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Determinants of Non-maturing Deposit Pass-through Rates in Eurozone Countries*

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Abstract

The non-maturing deposit (NMD) pass-through rate represents a key parameter needed in the process of managing interest rate risk of the banking book (IRRBB). NMD interest rates for retail and corporate segments are usually not directly linked to market interest rates, but depend rather on the bank's marketing strategy, market competition, liquidity, and possibly on other factors. The ratio at which banks adjust their NMD interest rates to changes in interbank market interest rates is known as the NMD pass-through rate. The goal of this paper is to analyse the variability of NMD pass-through rates in the 19 Eurozone countries and identify their possible determinants. The pass-through rates are estimated using cointegration analysis based on datasets available from the ECB Statistical Data Warehouse and the results show significant variability between countries. To analyse the determinants of pass-through rates in the Eurozone, the rates are regressed on nine aggregates of the country-level banking sector including concentration, profitability or funding, and three macroeconomic and socio-economic variables. Out of the tested predictors, the ratio of wholesale funding to liabilities was found to be the most significant predictor of retail and corporate pass-through rates, with a positive coefficient, indicating that countries where banks rely more heavily on wholesale funding exhibit higher pass-through of market interest rate changes to NMD deposit rates. Additionally, the loan-to-deposit ratio was found to have a significantly negative impact on retail pass-through rates, while the return on equity has a significantly positive impact on the corporate pass-through rates.

Keywords: Non-maturing deposits (NMD), pass-through rate, IRRBB

JEL Classification: E43, E58, G21

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1. Introduction

Non-maturing deposits (NMD), defined as "liabilities without a maturity date, in which the depositor is free to withdraw the deposit at any point in time" (EBA, 2022), represented roughly 61.7% of all household deposits and roughly 81.4% of all non-financial corporate deposits in the Eurozone banking sector as of November 2022 (ECB, 2022).

Modelling of non-maturing deposits (NMD) for the purposes of interest rate risk of the banking book (IRRBB) management in commercial banks was standardized by the Basel Committee on Banking Supervision (BCBS) standards (BCBS, 2016), European Banking Authority (EBA) guidelines (EBA, 2018) and the final regulatory standards draft (EBA, 2022). The NMD modelling methodology, described in the BCBS consultative paper (BCBS, 2015), requires that banks estimate the pass-through rate parameter, corresponding to the "proportion of a market interest rate change that the bank will pass onto its customers in order to maintain the same level of stable deposit balances" (BCBS, 2015), with the pass-through rate effect assessed by the banks "over the time horizon they deem most relevant or until the full effect of the market rate move has been passed through to the customers" (BCBS, 2015).

To estimate the short-term and long-term pass-through rates of the market interest rate changes into the NMD client rates, banks typically use the error correction model (ECM) (Granger, 1981), which is also among the most commonly used models in academic literature (Hefferman, 1997; Chong *et al*., 2006; Liu *et al*., 2008; Wang *et al*., 2019; Witzany and Diviš, 2021), including ECB working papers (ECB, 2006). Using the ECM, banks can estimate the short-term as well as long-term relationship between their NMD rates and the market rates, allowing them to estimate the pass-through rate at any forecast horizon (Wang *et al*., 2019). Alternative approaches can be based on the concepts of static and dynamic NMD portfolio replication and a Monte Carlo valuation approach (Maes and Timmermans, 2005; Blöchlinger, 2019), or a VAR model with both the change in the composition of the deposits and the deposit rates (Gerlach, 2018). The NMD pass-through parameter is one of key inputs in interest rate risk modelling at the individual bank or banking sector level and has been studied in a number of empirical papers (Maes and Timmermans, 2005; O'Brien, 2000; Hejdová *et al*., 2017; Wang *et al*., 2019). However, we are not aware of any study that would analyse the NMD pass-through rate determinants over a set of national markets.

In our presented study, we estimate the NMD pass-through rates in different horizons (from 1-month to 10-year) for the retail and corporate deposit rates, for the 19 Eurozone countries based on the datasets available in the ECB Statistical Data Warehouse. In the next step, we analyse the determinants of pass-through rates in the Eurozone by regressing the estimated 1-year pass-through rates for the 19 Eurozone countries, on 9 aggregate metrics of the banking sector (i) concentration (Herfindahl index), (ii) profitability (return on assets, return on equity, cost to income,

risk costs to operating income and net interest income to assets), and (iii) funding profile (loan to deposit ratio, liquid assets to total assets, wholesale funding to liabilities), and 3 additional (iv) macroeconomic and socio-economic variables (10-year government bond yield, household saving rate, and working age population rate). The goal of the study is to explain the variability of NMD pass-through rates in the Eurozone and identify their main drivers.

The rest of the study is organized as follows. Section 2 describes the methodology for estimation of the error correction model and for the pass-through rate estimation. Section 3 provides a description of the modelling dataset. Section 4 analyses the results of the pass-through rate estimation in the Eurozone. Section 5 analyses the effect of main determinants of the pass-through rates in the Eurozone, and Section 6 concludes the paper.

2. NMD Client Rate Modelling Methodology

For the modelling of the short-term and long-term relationship between the NMD client rate and the market rate in a given country, the error correction model (ECM) (Granger, 1981) is used, estimated with the Engle-Granger two-step procedure (Engle and Granger, 1987). While individual banks and academic researchers may use different modifications of the model, including multiple lags or asymmetries, for the purposes of this study, only the basic version of the model is applied.

In Step 1, we estimate the cointegration regression in the form:

$$y_t = \beta_0 + \beta_1 x_t + \varepsilon_t \tag{1}$$

where y_t is the NMD client rate and x_t is the market rate. As the interest rate time series can be viewed as integrated of order one in the analysed time period, residuals of the regression ε_t need to fulfil the stationarity assumption for the time series y_t and x_t to be cointegrated. To confirm stationarity of ε_t the Augmented Dickey Fuller (ADF) unit root test is used.

