), 282-288.

8 APPENDICES

8.1 Appendix 1. Results of estimating ARDL regressions

Germany, Model 4

ARDL Error Correction Regression
Dependent Variable: D(LOG_DDHH_SA)
Selected Model: ARDL(4, 0, 8, 6)
Case 5: Unrestricted Constant and Unrestricted Trend
Date: 11/22/20 Time: 21:18
Sample: 2003M01 2020M06
Included observations: 202

ECM Regression
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.917794	0.333050	5.758281	0.0000
@TREND	0.000888	0.000153	5.790716	0.0000
D(LOG_DDHH_SA(-1))	-0.169373	0.061681	-2.745966	0.0066
D(LOG_DDHH_SA(-2))	-0.113634	0.062845	-1.808165	0.0723
D(LOG_DDHH_SA(-3))	0.327731	0.061647	5.316272	0.0000
D(PC1)	-0.007918	0.005356	-1.478485	0.1410
D(PC1(-1))	0.003741	0.006455	0.579570	0.5629
D(PC1(-2))	-0.004679	0.006372	-0.734252	0.4638
D(PC1(-3))	-0.002646	0.006286	-0.420858	0.6744
D(PC1(-4))	0.007870	0.006284	1.252504	0.2120
D(PC1(-5))	0.007980	0.006080	1.312445	0.1911
D(PC1(-6))	-0.009555	0.004426	-2.158922	0.0322
D(PC1(-7))	0.016798	0.004270	3.933604	0.0001
D(PC2)	-0.009224	0.003460	-2.665634	0.0084
D(PC2(-1))	-0.000436	0.003954	-0.110225	0.9124
D(PC2(-2))	-0.006086	0.003906	-1.558015	0.1210
D(PC2(-3))	-0.000678	0.003877	-0.174767	0.8615
D(PC2(-4))	0.001793	0.003847	0.466058	0.6417
D(PC2(-5))	0.007432	0.003577	2.077725	0.0392
CointEq(-1)*	-0.148045	0.025771	-5.744679	0.0000

R-squared	0.596459	Mean dependent var	0.007002
Adjusted R-squared	0.554331	S.D. dependent var	0.007679
S.E. of regression	0.005126	Akaike info criterion	-7.615078
Sum squared resid	0.004783	Schwarz criterion	-7.287526
Log likelihood	789.1228	Hannan-Quinn criter.	-7.482550
F-statistic	14.15829	Durbin-Watson stat	1.980043
Prob(F-statistic)	0.000000		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	8.114339	10%	3.47	4.45
k	3	5%	4.01	5.07
		2.5%	4.52	5.62
		1%	5.17	6.36

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-5.744679	10%	-3.13	-3.84
		5%	-3.41	-4.16
		2.5%	-3.65	-4.42
		1%	-3.96	-4.73

Lithuania, Model 3

ARDL Error Correction Regression
Dependent Variable: D(LOG_DDHH_SA)
Selected Model: ARDL(1, 11, 10, 2, 10, 10, 12)
Case 5: Unrestricted Constant and Unrestricted Trend
Date: 11/22/20 Time: 21:27
Sample: 2003M01 2020M06
Included observations: 172

ECM Regression
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.554241	0.786789	7.059377	0.0000
@TREND	0.005869	0.000835	7.028438	0.0000
D(B2008_RDTD_IRD...	0.051985	0.015139	3.433829	0.0008
D(B2008_RDTD_IRD...	-0.034068	0.019868	-1.714692	0.0893
D(B2008_RDTD_IRD...	-0.082815	0.019629	-4.218963	0.0001
D(B2008_RDTD_IRD...	-0.053371	0.018163	-2.938470	0.0040
D(B2008_RDTD_IRD...	-0.012979	0.016525	-0.785407	0.4339
D(B2008_RDTD_IRD...	-0.020608	0.015389	-1.339116	0.1833
D(B2008_RDTD_IRD...	-0.055496	0.015917	-3.486560	0.0007
D(B2008_RDTD_IRD...	-0.015703	0.016437	-0.955351	0.3415
D(B2008_RDTD_IRD...	-0.001679	0.016708	-0.100521	0.9201
D(B2008_RDTD_IRD...	0.000160	0.015561	0.010285	0.9918
D(B2008_RDTD_IRD...	-0.078032	0.012312	-6.337806	0.0000
D(B2008_PC1)	-0.006888	0.031505	-0.218643	0.8273
D(B2008_PC1(-1))	-0.038120	0.031813	-1.198244	0.2334
D(B2008_PC1(-2))	0.071512	0.029115	2.456177	0.0156
D(B2008_PC1(-3))	0.044003	0.028163	1.562446	0.1211
D(B2008_PC1(-4))	0.030913	0.027267	1.133714	0.2594
D(B2008_PC1(-5))	-0.044811	0.026049	-1.720275	0.0882
D(B2008_PC1(-6))	-0.054131	0.028070	-1.928429	0.0564
D(B2008_PC1(-7))	-0.089298	0.029999	-2.976709	0.0036
D(B2008_PC1(-8))	-0.017229	0.029170	-0.590651	0.5560
D(B2008_PC1(-9))	-0.129551	0.029526	-4.387735	0.0000
D(PC2)	0.027220	0.012349	2.204294	0.0296
D(PC2(-1))	0.032061	0.012627	2.539121	0.0125
D(LOG_GDPNOM_SA)	-0.287165	0.064208	-4.472446	0.0000
D(LOG_GDPNOM_SA...	0.414287	0.075642	5.476939	0.0000
D(LOG_GDPNOM_SA...	0.414731	0.079191	5.237125	0.0000
D(LOG_GDPNOM_SA...	0.568860	0.083710	6.795623	0.0000
D(LOG_GDPNOM_SA...	0.165883	0.071415	2.322793	0.0221
D(LOG_GDPNOM_SA...	0.174341	0.059370	2.936541	0.0041
D(LOG_GDPNOM_SA...	0.246180	0.062037	3.968305	0.0001
D(LOG_GDPNOM_SA...	0.196852	0.061553	3.198066	0.0018
D(LOG_GDPNOM_SA...	0.097033	0.060496	1.603959	0.1116
D(LOG_GDPNOM_SA...	0.107550	0.057258	1.878330	0.0630
D(A2008_PC1)	0.027420	0.018160	1.509928	0.1340
D(A2008_PC1(-1))	0.046181	0.019513	2.366720	0.0197
D(A2008_PC1(-2))	0.002655	0.011306	0.234816	0.8148
D(A2008_PC1(-3))	-0.005310	0.011161	-0.475766	0.6352
D(A2008_PC1(-4))	-0.002250	0.011041	-0.203825	0.8389
D(A2008_PC1(-5))	-0.007700	0.010781	-0.714263	0.4766
D(A2008_PC1(-6))	-0.022971	0.010614	-2.164246	0.0326
D(A2008_PC1(-7))	-0.011625	0.010463	-1.111082	0.2690
D(A2008_PC1(-8))	-0.005322	0.010465	-0.508600	0.6121
D(A2008_PC1(-9))	-0.030984	0.010196	-3.038927	0.0030
D(A2008_RDTD_IRD...	0.038542	0.013087	2.944944	0.0040
D(A2008_RDTD_IRD...	-0.055646	0.014138	-3.935759	0.0001
D(A2008_RDTD_IRD...	-0.032224	0.013437	-2.398069	0.0182
D(A2008_RDTD_IRD...	0.001231	0.012698	0.096931	0.9230
D(A2008_RDTD_IRD...	0.001712	0.012935	0.132379	0.8949
D(A2008_RDTD_IRD...	-0.014951	0.012208	-1.224688	0.2234
D(A2008_RDTD_IRD...	-0.050070	0.011342	-4.414537	0.0000
D(A2008_RDTD_IRD...	-0.025830	0.012527	-2.061945	0.0416
D(A2008_RDTD_IRD...	0.023015	0.012742	1.806208	0.0737
D(A2008_RDTD_IRD...	-0.007483	0.010508	-0.712074	0.4780
D(A2008_RDTD_IRD...	-0.033873	0.009735	-3.479589	0.0007
D(A2008_RDTD_IRD...	0.006831	0.005082	1.344351	0.1817
CointEq(-1)*	-0.291787	0.041408	-7.046698	0.0000