In Step 2, the error correction model (ECM) is estimated:

$$\Delta y_t = \gamma_1 \Delta x_t + \theta_1 \left(y_{t-1} - \beta_0 - \beta_1 x_{t-1} \right) + \sigma \epsilon_t \tag{2}$$

where Δy_t denotes the change in the NMD client rate and Δx_t is the change in the market rate in the period t. The parameter γ_1 measures the immediate reaction of the NMD rate to the market rate, while θ_1 measures the speed of adjustment of the NMD client rate to changes in the market rate, which result in deviations of the long-term equilibrium relationship $y_{t-1} - \beta_0 - \beta_1 x_{t-1}$, estimated with the Step 1 regression (1).

Pass-through rate estimation

To estimate the pass-through rate in different horizons, we first rewrite the ECM model (1) by separating all of the *x* and *y* terms with different lags:

$$y_t = -\theta_1\beta_0 + \gamma_1 x_t + \left(-\gamma_1 - \theta_1\beta_1\right)x_{t-1} + \left(1+\theta_1\right)y_{t-1} + \sigma\epsilon_t$$

We then define a market rate shock at the time *t* as:

$$x_t^* = x_t + K$$

where x_t^* denotes the post-shock market rate and y_t^* the post-shock NMD client rate.

We then define the cumulative pass-through of a permanent shock *K* into the client rate y_t^* as:

$$P_t = (y_t^* - y_t)/K$$

which can be computed for different horizons $k = 0, \ldots, H$ by rewriting the ECM equation for y_{t+k} and y_{t+k}^* (with the same innovations ϵ_{t+k}) and evaluating recursively the relationship above.

Immediate pass-through at the time is then equal to (see Appendix 2 for derivation):

$$P_t = \gamma_1$$

and the cumulative pass-through for any horizon $t + k$ where $k > 0$ is equal to:

$$P_{t+k} = -\theta_1\beta_1 + \left(1+\theta_1\right)P_{t+k-1}$$

which converges to $P_{t+k} \to \beta_1$ for $k \to \infty$.

3. Dataset Description and Cleaning

The modelling dataset was downloaded from the ECB Statistical Data Warehouse and consists of the proxy for the short-term market rate (1-month Euribor), and the average non-maturing deposit (NMD) rates for the retail and corporate segments for the 19 Eurozone countries (as of 30 September 2021) observed at a monthly frequency. For ECB series keys of the individual time-series, see Appendix 1.

For most of the countries, the retail NMD interest rate data start from Jan 2000, or Jan 2003 (France, Luxembourg and Estonia), with the exception of Estonia (Mar 2003), Latvia (Jan 2004), Lithuania (Mar 2005), Slovenia (May 2005), Malta (Mar 2007), Cyprus (Jan 2008) and Slovakia (Jan 2008). The corporate NMD interest rate data start usually from the same date as the retail ones, with the exception of Belgium (Oct 2006) and Finland (Mar 2003).

In addition to shorter history, time series for some of the countries exhibit extensive periods of missing values, affecting especially the retail rates of Belgium (Jan 2003 to Sep 2006) and Ireland (Jun 2006 to Nov 2014). Isolated missing values (1 or 2 months of missing values at most) also appear in the retail and corporate rate time series of Malta, Cyprus and Slovakia.

For the purposes of the analysis, all the missing values were imputed using linear interpolation based on the nearest observable values before and after the missing period respectively. The error correction model was then estimated separately for each country and segment (retail and corporate) based on the entire available dataset since the first non-missing observation (usually Jan 2000).

In addition to the NMD interest rates for individual countries, average retail and corporate NMD rates in the Eurozone were estimated for each month, based on the interest rate data from all countries whose interest rates were available in that month. These aggregate time series will serve as proxy for the overall level of NMD interest rates in the Eurozone.

4. ECM Model Empirical Estimates

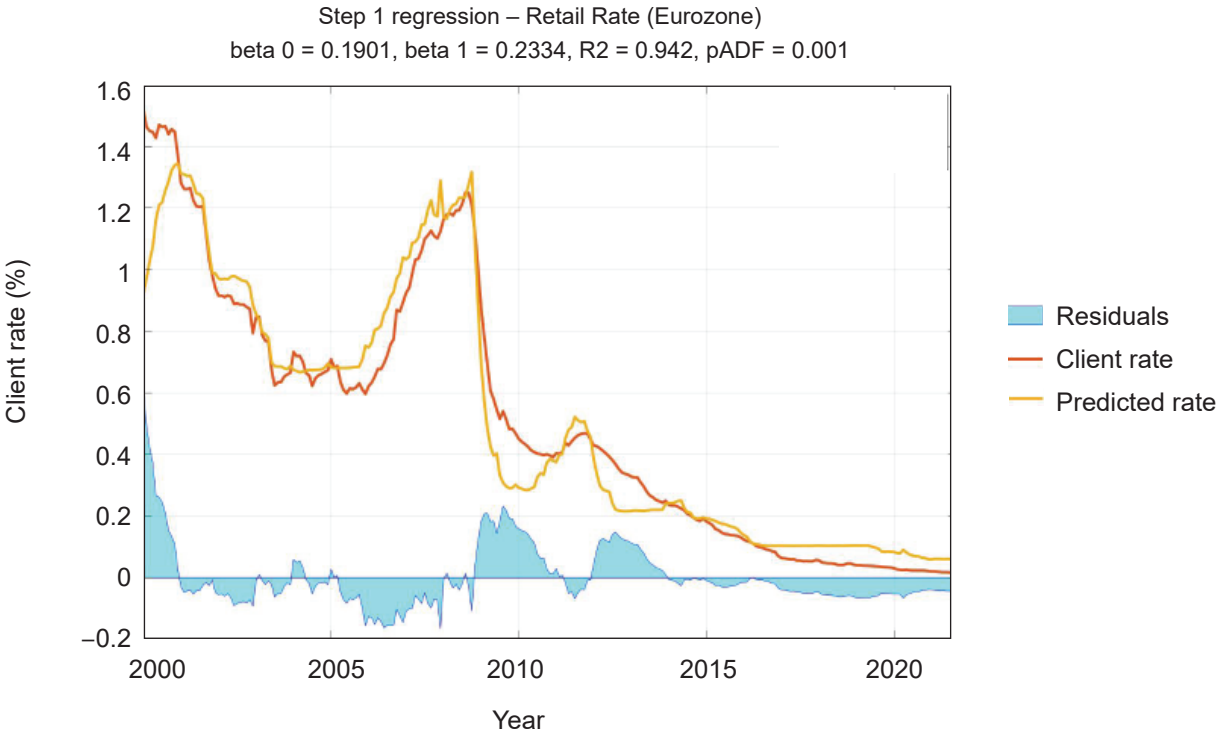
Cointegration regression results (Step 1)

In the first step, cointegration regression was computed, between the retail and corporate NMD interest rates of the Eurozone countries as the dependent variable, and the 1-month Euribor as the independent variable. The detailed results are shown in Table 8 (retail) and Table 9 (corporate) in Appendix 3. The tables include the parameter estimates (beta0 and beta1), *t*-values (t_beta0 and t_beta1), *p*-values (p_beta0 and p_beta1) and the regression R-squared (R2), as well as the *p*-values of the Augmented Dickey Fuller test (pADF) applied to the model residuals in order to assess whether cointegration is present between the NMD interest rates and 1-month Euribor.

It is apparent from the Augmented Dickey-Fuller test values that for most of the Eurozone countries, we can reject the hypothesis of non-stationarity of model residuals at the 10% confidence level, indicating a presence of cointegration between the retail NMD interest rates and the 1-month Euribor. Belgium, Cyprus and Slovakia are the countries for which cointegration could not be proved (on the 10% confidence level). The negative result for Belgium can be explained by the relatively high missing data rate in the available time series, as the entire period from Jan 2003 to Sep 2006 is missing and had to be replaced with linear interpolation. In the case of Cyprus and Slovakia, the available time series start only in Jan 2008, covering almost exclusively a period of a long-term interest rate decrease, which could have negatively affected the results.

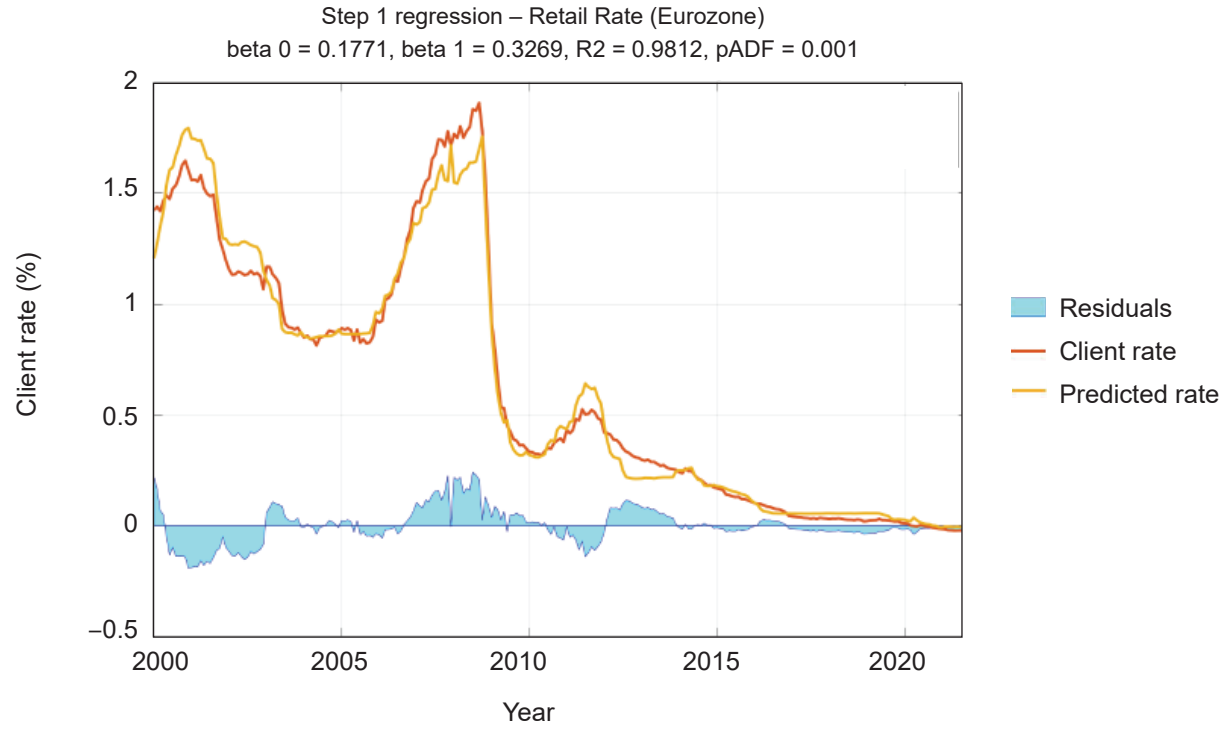
For the corporate segment (Table 9), cointegration was confirmed (on 10% confidence level) for almost all the Eurozone countries. The only two exceptions are Cyprus and Italy, for which the cointegration could be confirmed only at the 15% confidence level.

Figure 1: Average Eurozone NMD retail rates vs. NMD rates predicted with 1-month Euribor



Source: own elaboration

Figure 2: Average Eurozone NMD retail rates vs. NMD rates predicted with 1-month Euribor



Source: own elaboration

To illustrate the regression fit, we can plot the evolution of the NMD client rates and the predicted rates based on the 1-month Euribor. Illustration of the fit for the average NMD client rates in the Eurozone is shown in Figure 1 for the retail segment and Figure 2 for the corporate segment.

We can see that the pattern of variability in the NMD client rates closely matches the one predicted with the 1-month Euribor, with regression residuals oscillating closely around zero.

Error correction model and pass-through rate estimation (Step 2)

In Step 2, the regression residuals from Step 1 were used to estimate the error correction model (ECM) for each of the Eurozone countries. From the ECM estimates we then derived the pass-through rates in the 1-month (pass1M), 1-year (pass1Y) and 10-year (pass10Y) horizons. Detailed results of the estimation are shown in Appendix 3, Table 10 (retail) and Table 11 (corporate).