Germany, Model 4 (continued)

Levels Equation
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RDTD_IRDDHH	-0.029039	0.019486	-1.490296	0.1379
PC1	-0.078047	0.009855	-7.919595	0.0000
PC2	-0.030573	0.010234	-2.987448	0.0032

EC = LOG_DDHH_SA - (-0.0290*RDTD_IRDDHH -0.0780*PC1 -0.0306 *PC2)

Lithuania, Model 3 (continued)

R-squared	0.825940	Mean dependent var	0.010578
Adjusted R-squared	0.738911	S.D. dependent var	0.019370
S.E. of regression	0.009897	Akaike info criterion	-6.129989
Sum squared resid	0.011167	Schwarz criterion	-5.068625
Log likelihood	585.1791	Hannan-Quinn criter.	-5.699366
F-statistic	9.490313	Durbin-Watson stat	2.094282
Prob(F-statistic)	0.000000		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	6.720355	10%	2.53	3.59
k	6	5%	2.87	4
		2.5%	3.19	4.38
		1%	3.6	4.9

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-7.046698	10%	-3.13	-4.37
		5%	-3.41	-4.69
		2.5%	-3.65	-4.96
		1%	-3.96	-5.31

Levels Equation
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
B2008_RDTD_IRDDHH	0.397248	0.056065	7.085492	0.0000
B2008_PC1	-0.372354	0.135883	-2.740264	0.0072
PC2	-0.038324	0.020173	-1.899790	0.0601
LOG_GDPNOM_SA	-1.469599	0.426971	-3.441920	0.0008
A2008_PC1	-0.075436	0.019872	-3.796046	0.0002
A2008_RDTD_IRDDHH	0.183060	0.049713	3.682347	0.0004

EC = LOG_DDHH_SA - (0.3972*B2008_RDTD_IRDDHH -0.3724 *B2008_PC1 -0.0383*PC2 -1.4696*LOG_GDPNOM_SA -0.0754 *A2008_PC1 + 0.1831*A2008_RDTD_IRDDHH)

Spain, Model 3

ARDL Error Correction Regression
Dependent Variable: D(LOG_DDHH_SA)
Selected Model: ARDL(1, 4, 4, 1, 9, 0, 1)
Case 5: Unrestricted Constant and Unrestricted Trend
Date: 11/22/20 Time: 21:48
Sample: 2003M01 2020M06
Included observations: 201

ECM Regression
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.451822	0.651481	-8.368357	0.0000
@TREND	0.000470	9.06E-05	5.185961	0.0000
D(B2008_RDTD_IRD...	0.315658	0.056136	5.623062	0.0000
D(B2008_RDTD_IRD...	-0.022315	0.041676	-0.535435	0.5930
D(B2008_RDTD_IRD...	0.040256	0.041535	0.969209	0.3338
D(B2008_RDTD_IRD...	-0.200312	0.038400	-5.216492	0.0000
D(B2008_PC1)	-0.372585	0.092451	-4.030093	0.0001
D(B2008_PC1(-1))	0.129650	0.097293	1.332563	0.1844
D(B2008_PC1(-2))	-0.056609	0.096708	-0.585364	0.5591
D(B2008_PC1(-3))	0.519897	0.088528	5.872692	0.0000
D(PC2)	-0.108795	0.030855	-3.526045	0.0005
D(LOG_GDPNOM_SA)	-0.042466	0.261699	-0.162272	0.8713
D(LOG_GDPNOM_SA...	-0.846445	0.273477	-3.095121	0.0023
D(LOG_GDPNOM_SA...	-0.820601	0.274205	-2.992662	0.0032
D(LOG_GDPNOM_SA...	-1.064913	0.484684	-2.197129	0.0293
D(LOG_GDPNOM_SA...	-0.807307	0.479920	-1.682170	0.0943
D(LOG_GDPNOM_SA...	0.109697	0.485815	0.225801	0.8216
D(LOG_GDPNOM_SA...	0.260899	0.520868	0.500893	0.6171
D(LOG_GDPNOM_SA...	0.235003	0.499939	0.470063	0.6389
D(LOG_GDPNOM_SA...	2.618795	0.523672	5.000834	0.0000
D(A2008_RDTD_IRD...	0.187568	0.045152	4.154134	0.0001
CointEq(-1)*	-0.286862	0.034267	-8.371262	0.0000

R-squared	0.454580	Mean dependent var	0.011375
Adjusted R-squared	0.390592	S.D. dependent var	0.070772
S.E. of regression	0.055248	Akaike info criterion	-2.851000
Sum squared resid	0.546360	Schwarz criterion	-2.489444
Log likelihood	308.5255	Hannan-Quinn criter.	-2.704699
F-statistic	7.104158	Durbin-Watson stat	1.991230
Prob(F-statistic)	0.000000		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	9.675578	10%	2.53	3.59
k	6	5%	2.87	4
		2.5%	3.19	4.38
		1%	3.6	4.9

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-8.371262	10%	-3.13	-4.37
		5%	-3.41	-4.69
		2.5%	-3.65	-4.96
		1%	-3.96	-5.31

Levels Equation
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
B2008_RDTD_IRDDHH	0.663304	0.192218	3.450791	0.0007
B2008_PC1	-1.602791	0.260909	-6.143090	0.0000
PC2	-0.193619	0.140726	-1.375865	0.1706
LOG_GDPNOM_SA	2.515929	0.398355	6.315796	0.0000
A2008_PC1	-0.337452	0.188204	-1.793007	0.0747
A2008_RDTD_IRDDHH	0.224545	0.205769	1.091248	0.2767