We can see that for the retail segment (Table 10), the ECM parameters correspond to the expectations for most of the countries, with gamma1 being positive, indicating a positive immediate reaction of the NMD client rates to changes in the market rates, and theta1 being negative, indicating convergence of the client rates towards their long-term equilibrium relationship with the market rates. Among the main exceptions is Lithuania, for which the gamma1 was estimated as negative, indicating a counterintuitively negative immediate reaction of the NMD interest rates to changes in the 1-month Euribor, and Belgium, for which the theta1 was estimated as positive, indicating that the retail NMD interest rates do not adjust their deviations from Euribor in the long-term. Regarding the statistical significance of the results, gamma1 turned out as statistically significant (at the 10% confidence level) for all of the Eurozone countries, while theta1 turned out as statistically significant for all the countries except Belgium and Slovakia.

In the corporate segment (Table 11), the parameter estimates correspond to the expectations (positive gamma1 and negative theta1) for all the countries in the Eurozone, except Malta, for which both parameters have the wrong sign. Gamma1 was further estimated as statistically significant (at the 10% level) for all the countries except Lithuania and Slovenia, while theta1 turned out as statistically significant for all the countries except Malta.

Results for both segments confirm the appropriateness of the ECM model for the modelling of pass-through rates in the Eurozone, as apart from a few outlier countries, the cointegration relationship between NMD client rates and market rates was proved, and the ECM model parameter estimates are statistically significant and with the correct signs.

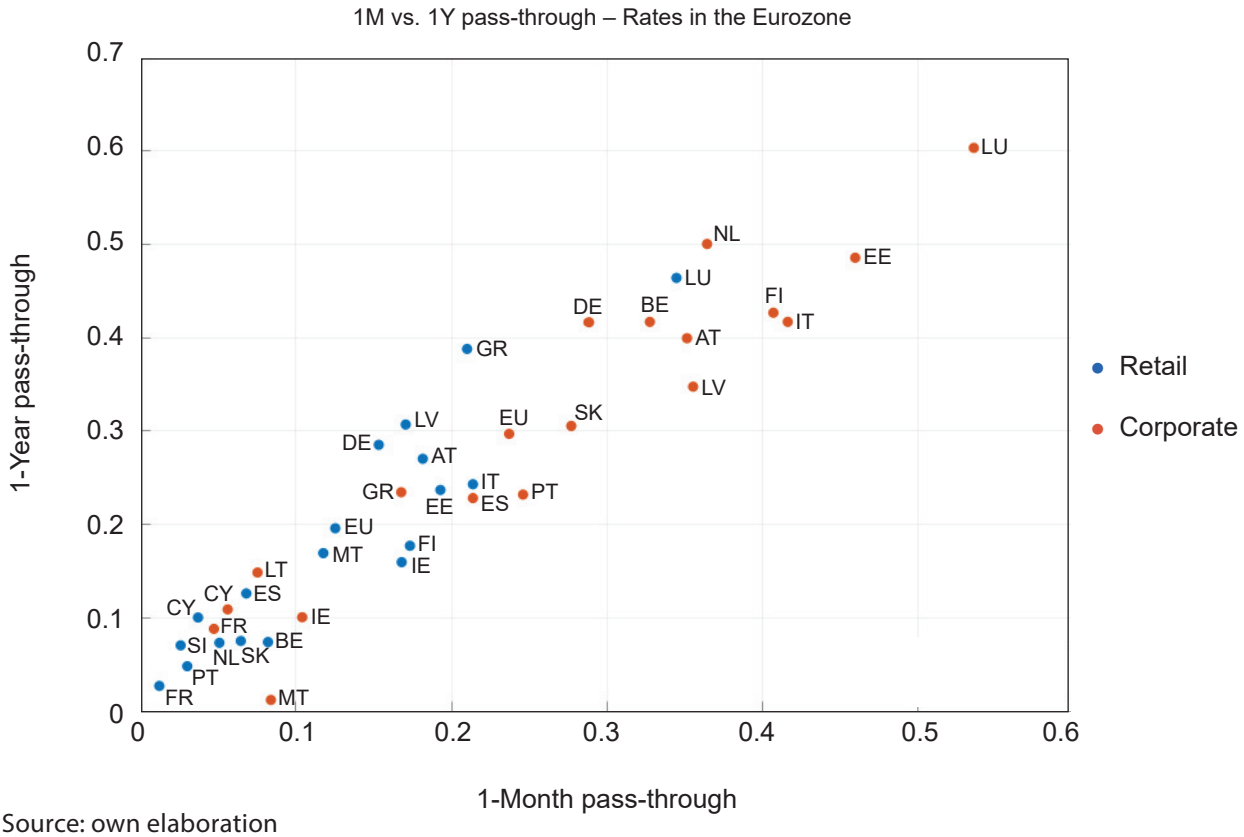
In Figure 3, we compare the magnitudes of the 1-month and 1-year pass-through rates in the Eurozone countries. A clear tendency can be observed of the corporate pass-through rates to be higher than the retail ones, which is in accordance with economic intuition, as corporate clients tend to switch banks more readily, with the goal to optimize their interest rate income, forcing banks to adjust their NMD deposit rates more speedily to the interest rate changes on the money market.

The average Eurozone NMD corporate pass-through rate at the 1-year horizon is estimated at 29.71%, indicating that almost 30% of the 1-month Euribor changes are passed to corporate customers in the Eurozone at the 1-year horizon, while for the retail rate it is only 19.61%. At the same time, relatively large cross-country variability in the pass-through rates seems to be present.

The highest 1-year corporate pass-through rate is observed in Luxembourg (60.31%), where more than 60% of the 1-month Euribor rate changes are passed to customers at the 1-year horizon. High corporate pass-through rates are further observed in the Netherlands (50.03%) and Estonia (48.55%), followed by Finland (42.67%), Italy (41.70%), Belgium (41.70%), Germany (41.65%) and Austria (39.95%). On the other hand, the lowest 1-year corporate pass-through rate can be observed in Malta (1.24%) (with the result, however, being affected by the counterintuitive model parameter estimates), followed by Slovenia (7.54%), France (8.84%), Ireland (10.08%) and Cyprus (10.92%).