EC = LOG_DDHH_SA - (0.6633*B2008_RDTD_IRDDHH -1.6028
*B2008_PC1 -0.1936*PC2 + 2.5159*LOG_GDPNOM_SA -0.3375
*A2008_PC1 + 0.2245*A2008_RDTD_IRDDHH)

Spain, Model 5

ARDL Error Correction Regression
Dependent Variable: D(LOG_DDHH_SA)
Selected Model: ARDL(1, 4, 4, 4, 0, 1)
Case 5: Unrestricted Constant and Unrestricted Trend
Date: 11/22/20 Time: 21:52
Sample: 2003M01 2020M06
Included observations: 206

ECM Regression
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.357948	0.343070	6.873073	0.0000
@TREND	0.001283	0.000207	6.208648	0.0000
D(B2008_RDTD_IRD...	0.301267	0.057051	5.280642	0.0000
D(B2008_RDTD_IRD...	-0.004609	0.039608	-0.116372	0.9075
D(B2008_RDTD_IRD...	0.055233	0.039269	1.406542	0.1612
D(B2008_RDTD_IRD...	-0.115173	0.038848	-2.964707	0.0034
D(B2008_PC1)	-0.342843	0.087118	-3.935396	0.0001
D(B2008_PC1(-1))	0.101786	0.094022	1.082579	0.2804
D(B2008_PC1(-2))	-0.071535	0.091888	-0.778504	0.4373
D(B2008_PC1(-3))	0.353703	0.090616	3.903292	0.0001
D(PC2)	-0.029914	0.032880	-0.909798	0.3641
D(PC2(-1))	-0.013144	0.031972	-0.411099	0.6815
D(PC2(-2))	-0.022992	0.031417	-0.731822	0.4652
D(PC2(-3))	-0.073078	0.030016	-2.434598	0.0159
D(A2008_RDTD_IRD...	0.169824	0.047261	3.593340	0.0004
CointEq(-1)*	-0.195135	0.028587	-6.826001	0.0000

R-squared	0.323728	Mean dependent var	0.011260
Adjusted R-squared	0.270338	S.D. dependent var	0.069933
S.E. of regression	0.059737	Akaike info criterion	-2.723258
Sum squared resid	0.678006	Schwarz criterion	-2.464783
Log likelihood	296.4956	Hannan-Quinn criter.	-2.618722
F-statistic	6.063478	Durbin-Watson stat	1.962790
Prob(F-statistic)	0.000000		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	7.561353	10%	2.75	3.79
k	5	5%	3.12	4.25
		2.5%	3.49	4.67
		1%	3.93	5.23

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-6.826001	10%	-3.13	-4.21
		5%	-3.41	-4.52
		2.5%	-3.65	-4.79
		1%	-3.96	-5.13

Levels Equation
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
B2008_RDTD_IRDDHH	0.479508	0.196587	2.439162	0.0157
B2008_PC1	-1.511629	0.285271	-5.298924	0.0000
PC2	0.103168	0.127701	0.807888	0.4202
A2008_PC1	-0.018920	0.156620	-0.120801	0.9040
A2008_RDTD_IRDDHH	0.050954	0.211330	0.241111	0.8097

EC = LOG_DDHH_SA - (0.4795*B2008_RDTD_IRDDHH -1.5116
*B2008_PC1 + 0.1032*PC2 -0.0189*A2008_PC1 + 0.0510
*A2008_RDTD_IRDDHH)

Cyprus, Model 8

ARDL Error Correction Regression
Dependent Variable: D(LOG_DDNFC_SA)
Selected Model: ARDL(7, 0, 7, 0, 5, 0, 1)
Case 5: Unrestricted Constant and Unrestricted Trend
Date: 11/22/20 Time: 21:57
Sample: 2003M01 2020M06
Included observations: 147

ECM Regression
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.998337	0.919709	-5.434692	0.0000
@TREND	0.001292	0.000281	4.606002	0.0000
D(LOG_DDNFC_SA(-1))	0.229800	0.087296	2.632424	0.0096
D(LOG_DDNFC_SA(-2))	0.102915	0.081729	1.259224	0.2104
D(LOG_DDNFC_SA(-3))	0.246753	0.079935	3.086923	0.0025
D(LOG_DDNFC_SA(-4))	0.174264	0.080725	2.158730	0.0329
D(LOG_DDNFC_SA(-5))	0.147259	0.079926	1.842435	0.0679
D(LOG_DDNFC_SA(-6))	0.262825	0.075495	3.481361	0.0007
D(B2014_PC1)	0.090762	0.070370	1.289774	0.1996
D(B2014_PC1(-1))	0.051918	0.056623	0.916905	0.3610
D(B2014_PC1(-2))	0.020492	0.056297	0.363989	0.7165
D(B2014_PC1(-3))	-0.005370	0.056390	-0.095226	0.9243
D(B2014_PC1(-4))	-0.045795	0.055937	-0.818675	0.4146
D(B2014_PC1(-5))	-0.035883	0.056050	-0.640197	0.5233
D(B2014_PC1(-6))	0.082964	0.054821	1.513353	0.1328
D(LOG_GDPNOM_SA)	0.107724	0.276185	0.390044	0.6972
D(LOG_GDPNOM_SA...	-0.939273	0.312852	-3.002295	0.0033
D(LOG_GDPNOM_SA...	-0.950569	0.312597	-3.040874	0.0029
D(LOG_GDPNOM_SA...	1.104967	0.426847	2.588675	0.0108
D(LOG_GDPNOM_SA...	0.636983	0.431556	1.476014	0.1426
D(A2014_RDTD_IRD...	0.075179	0.160579	0.468174	0.6405
CointEq(-1)*	-0.383098	0.070162	-5.460232	0.0000

R-squared	0.406000	Mean dependent var	0.008654
Adjusted R-squared	0.306208	S.D. dependent var	0.065109
S.E. of regression	0.054232	Akaike info criterion	-2.853898
Sum squared resid	0.367636	Schwarz criterion	-2.406350
Log likelihood	231.7615	Hannan-Quinn criter.	-2.672054
F-statistic	4.068466	Durbin-Watson stat	2.038793
Prob(F-statistic)	0.000000		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.054722	10%	2.53	3.59
k	6	5%	2.87	4
		2.5%	3.19	4.38
		1%	3.6	4.9

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-5.460232	10%	-3.13	-4.37
		5%	-3.41	-4.69
		2.5%	-3.65	-4.96
		1%	-3.96	-5.31

Levels Equation
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
B2014_RDTD_IRDDNFC	-0.083889	0.167730	-0.500142	0.6179
B2014_PC1	0.224563	0.126850	1.770305	0.0792
PC2	-0.061554	0.137132	-0.448862	0.6543
LOG_GDPNOM_SA	2.461146	0.345869	7.115824	0.0000
A2014_PC1	-0.051347	0.246344	-0.208435	0.8352
A2014_RDTD_IRDDNFC	-0.109450	0.396414	-0.276100	0.7830

EC = LOG_DDNFC_SA - (-0.0839*B2014_RDTD_IRDDNFC + 0.2246 *B2014_PC1 -0.0616*PC2 + 2.4611*LOG_GDPNOM_SA -0.0513 *A2014_PC1 -0.1094*A2014_RDTD_IRDDNFC)

Luxembourg, Model 5

ARDL Error Correction Regression
Dependent Variable: D(LOG_DDHH_SA)
Selected Model: ARDL(6, 3, 0, 9, 4, 0, 0)
Case 5: Unrestricted Constant and Unrestricted Trend
Date: 11/22/20 Time: 22:46
Sample: 2003M01 2020M06
Included observations: 201

ECM Regression
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.685049	0.334655	8.023339	0.0000
@TREND	0.001464	0.000179	8.200248	0.0000
D(LOG_DDHH_SA(-1))	0.005066	0.063398	0.079906	0.9364
D(LOG_DDHH_SA(-2))	-0.136880	0.063322	-2.161643	0.0320
D(LOG_DDHH_SA(-3))	0.091582	0.061672	1.485000	0.1394
D(LOG_DDHH_SA(-4))	0.022527	0.060969	0.369482	0.7122
D(LOG_DDHH_SA(-5))	0.177138	0.059511	2.976561	0.0033
D(B2014_RDTD_IRD...	0.015237	0.011946	1.275512	0.2039
D(B2014_RDTD_IRD...	0.010508	0.012857	0.817356	0.4149
D(B2014_RDTD_IRD...	0.036812	0.012615	2.918062	0.0040
D(PC2)	-0.020912	0.006759	-3.093800	0.0023
D(PC2(-1))	0.015156	0.006994	2.167061	0.0316
D(PC2(-2))	-0.019716	0.007048	-2.797257	0.0057
D(PC2(-3))	0.011290	0.006863	1.645051	0.1018
D(PC2(-4))	0.005174	0.006744	0.767204	0.4440
D(PC2(-5))	-0.003017	0.006947	-0.434336	0.6646
D(PC2(-6))	-0.002811	0.006800	-0.413439	0.6798
D(PC2(-7))	-0.001163	0.006599	-0.176200	0.8603
D(PC2(-8))	-0.019573	0.006424	-3.046948	0.0027
D(LOG_GDPNOM_SA)	0.052070	0.079347	0.656239	0.5126
D(LOG_GDPNOM_SA...	0.262628	0.081808	3.210291	0.0016
D(LOG_GDPNOM_SA...	0.175968	0.083495	2.107522	0.0365
D(LOG_GDPNOM_SA...	0.201995	0.091246	2.213738	0.0282
CointEq(-1)*	-0.160111	0.019942	-8.028729	0.0000

R-squared	0.551592	Mean dependent var	0.005542
Adjusted R-squared	0.493325	S.D. dependent var	0.017030
S.E. of regression	0.012122	Akaike info criterion	-5.875933
Sum squared resid	0.026009	Schwarz criterion	-5.481509
Log likelihood	614.5313	Hannan-Quinn criter.	-5.716332
F-statistic	9.466520	Durbin-Watson stat	1.876072
Prob(F-statistic)	0.000000		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	8.896485	10%	2.53	3.59
k	6	5%	2.87	4
		2.5%	3.19	4.38
		1%	3.6	4.9

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-8.028729	10%	-3.13	-4.37
		5%	-3.41	-4.69
		2.5%	-3.65	-4.96
		1%	-3.96	-5.31

Levels Equation
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
B2014_RDTD_IRDDHH	-0.151432	0.056114	-2.698659	0.0077
B2014_PC1	0.045678	0.033355	1.369475	0.1726
PC2	-0.026892	0.033871	-0.793933	0.4283
LOG_GDPNOM_SA	-0.797337	0.434463	-1.835225	0.0682
A2014_PC1	-0.204628	0.057624	-3.551089	0.0005
A2014_RDTD_IRDDHH	0.543856	0.151546	3.588727	0.0004

EC = LOG_DDHH_SA - (-0.1514*B2014_RDTD_IRDDHH + 0.0457 *B2014_PC1 -0.0269*PC2 -0.7973*LOG_GDPNOM_SA -0.2046 *A2014_PC1 + 0.5439*A2014_RDTD_IRDDHH)

8.2 Appendix 2. Results of estimating regressions equations for short-term relationship (first differences)

Table 21. Short-term relationship Model 1 (households deposits) estimation results