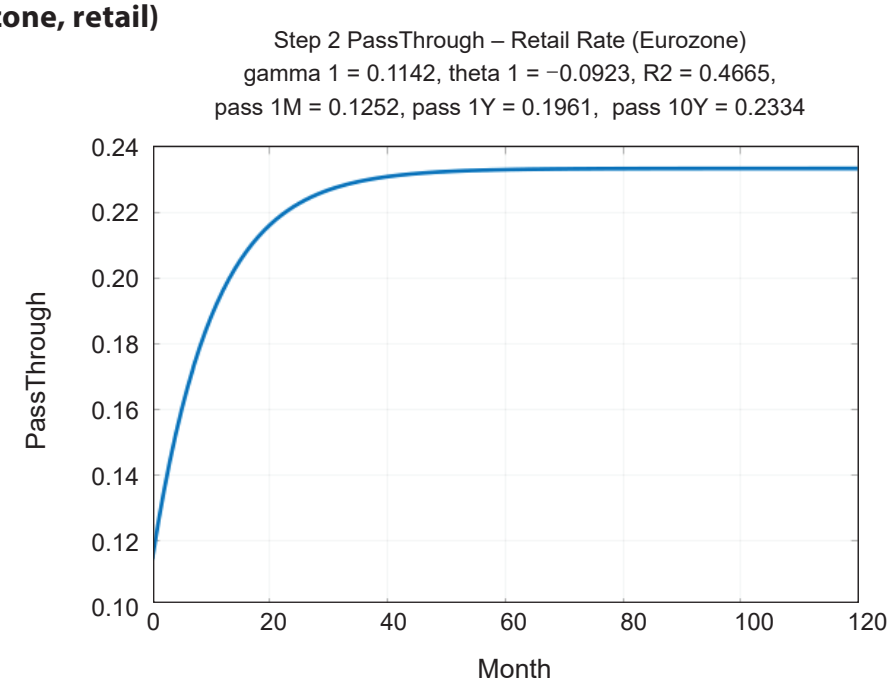
The highest 1-year retail pass-through rates are again observed in Luxembourg (46.40%), followed by Greece (38.80%), Latvia (30.71%), Germany (28.54%) and Austria (27.04%). The lowest 1-year retail pass-through rates are observed in France (2.73%), Portugal (4.84%), Slovenia (7.08%), Belgium (7.43%) and Slovakia (7.55%).

Figure 3: Comparison of 1-month and 1-year pass-through rates for all Eurozone countries



Source: own elaboration

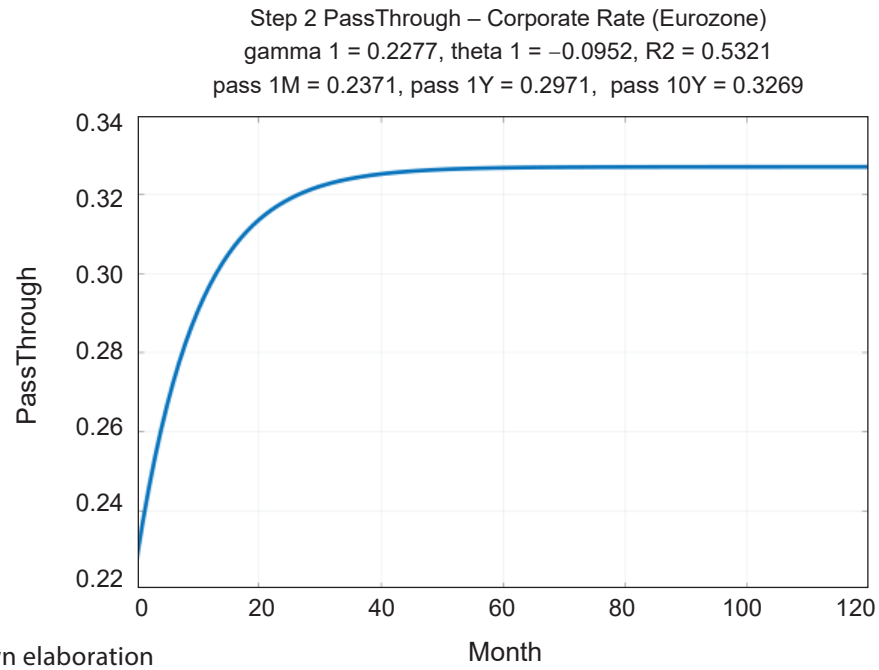
Figure 4: NMD pass-through rate for horizons ranging from 0 to 120 months (Eurozone, retail)



Source: own elaboration

As the pass-through rates can be calculated from the ECM model for any horizon into the future, it also allows us to assess the speed of adjustment of the NMD client rates to the market rates. For illustration, we show the result for the average Eurozone NMD client rates in the retail and corporate segments in Figure 4 (retail) and Figure 5 (corporate).

Figure 5: NMD pass-through rate for horizons ranging from 0 to 120 months (Eurozone, corporate)



Source: own elaboration

The results show that it may take up to 3 years for the full effect of the market rate changes to be reflected in the NMD rates for the retail and corporate segments in the Eurozone. Nevertheless, as the majority of the adjustment occurs at the 1-year horizon, and this is also the horizon most often used by commercial banks for the IRRBB risk management purposes, we will use the 1-year pass-through rates in the analysis of the pass-through rate determinants in the next section.

5. Determinants of Eurozone NMD Pass-through Rates

In the previous section, we estimated the NMD pass-through rates for the retail and corporate segments for all 19 Eurozone countries. The pass-through rates seem to exhibit high variability among the Eurozone countries, with the 1-year retail pass-through rates ranging from 2.73% (France) to 46.40% (Luxembourg), while the corporate pass-through rates range from 7.54% (Slovenia) to 60.31% (Luxembourg).