	Dependent variable: d_log_ddhh_sa																		
	Austria	Belgium	Cyprus	Estonia	Finland	France	Germany	Greece	Ireland	Italy	Latvia	Lithuania	Luxembourg	Malta	Netherlands	Portugal	Slovakia	Slovenia	Spain
d_log_ddhh_sa_Lag1	-0.35***	-0.25***	0.20**	0.30***	-0.18	-0.05	-0.10	0.12**	-0.05	-0.07	-0.06	0.16	0.15*	-0.22**	-0.12**	-0.13**	-0.06	-0.15**	0.02**
	(0.13)	(0.08)	(0.08)	(0.07)	(0.13)	(0.04)	(0.13)	(0.05)	(0.09)	(0.10)	(0.08)	(0.12)	(0.09)	(0.10)	(0.05)	(0.06)	(0.10)	(0.06)	(0.01)
d_log_ddhh_sa_Lag2	-0.07	0.13	0.001	0.07	-0.09*	-0.11***	-0.10*	0.22***	-0.08	0.03	0.005	0.11	0.10	0.12*	-0.11	0.12*	0.08	0.05	-0.01
	(0.07)	(0.08)	(0.12)	(0.07)	(0.05)	(0.03)	(0.06)	(0.04)	(0.12)	(0.12)	(0.05)	(0.08)	(0.07)	(0.06)	(0.07)	(0.07)	(0.08)	(0.04)	(0.01)
d_log_ddhh_sa_Lag3	0.19***	0.04	0.22***	0.22***	0.20*	0.15***	0.39***	0.18**	0.03	0.06	0.09	0.19**	0.21***	0.17**	0.04	0.23***	0.12	0.16**	0.02
	(0.06)	(0.08)	(0.06)	(0.05)	(0.11)	(0.05)	(0.08)	(0.08)	(0.06)	(0.09)	(0.10)	(0.08)	(0.08)	(0.07)	(0.09)	(0.04)	(0.09)	(0.07)	(0.01)
d_log_ddhh_sa_Lag4	-0.02	0.04	0.04	-0.15	0.05	0.04	0.02	0.09**	-0.07	-0.09	0.10	-0.12	0.08	-0.03	0.03	0.03	0.08	-0.03	0.01
	(0.10)	(0.08)	(0.05)	(0.10)	(0.07)	(0.03)	(0.10)	(0.05)	(0.06)	(0.07)	(0.08)	(0.09)	(0.06)	(0.09)	(0.05)	(0.08)	(0.06)	(0.06)	(0.01)
d_log_ddhh_sa_Lag5	0.05	-0.01	-0.04	0.11	0.12**	-0.04	0.14**	-0.08	0.02	0.14**	0.12	0.07	0.14	0.06	0.14*	0.12**	0.16***	0.06	0.01**
	(0.06)	(0.10)	(0.07)	(0.07)	(0.05)	(0.03)	(0.05)	(0.07)	(0.05)	(0.06)	(0.13)	(0.05)	(0.09)	(0.07)	(0.08)	(0.05)	(0.05)	(0.06)	(0.01)
d_log_ddhh_sa_Lag6	0.11	-0.03	0.13*	0.11	0.06	0.21***	0.09**	0.18*	0.02	0.21***	0.07	-0.03	-0.05	0.25***	0.13**	0.12*	0.12	0.37***	-0.001
	(0.10)	(0.06)	(0.06)	(0.07)	(0.05)	(0.07)	(0.05)	(0.09)	(0.06)	(0.05)	(0.11)	(0.08)	(0.09)	(0.07)	(0.06)	(0.07)	(0.13)	(0.12)	(0.01)
d_rdtd_irddhh_Lag1	-0.03	-0.03*	0.02	-0.002	-0.02**	-0.02	-0.01***	-0.001	-0.06*	-0.02*	-0.05**	0.02	-0.03***	-0.01	-0.02	-0.03**	-0.01	-0.001	-0.02
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.004)	(0.01)	(0.03)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
d_pc1_Lag1	0.01	-0.02	-0.01	-0.0005	-0.003	0.02	-0.02***	0.01	-0.05	-0.01	0.03	0.02	-0.03**	-0.01	0.02**	0.03*	-0.01	0.02	-0.03
	(0.03)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.004)	(0.01)	(0.04)	(0.01)	(0.03)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.03)	(0.05)
d_pc2_Lag1	-0.003	0.01	-0.02	0.003	-0.01	0.02**	-0.01***	-0.01	-0.01	0.002	0.01	0.01	-0.002	-0.005	0.02***	0.02*	-0.01	0.01	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.004)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
d_log_gdpnom_sa	0.12*	-0.04	0.08	0.06	-0.02	-0.08***	-0.15**	0.02	-0.16	0.01	-0.02	0.03	-0.07	0.01	-0.24***	-0.06	0.15*	-0.01	-0.01
	(0.07)	(0.07)	(0.09)	(0.09)	(0.11)	(0.02)	(0.06)	(0.04)	(0.11)	(0.03)	(0.06)	(0.07)	(0.11)	(0.07)	(0.07)	(0.04)	(0.07)	(0.09)	(0.06)
Constant	0.01***	0.01***	0.003*	0.003	0.004***	0.004***	0.004***	0.001	0.01**	0.003*	0.01**	0.01**	0.002	0.01***	0.004**	0.003**	0.004	0.005**	0.01**
	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)	(0.002)	(0.003)	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)	(0.003)	(0.002)	(0.005)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 22. Short-term relationship model 2 (non-financial companies' deposits) estimation results

	Dependent variable: d_log_ddnfc_sa																		
	Austria	Belgium	Cyprus	Estonia	Finland	France	Germany	Greece	Ireland	Italy	Latvia	Lithuania	Luxembourg	Malta	Netherlands	Portugal	Slovakia	Slovenia	Spain
d_log_ddnfc_sa_Lag1	-0.07	-0.40***	0.11	-0.03	-0.40***	-0.28***	-0.24***	-0.33***	-0.06	-0.62***	-0.39***	-0.20**	-0.46***	-0.17*	-0.16***	-0.53***	-0.29***	-0.41***	-0.29***
	(0.15)	(0.09)	(0.11)	(0.08)	(0.08)	(0.10)	(0.08)	(0.08)	(0.05)	(0.07)	(0.10)	(0.09)	(0.09)	(0.09)	(0.04)	(0.09)	(0.07)	(0.08)	(0.08)
d_log_ddnfc_sa_Lag2	-0.12*	-0.23***	-0.13***	0.08	-0.23**	-0.06	-0.16**	-0.18**	0.02	-0.36***	-0.15	-0.12	-0.18*	-0.12*	-0.09***	-0.22**	-0.23***	-0.12	-0.002
	(0.07)	(0.08)	(0.05)	(0.06)	(0.10)	(0.13)	(0.06)	(0.09)	(0.06)	(0.09)	(0.11)	(0.12)	(0.11)	(0.07)	(0.03)	(0.09)	(0.05)	(0.08)	(0.08)
d_log_ddnfc_sa_Lag3	0.003	-0.01	0.06	0.07	0.16**	0.16**	0.15**	-0.01	0.10	0.14	0.14	-0.08	-0.26***	-0.02	0.02	0.002	0.02	0.07	0.24***
	(0.07)	(0.09)	(0.10)	(0.06)	(0.07)	(0.07)	(0.07)	(0.09)	(0.07)	(0.09)	(0.12)	(0.09)	(0.10)	(0.06)	(0.04)	(0.12)	(0.06)	(0.10)	(0.07)
d_log_ddnfc_sa_Lag4	-0.04	0.03	-0.08	0.02	-0.13*	0.04	0.05	0.09	0.12*	0.08	0.11	0.09	-0.17	0.07	0.02	0.01	-0.16*	0.06	0.04
	(0.05)	(0.08)	(0.10)	(0.07)	(0.07)	(0.08)	(0.07)	(0.10)	(0.07)	(0.08)	(0.08)	(0.07)	(0.11)	(0.06)	(0.03)	(0.13)	(0.09)	(0.08)	(0.06)
d_log_ddnfc_sa_Lag5	0.002	0.08	0.04	0.09	-0.14*	-0.13	0.11	0.07	0.01	0.06	0.08	0.03	-0.02	0.01	0.002	0.08	-0.06	0.04	0.08
	(0.05)	(0.09)	(0.06)	(0.08)	(0.08)	(0.11)	(0.08)	(0.09)	(0.06)	(0.10)	(0.10)	(0.07)	(0.08)	(0.09)	(0.04)	(0.07)	(0.08)	(0.08)	(0.07)
d_log_ddnfc_sa_Lag6	0.02	0.19**	0.15*	0.02	-0.02	0.08	0.001	-0.03	0.18***	0.13*	0.01	0.06	-0.12	0.03	0.04	0.15*	0.11***	0.11	0.07
	(0.08)	(0.09)	(0.08)	(0.07)	(0.06)	(0.06)	(0.07)	(0.09)	(0.05)	(0.07)	(0.06)	(0.07)	(0.08)	(0.07)	(0.05)	(0.09)	(0.04)	(0.10)	(0.05)
d_rdtd_irddnfc_Lag1	0.01	-0.04*	-0.11	-0.01	0.10***	0.01	0.01	0.09**	0.01	-0.01	0.11	0.06*	0.19*	-0.02	-0.03	-0.07***	-0.02	0.002	0.01
	(0.03)	(0.03)	(0.10)	(0.02)	(0.03)	(0.02)	(0.01)	(0.04)	(0.02)	(0.02)	(0.07)	(0.03)	(0.10)	(0.02)	(0.02)	(0.03)	(0.04)	(0.03)	(0.02)
d_pc1_Lag1	-0.06***	0.02	0.18	0.01	-0.05*	-0.002	-0.03**	-0.10**	-0.02	0.01	-0.08	0.03	-0.04	0.05**	0.01	0.05*	0.01	0.01	0.01
	(0.02)	(0.03)	(0.15)	(0.02)	(0.03)	(0.02)	(0.01)	(0.04)	(0.02)	(0.02)	(0.06)	(0.03)	(0.10)	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.02)
d_pc2_Lag1	-0.04***	0.01	0.11	0.005	-0.06***	0.02	-0.02**	-0.08***	-0.01	0.01	-0.06	0.01	-0.02	0.02	0.04**	0.03	0.03*	0.02	0.02*
	(0.01)	(0.02)	(0.09)	(0.01)	(0.02)	(0.02)	(0.01)	(0.03)	(0.01)	(0.01)	(0.04)	(0.02)	(0.06)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.01)
d_log_gdpnom_sa	-0.16	-0.32**	0.16	-0.06	-0.34	-0.56***	-0.22**	0.16	0.13**	0.12*	-0.01	-0.19**	-0.04	-0.05	-0.31**	-0.26**	0.03	-0.11	-0.23*
	(0.12)	(0.13)	(0.23)	(0.12)	(0.27)	(0.12)	(0.09)	(0.16)	(0.06)	(0.06)	(0.16)	(0.09)	(0.66)	(0.12)	(0.13)	(0.13)	(0.10)	(0.12)	(0.12)
Constant	0.01***	0.01***	0.01	0.01**	0.01***	0.01***	0.01***	0.01*	0.004	0.01***	0.01**	0.01***	0.01	0.01***	0.01**	0.01**	0.01***	0.01***	0.01***
	(0.002)	(0.003)	(0.01)	(0.003)	(0.003)	(0.002)	(0.001)	(0.004)	(0.002)	(0.003)	(0.004)	(0.003)	(0.01)	(0.004)	(0.003)	(0.004)	(0.002)	(0.003)	(0.002)

Note: *p<0.1; **p<0.05; ***p<0.01

8.3 Appendix 3. Results of estimation of the pooled mean group regressions

Model 1 - no breaks				
Dependent Variable: D(LOG_DDHH_SA)				
Selected Model: ARDL(2, 1, 1, 1, 1)				
Long Run Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
RDTD_IRDDHH	0.244	0.075	3.241	0.001
PC1	-0.088	0.026	-3.372	0.001
PC2	-0.013	0.011	-1.204	0.229
LOG_GDPNOM_SA	1.730	0.262	6.597	0.000
Short Run Equation (average cross-sectional)				
COINTEQ01	-0.040	0.005	-7.867	0.000
D(LOG_DDHH_SA(-1))	-0.051	0.022	-2.340	0.019
D(RDTD_IRDDHH)	0.160	0.095	1.690	0.091
D(PC1)	0.009	0.010	0.879	0.380
D(PC2)	0.002	0.007	0.313	0.755
D(LOG_GDPNOM_SA)	0.081	0.126	0.643	0.520
C	0.007049	0.012282	0.573913	0.5661
@TREND	-3.16E-05	1.60E-05	-1.976456	0.0482
Root MSE	0.029089	Mean dependent var		0.0037
S.D. dependent var	0.032804	S.E. of regression		0.0297
Akaike info criterion	-4.299678	Sum squared resid		3.0199
Schwarz criterion	-4.02955	Log likelihood		7828.8
Hannan-Quinn criter.	-4.203368			

Model 2 - no breaks				
Dependent Variable: D(LOG_DDNFC_SA)				
Selected Model: ARDL(3, 1, 1, 1, 1)				
Long Run Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
RDTD_IRDDNFC	-0.084	0.075	-1.120	0.263
PC1	-0.100	0.036	-2.771	0.006
PC2	-0.016	0.014	-1.137	0.256
LOG_GDPNOM_SA	1.061	0.349	3.044	0.002
Short Run Equation (average cross-sectional)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
COINTEQ01	-0.052	0.007	-7.407	0.000
D(LOG_DDNFC_SA(-1))	-0.199	0.028	-7.141	0.000
D(LOG_DDNFC_SA(-2))	-0.106	0.023	-4.562	0.000
D(RDTD_IRDDNFC)	-0.046	0.031	-1.458	0.145
D(PC1)	0.011	0.015	0.710	0.478
D(PC2)	0.003	0.010	0.321	0.749
D(LOG_GDPNOM_SA)	-0.070	0.096	-0.730	0.466
C	0.018	0.011	1.591	0.112
@TREND	0.000	0.000	-2.918	0.004
Root MSE	0.046	Mean dependent var		0.003
S.D. dependent var	0.053	S.E. of regression		0.047
Akaike info criterion	-3.554	Sum squared resid		7.605
Schwarz criterion	-3.254	Log likelihood		6,610.776
Hannan-Quinn criter.	-3.447			

Model 1 - 2014 break				
Dependent Variable: D(LOG_DDHH_SA)				
Selected Model: ARDL(2, 1, 1, 1, 1, 1, 1)				
Long Run Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
B2014*RDTD_IRDDHH	0.162	0.063	2.560	0.011
A2014*RDTD_IRDDHH	0.651	0.217	2.995	0.003
B2014*PC1	-0.127	0.029	-4.324	0.000
A2014*PC1	0.046	0.033	1.368	0.171
B2014*LOG_GDPNOM_SA	1.508	0.231	6.519	0.000
A2014*LOG_GDPNOM_SA	1.497	0.232	6.446	0.000
PC2	0.026	0.012	2.243	0.025
Short Run Equation (average cross-sectional)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
COINTEQ01	-0.048	0.006	-8.268	0.000
D(LOG_DDHH_SA(-1))	-0.050	0.021	-2.394	0.017
D(B2014*RDTD_IRDDHH)	0.171	0.098	1.755	0.079
D(A2014*RDTD_IRDDHH)	0.040	0.052	0.761	0.447
D(B2014*PC1)	0.012	0.011	1.141	0.254
D(A2014*PC1)	0.002	0.012	0.147	0.883
D(B2014*LOG_GDPNOM_SA)	0.084	0.130	0.644	0.520
D(A2014*LOG_GDPNOM_SA)	0.076	0.125	0.604	0.546
D(PC2)	0.000	0.007	-0.021	0.983
C	0.000	0.012	0.036	0.972
@TREND	0.000	0.000	1.222	0.222
Root MSE	0.029	Mean dependent var		0.004
S.D. dependent var	0.033	S.E. of regression		0.030
Akaike info criterion	-4.280	Sum squared resid		2.981
Schwarz criterion	-3.906	Log likelihood		7,854.209
Hannan-Quinn criter.	-4.147			