Apart from the intuitive finding that the corporate pass-through rates tend to be higher than the retail ones, there does not seem to be any clear factor explaining the variability in pass-through rates in the Eurozone, as the level of the pass-through rates does not seem to depend on country size (large countries such as Germany vs. France have vastly different pass-through rates, and the same holds for small countries such as Luxembourg and Malta), neither on how recently the country joined the Eurozone (Latvia and Lithuania have vastly different pass-through rates).

To identify the drivers of the pass-through rates in the Eurozone, we regress the estimated 1-year pass-through rates on 9 aggregate variables describing the banking sector characteristics in each country, namely its: (i) concentration (Herfindahl index), (ii) profitability (return on assets, return on equity, cost to income, risk costs to operating income and net interest income to assets), and (iii) funding profile (loan to deposit ratio, liquid assets to total assets, wholesale funding to liabilities), and 3 additional (iv) macroeconomic and socio-economic variables (10-year government bond yield, household saving rate, and working age population rate).

The banking sector characteristics and macroeconomic and socio-economic variables for the 19 Eurozone countries were downloaded from ECB Statistical Data Warehouse in the form of annual time series (see Appendix 2). As the pass-through rates in the previous section are estimated based on the years 2000–2021, we compute the average values of the banking sector characteristics over the available history (which unfortunately often starts later than in 2000) and use them as predictors of the NMD pass-through rates in the Eurozone. A summary of the dataset is provided in Table 12 (Appendix 3), with the StartDate and EndDate showing the available time series history, and the Mean, Std. Dev., Min and Max, showing the statistics of the averages computed at the Eurozone-country level.

For some of the countries, only a shorter history of some of the predictors was available, in which case the averages used in the analysis were computed over the shorter history. Additionally, the wholesale funding [% liabilities] measure was not available for France, and its values were thus replaced with the sample averages computed based on available data of the other countries for each year. The same approach was used for the unavailable time-series of the household saving rate in Malta.

In the first step of the analysis, univariate regressions are computed, between the average values of each predictor for each country, as the independent variable, and the 1-year pass-through rates, estimated for the retail and the corporate segments, as the dependent variable. The results of the univariate regressions are shown in Table 1 (retail) and Table 2 (corporate).

Table 1: Univariate regression results between banking sector aggregates and 1-year pass-through rate (retail)

Univariate regression - 1-year NMD pass-through rate (Retail)							
Equation: PassThrough1Y(i) = const + slope*X(i) + Res(i)							
Predictor	**const**	**slope**	**t_const**	**t_slope**	**p_const**	**p_slope**	**R2**
Herfindahl Index	0,215	−0,297	4,071	−0,834	0,08%	41,56%	3,93%
Return on Assets	0,178	−0,004	5,521	−0,063	0,00%	95,03%	0,02%
Return on Equity	0,176	0,001	5,894	0,164	0,00%	87,17%	0,16%
Cost-to-income	0,217	0,001	1,362	0,254	19,11%	80,26%	0,38%
Risk-costs-to-op-income	0,158	−0,001	3,896	−0,679	0,12%	50,60%	2,64%
Net interest income	0,222	−0,028	2,429	−0,509	2,65%	61,71%	1,50%
Loan-to-deposit ratio	0,322	−0,002	1,961	−0,894	6,65%	38,37%	4,49%
Liquid assets	0,227	−0,003	2,427	−0,554	2,66%	58,69%	1,77%
Wholesale funding	−0,058	0,006	−0,581	2,444	56,86%	2,57%	26,00%
Household saving rate	0,204	−0,003	2,895	−0,417	1,01%	68,17%	1,01%
10-Year Gvt. bond yield	0,125	0,015	1,236	0,544	23,34%	59,35%	1,71%
Working age population rate	0,436	−0,530	0,962	−0,571	34,96%	57,53%	1,88%

Note: Green denotes predictors with stronger predictive power (lower *p*-value and higher R2) and red predictors with weaker predictive power (higher *p*-value and lower R2).

Source: own elaboration

It is apparent that the only predictor that predicts the 1-year NMD pass-through rate statistically significantly (at the 10% confidence level) for the retail segment is the ratio of wholesale funding as % of liabilities, with a *p*-value of 2.57%. The parameter of the regression is positive, indicating that banks in the countries that rely more heavily on wholesale funding tend to adjust the NMD client rates for their retail clients more readily according to changes in the Euribor rates.

Table 2: Univariate regression results between banking sector aggregates and 1-year pass-through rate (corporate)

Univariate regression - 1-year NMD pass-through rate (Corporate)							
Equation: PassThrough1Y(i) = const + slope*X(i) + Res(i)							
Predictor	**const**	**slope**	**t_const**	**t_slope**	**p_const**	**p_slope**	**R2**
Herfindahl Index	0,268	0,195	3,608	0,389	0,22%	70,22%	0,88%
Return on Assets	0,267	0,109	6,268	1,360	8,49E−6	19,17%	9,81%
Return on Equity	0,274	0,011	7,326	1,973	1,18E−6	6,50%	18,62%
Cost-to-income	0,234	−0,001	1,055	−0,269	30,61%	79,15%	0,42%
Risk-costs-to-op-income	0,331	0,002	5,975	0,997	1,51E−5	33,29%	5,52%
Net interest income	0,451	−0,100	3,734	−1,388	0,17%	18,30%	10,18%
Loan-to-deposit ratio	−0,135	0,005	−0,647	2,081	52,65%	5,29%	20,30%
Liquid assets	0,428	−0,007	3,392	−1,130	0,35%	27,40%	6,99%
Wholesale funding	−0,086	0,009	−0,663	3,016	51,59%	0,78%	34,85%
Household saving rate	0,193	0,010	2,036	1,145	5,77%	26,81%	7,16%
10-Year Gvt. bond yield	0,523	−0,066	4,068	−1,876	0,08%	7,80%	17,15%
Working age population rate	−0,162	0,930	−0,259	0,728	79,89%	47,66%	3,02%