Model 2 - 2014 break				
Dependent Variable: D(LOG_DDNFC_SA)				
Selected Model: ARDL(3, 1, 1, 1, 1, 1, 1)				
Long Run Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
B2014*RDTD_IRDDNFC	-0.121	0.064	-1.874	0.061
A2014*RDTD_IRDDNFC	-1.020	0.334	-3.054	0.002
B2014*PC1	-0.095	0.029	-3.227	0.001
A2014*PC1	0.013	0.032	0.407	0.684
B2014*LOG_GDPNOM_SA	0.989	0.267	3.704	0.000
A2014*LOG_GDPNOM_SA	0.907	0.264	3.442	0.001
PC2	-0.002	0.010	-0.215	0.830
Short Run Equation (average cross-sectional)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
COINTEQ01	-0.067	0.014	-4.661	0.000
D(LOG_DDNFC_SA(-1))	-0.188	0.026	-7.144	0.000
D(LOG_DDNFC_SA(-2))	-0.100	0.022	-4.455	0.000
D(B2014*RDTD_IRDDNFC)	-0.046	0.033	-1.381	0.167
D(A2014*RDTD_IRDDNFC)	0.096	0.092	1.041	0.298
D(B2014*PC1)	0.015	0.016	0.945	0.345
D(A2014*PC1)	0.000	0.020	-0.017	0.986
D(B2014*LOG_GDPNOM_SA)	-0.067	0.106	-0.627	0.530
D(A2014*LOG_GDPNOM_SA)	-0.076	0.100	-0.762	0.446
D(PC2)	0.000	0.012	-0.036	0.971
C	0.013	0.010	1.281	0.200
@TREND	0.000	0.000	-1.618	0.106
Root MSE	0.045	Mean dependent var		0.003
S.D. dependent var	0.053	S.E. of regression		0.047
Akaike info criterion	-3.539	Sum squared resid		7.482
Schwarz criterion	-3.137	Log likelihood		6,643.652
Hannan-Quinn criter.	-3.396			

8.4 Appendix 4. Cross-sectional correlations before de-meaning process

Table 23. Cross-sectional correlation for Model 1 (households) before de-meaning

Panel Covariance Analysis: Ordinary
Sample: 2003M01 2020M06
Included observations: 3990
Analysis of contemporaneous (between cross-sections) relationships
Number of cross-sections employed: 19
Balanced sample (listwise missing value deletion)

	Austria	Belgium	Cyprus	Germany	Estonia	Spain	Finland	France	Greece	Ireland	Italy	Lithuania	Luxembc	Latvia	Malta	Netherla	Portugal	Slovenia	Slovakia
Austria	1																		
Belgium	0.23	1.00																	
Cyprus	0.22	0.17	1.00																
Germany	0.21	0.32	0.18	1.00															
Estonia	0.19	0.21	0.43	-0.01	1.00														
Spain	0.26	0.24	0.15	0.18	0.16	1.00													
Finland	0.25	-0.06	0.16	0.07	0.05	0.31	1.00												
France	0.00	-0.14	0.17	-0.23	0.26	-0.01	0.13	1.00											
Greece	0.11	0.00	0.14	-0.04	0.16	0.25	0.09	0.19	1.00										
Ireland	0.31	0.22	0.09	0.30	0.14	0.13	0.09	0.31	0.28	1.00									
Italy	0.02	-0.07	0.32	0.21	0.26	0.14	0.35	0.42	0.15	0.30	1.00								
Lithuania	0.04	-0.17	0.29	-0.22	0.23	0.13	0.26	0.50	0.15	0.08	0.45	1.00							
Luxembourg	0.14	0.19	0.06	0.21	0.21	0.00	-0.15	0.08	0.12	0.40	0.21	0.01	1.00						
Latvia	0.00	0.01	0.04	0.10	0.25	0.18	0.10	0.02	0.19	-0.06	0.24	0.40	0.11	1.00					
Malta	-0.16	0.06	-0.04	-0.11	-0.06	0.02	-0.04	0.19	0.04	-0.02	0.04	0.17	-0.08	0.08	1.00				
Netherlands	0.13	0.24	0.33	0.30	0.28	0.29	0.09	0.09	0.17	0.22	0.36	0.09	0.11	0.11	-0.02	1.00			
Portugal	0.05	0.10	-0.01	0.03	0.12	0.41	0.11	0.12	0.16	-0.03	0.16	0.15	-0.08	0.34	-0.01	0.04	1.00		
Slovenia	-0.06	0.20	-0.13	-0.01	0.06	-0.06	-0.10	0.02	0.04	0.25	0.01	0.02	0.18	0.03	0.02	0.07	-0.10	1.00	
Slovakia	0.04	-0.11	0.11	-0.15	0.07	0.34	0.08	0.04	0.11	-0.09	0.03	0.27	-0.20	0.14	0.05	0.18	0.21	0.05	1.00

Table 24. Cross-sectional correlation for Model 2 (non-financial companies) before de-meaning

Panel Covariance Analysis: Ordinary
Sample: 2003M01 2020M06
Included observations: 3990
Analysis of contemporaneous (between cross-sections) relationships
Number of cross-sections employed: 19
Balanced sample (listwise missing value deletion)

Correlation	Austria	Belgium	Cyprus	Germany	Estonia	Spain	Finland	France	Greece	Ireland	Italy	Lithuania	Luxembc	Latvia	Malta	Netherla	Portugal	Slovenia	Slovakia
Austria	1																		
Belgium	0.26	1.00																	
Cyprus	-0.03	-0.02	1.00																
Germany	0.17	0.32	0.01	1.00															
Estonia	-0.12	0.10	0.14	0.18	1.00														
Spain	0.15	0.08	0.08	-0.09	-0.12	1.00													
Finland	0.07	0.14	0.05	0.20	0.07	0.01	1.00												
France	0.06	0.23	-0.02	0.27	0.06	0.15	0.15	1.00											
Greece	-0.07	0.34	0.06	0.16	0.05	0.06	0.10	0.17	1.00										
Ireland	-0.01	0.23	-0.16	0.14	0.05	-0.11	0.13	0.14	0.23	1.00									
Italy	0.16	-0.06	0.01	-0.16	-0.14	0.39	0.11	0.11	0.03	-0.01	1.00								
Lithuania	0.06	0.18	0.08	0.12	0.30	-0.14	-0.02	0.05	0.01	-0.01	-0.13	1.00							
Luxembourg	0.05	0.23	-0.01	0.13	0.02	0.12	-0.08	-0.03	0.07	0.07	-0.09	0.03	1.00						
Latvia	0.24	0.18	-0.06	0.06	0.02	-0.03	0.27	0.00	0.06	0.00	0.04	-0.14	0.16	1.00					
Malta	-0.12	-0.22	0.07	-0.01	0.14	-0.01	-0.11	-0.05	-0.16	0.01	0.07	0.06	0.00	-0.04	1.00				
Netherlands	-0.27	-0.21	-0.04	0.03	0.17	-0.34	-0.03	0.06	-0.07	0.04	-0.23	0.08	-0.10	0.06	0.21	1.00			
Portugal	0.04	0.16	-0.04	0.04	-0.02	-0.18	0.11	0.02	0.26	0.07	0.01	0.09	-0.01	0.07	0.05	-0.10	1.00		
Slovenia	0.01	0.22	0.03	0.02	0.18	0.11	0.15	0.22	0.25	0.05	-0.07	0.04	0.13	0.00	0.01	-0.04	0.16	1.00	
Slovakia	0.18	0.15	0.08	0.19	0.08	0.02	0.10	-0.01	0.05	0.08	-0.17	0.08	0.01	0.00	0.02	0.11	0.05	0.13	1.00