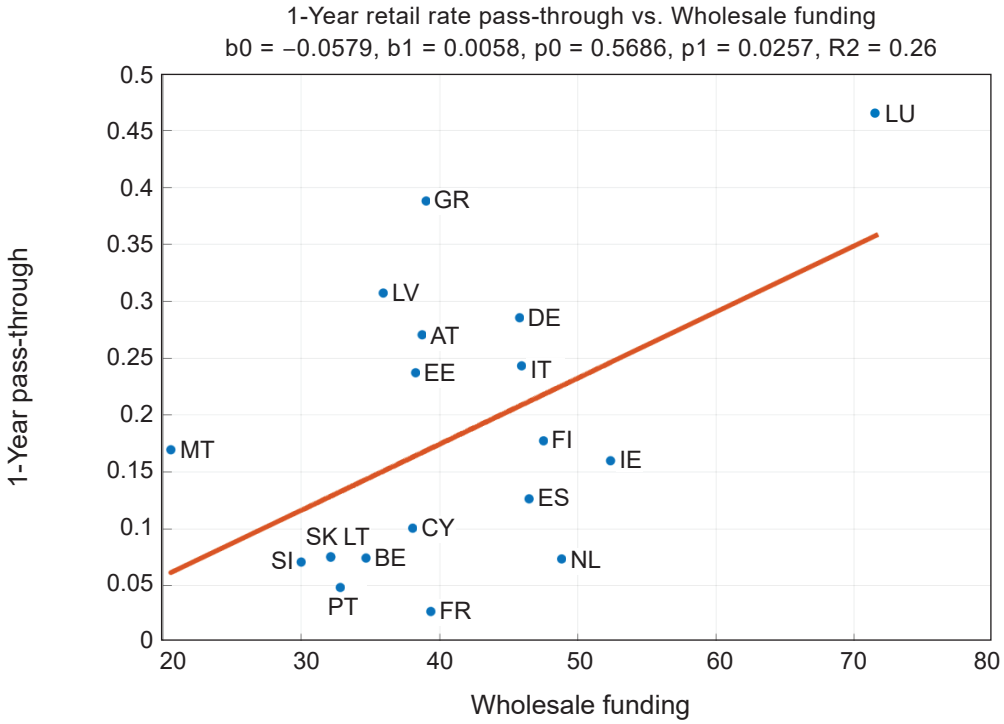
Note: Green denotes predictors with stronger predictive power (lower *p*-value and higher R2) and red predictors with weaker predictive power (higher *p*-value and lower R2).

Source: own elaboration

For the corporate segment, the ratio of wholesale funding as % of liabilities proved to be the most statistically significant predictor as well, with a *p*-value of 0.78%. The sign of the relationship is positive as for the retail segment. Additionally, the return on equity (positive relationship), loan-to-deposit ratio (positive relationship), and the household saving rate (positive relationship) also seem to be significant predictors of the 1-year pass-through rate in the corporate segment, although only at the 10% confidence level.

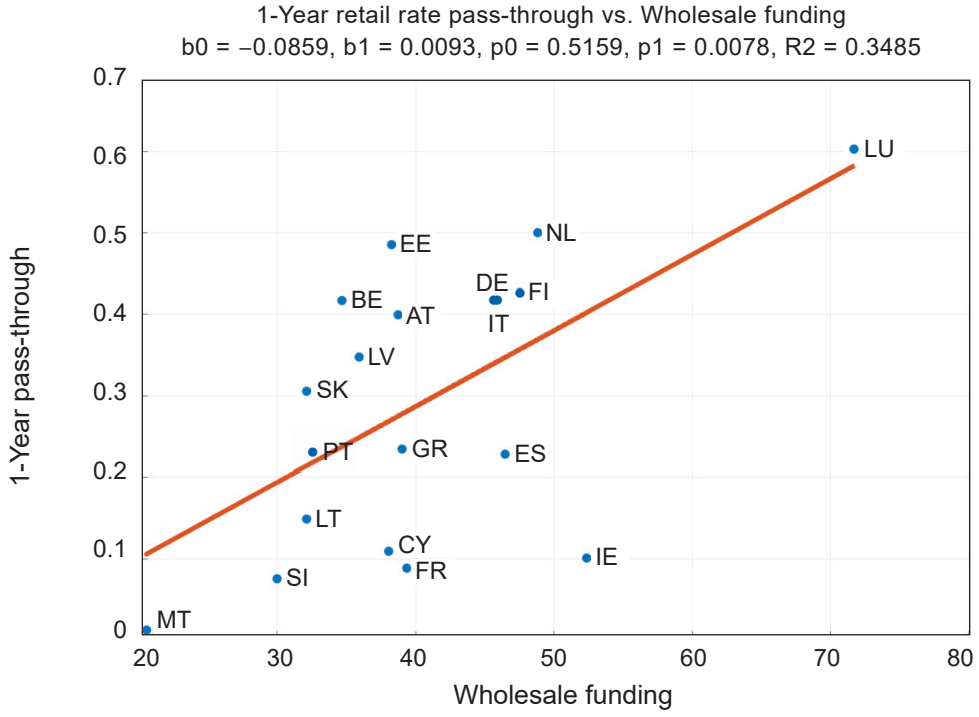
For illustration, we show the univariate regression fit between the 1-year NMD pass-through rates and the wholesale funding as % of liabilities, which is by far the strongest predictor in both segments. The figures are shown in Figure 6 (retail) and Figure 7 (corporate).

Figure 6: OLS regression fit between wholesale funding [% liabilities] and 1-year NMD pass-through rate (retail)



Source: own elaboration

Figure 7: OLS regression fit between wholesale funding [% liabilities] and 1-year NMD pass-through rate (corporate)



Source: own elaboration

In the next step, we estimate a multivariate regression model, using all of the potential predictors of the pass-through rates in a single model. The results for both segments (retail and corporate) are shown in Table 3.