8.5 Appendix 5. Unit root tests results

Table 25. Unit root testing of non-financial companies' non-maturing deposit volumes time series

Variable = log of non-financial companies' non-maturing deposit volumes (*log_ddnfc_sa*)								
	Individual ADF results for levels, with intercept and linear trend				Individual ADF results for fist differences, with intercept and linear trend			
	Prob.	Lag	Max Lag	Obs.	Prob.	Lag	Max Lag	Obs.
Austria	0.1177	0	14	209	0.0000	0	14	208
Belgium	0.0256	1	14	208	0.0000	0	14	208
Cyprus	0.4721	0	13	175	0.0000	0	13	174
Germany	0.2266	0	14	209	0.0000	0	14	208
Estonia	0.4978	0	14	209	0.0000	0	14	208
Spain	0.9829	3	14	206	0.0000	2	14	206
Finland	0.0677	3	14	206	0.0000	2	14	206
France	1.0000	2	14	207	0.0000	2	14	206
Greece	0.9598	2	14	207	0.0000	1	14	207
Ireland	0.9934	0	14	209	0.0000	0	14	208
Italy	0.9753	2	14	207	0.0000	1	14	207
Lithuania	0.5517	1	14	191	0.0000	0	14	191
Luxembourg	0.0109	1	14	208	0.0000	0	14	208
Latvia	0.3806	2	12	115	0.0000	1	12	115
Malta	0.8015	0	14	185	0.0000	0	14	184
Netherlands	0.1916	0	14	209	0.0000	0	14	208
Portugal	0.9997	2	14	207	0.0000	1	14	207
Slovenia	0.6552	1	14	196	0.0000	0	14	196
Slovakia	0.6758	2	13	171	0.0000	1	13	171

Table 26. Unit root testing of the interest premium paid on households' non-maturing deposits time series

Variable = interest premium paid on households' NMT deposits over interbank day to day interest rate (*rdtd_irddhh*)								
	Individual ADF results for levels, with intercept and no linear trend				Individual ADF results for fist differences, with intercept and no linear trend			
	Prob.	Lag	Max Lag	Obs.	Prob.	Lag	Max Lag	Obs.
Austria	0.5181	1	14	208	0.0000	0	14	208
Belgium	0.1553	2	13	162	0.0001	1	13	162
Cyprus	0.0000	6	13	143	0.0008	2	13	146
Germany	0.4524	1	14	208	0.0000	0	14	208
Estonia	0.4470	2	14	205	0.0000	1	14	205
Spain	0.4740	2	14	207	0.0000	1	14	207
Finland	0.5686	3	14	206	0.0001	2	14	206
France	0.5809	1	14	208	0.0000	0	14	208
Greece	0.5387	1	14	208	0.0000	0	14	208
Ireland	0.6579	2	11	150	0.0005	1	11	150
Italy	0.6767	1	14	208	0.0000	0	14	208
Lithuania	0.5309	1	13	182	0.0000	0	13	182
Luxembourg	0.6987	1	14	208	0.0000	0	14	208
Latvia	0.7298	1	14	196	0.0000	0	14	196
Malta	0.0409	1	13	152	0.0000	0	13	152
Netherlands	0.4550	2	14	207	0.0000	0	14	208
Portugal	0.4919	2	14	207	0.0000	0	14	208
Slovenia	0.6358	1	13	180	0.0000	0	13	180
Slovakia	0.0051	3	13	146	0.0005	2	13	146

Table 27. Unit root testing of the interest premium paid on non-financial companies' non-maturing deposits time series

Variable: interest premium paid on non-financial companies' NMT deposits over interbank day to day interest rate (*rdtd_irddnfc*)								
	Individual ADF results for levels, with intercept and no linear trend				Individual ADF results for fist differences, with intercept and no linear trend			
	Prob.	Lag	Max Lag	Obs.	Prob.	Lag	Max Lag	Obs.
Austria	0.4959	0	14	209	0.0000	0	14	208
Belgium	0.4130	1	13	163	0.0000	0	13	163
Cyprus	0.0010	3	12	141	0.0008	2	12	141
Germany	0.5006	3	14	206	0.0000	0	14	208
Estonia	0.2398	3	14	204	0.0000	2	14	204
Spain	0.4719	2	14	207	0.0000	1	14	207
Finland	0.6426	0	14	209	0.0000	2	14	206
France	0.5861	1	14	208	0.0000	0	14	208
Greece	0.6294	1	14	208	0.0000	0	14	208
Ireland	0.4757	2	14	207	0.0000	1	14	207
Italy	0.5768	1	14	208	0.0000	0	14	208
Lithuania	0.5444	3	13	180	0.0002	2	13	180
Luxembourg	0.7917	1	14	208	0.0000	0	14	208
Latvia	0.5860	4	14	193	0.0000	3	14	193
Malta	0.0949	1	13	152	0.0000	0	13	152
Netherlands	0.2014	4	14	205	0.0000	1	14	207
Portugal	0.5861	3	14	206	0.0000	3	14	205
Slovenia	0.6638	1	13	180	0.0000	0	13	180
Slovakia	0.0143	0	13	149	0.0020	2	13	146

Table 28. Unit root testing of the two first principle components of the 35 market interest rates time series (*pc1* and *pc2*)

p-values of unit root tests Null hypothesis: variable has a unit root				
Variable	ADF intercept only	ADF intercept and a trend	ADF with intercept break	ADF with trend break
pc1	0.9240	0.4561	0.3926	0.6762
pc2	0.2786	0.5996	0.6900	<0.01
d(pc1)	0.0000	0.0000	<0.01	<0.01
d(pc2)	0.0000	0.0000	<0.01	<0.01

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