Table 3: Multivariate regression results between banking sector aggregates and 1-year NMD pass-through rate

Multivariate regression - 1-year NMD pass-through rate						
Equation: PassThrough1Y(i) = const + XVec(i)'*CoeffVec + Res(i)						
Segment	**Retail**			**Corporate**		
Predictor	**coeff**	**t-val**	**p-val**	**coeff**	**t-val**	**p-val**
Constant	0,301	0,212	83,89%	0,171	0,117	91,03%
Herfindahl Index	0,948	0,821	44,32%	3,135	2,638	3,86%
Return on Assets	0,059	0,259	80,46%	−0,160	−0,686	51,85%
Return on Equity	0,015	0,598	57,15%	0,056	2,175	7,26%
Cost-to-income	−0,011	−0,807	45,07%	−0,032	−2,187	7,14%
Risk-costs-to-op-income	−0,008	−0,728	49,38%	−0,025	−2,151	7,50%
Net interest income	0,098	0,653	53,82%	0,323	2,084	8,23%
Loan-to-deposit ratio	−0,011	−1,303	24,05%	−0,018	−2,061	8,50%
Liquid assets	0,003	0,165	87,44%	0,026	1,230	26,46%
Wholesale funding	0,011	2,654	3,78%	0,016	3,586	1,16%
Household saving rate	−0,003	−0,132	89,93%	−0,004	−0,176	86,63%
10-Year Gvt. bond yield	−0,122	−0,535	61,22%	−0,470	−1,995	9,31%
Working age population rate	−0,788	−0,455	66,54%	−2,263	−1,270	25,12%

Note: Green means higher statistical significance (lower *p*-value) and red lower statistical significance (higher *p*-value)".

Source: own elaboration

While in the retail segment, only the rate of wholesale funding achieved statistical significance in the multivariate model (*p*-value = 3.78%), in the corporate segment there are multiple variables with statistically significant coefficients (at the 10% confidence level), but the significance of the ratio of wholesale funding is still the highest (*p*-value = 1.16%). In both multivariate models, the ratio of wholesale funding has a positive impact on the pass-through rates.

As the statistically insignificant relationships may be obscuring the true drivers of the NMD pass-through rates in the Eurozone, we apply the backward variable elimination procedure, eliminating one by one the statistically insignificant variables from the model (starting with the one with the highest *p*-value), followed by a model re-estimation, until we are left with a model where all the variables are statistically significant at the 5% confidence level (apart from the constant, which was not part of the elimination procedure). The results of the backward variable elimination are shown in Table 4 (retail) and Table 5 (corporate).

Table 4: Final model from the backward variable elimination (retail)

Backward elimination - 1-year NMD pass-through (Retail)			
Predictor	**coeff**	**t-val**	**p-val**
Constant	0,191	1,453	16,56%
Loan-to-deposit ratio	–0,004	–2,522	2,27%
Wholesale funding	0,008	3,586	0,25%

Source: own elaboration

Table 5: Final model from the backward variable elimination (corporate)

Backward elimination - 1-year NMD pass-through (Corporate)			
Predictor	**coeff**	**t-val**	**p-val**
Constant	–0,099	–0,873	39,58%
Return on Equity	0,011	2,463	2,55%
Wholesale funding	0,009	3,400	0,37%

Source: own elaboration

The application of the backward elimination procedure significantly reduced the number of variables in the model. The rate of wholesale funding remained the most significant variable in the models for both segments (*p*-values of 0.25% for retail and 0.37% for corporate) with a positive regression coefficient, indicating that in countries where banks need to rely more on wholesale funding, the NMD pass-through rates tend to be higher. Additionally, for the retail segment, the loan-to-deposit ratio achieved statistical significance (*p*-value = 2.27%) with a negative coefficient, indicating that in countries with a higher ratio of loans to deposits, the retail pass-through rates tend to be lower. For the corporate segment, the banking sector ROE ended up statistically significant (*p*-value = 2.55%) indicating that in countries where banks achieve higher levels of profitability to their owners, the corporate pass-through rates tend to be higher.

To avoid the issue of multicollinearity, the correlation between the regressors was computed. The correlation between the rate of wholesale funding and the loan-to-deposit ratio is 0.4064, while the correlation between the rate of wholesale funding and the return on equity is 0.0143. The regression models are thus unlikely to suffer from multicollinearity-related issues.

To prove the robustness of the model, we further recalculated the results without Luxembourg and Greece. Luxembourg was excluded as it is a potential outlier with respect to the target variable of the model, having by far the highest NMD pass-through rates of all the analysed countries. Greece was excluded as it is a potential outlier with respect to some of the predictor variables (especially the 10-year government bond yields).

The results of univariate and multivariate regressions without Luxembourg and Greece are shown in Table 13, Table 14 and Table 15 in Appendix 3. In Table 6 (retail) and Table 7 (corporate) below, we provide only the results of the final multivariate regression model identified using the backward variable elimination procedure.

Table 6: Final model from the backward variable elimination (retail, without Luxembourg and Greece)

Backward elimination - 1-year NMD pass-through (Retail)			
Predictor	**coeff**	**t-val**	**p-val**
Constant	0,117	1,054	31,10%
Return on Assets	0,113	2,241	4,31%
Loan-to-deposit ratio	−0,005	−2,543	2,45%
Wholesale funding	0,012	2,839	1,40%

Source: own elaboration

Table 7: Final model from the backward variable elimination (corporate, without Luxembourg and Greece)

Backward elimination - 1-year NMD pass-through (Corporate)			
Predictor	**coeff**	**t-val**	**p-val**
Constant	−0,130	−0,801	43,64%
Return on Equity	0,011	2,299	3,74%
Wholesale funding	0,010	2,458	2,76%

Source: own elaboration

We can see that the models identified on the dataset that excludes Luxembourg and Greece are almost the same as the ones identified on the full dataset of all 19 Eurozone countries. The main difference is that the model for the retail segment now also contains the return on assets as an additional predictor of pass-through rates (with a positive coefficient), and for both segments the statistical significance of all the variables is lower than for the model estimated on the full dataset (but with *p*-values still below the 5% threshold). Apart from that the models stay the same. The rate of wholesale funding (with a positive coefficient) is still the most significant predictor of pass-through rates for both segments. For the retail segment, the pass-through rates also seem to be significantly predicted by the loan-to-deposit ratio (with a negative coefficient) and by the ROA (with a positive coefficient), while for the corporate segment they are predicted by the ROE (with a positive coefficient).

6. Conclusion

Non-maturing deposit (NMD) pass-through rates were estimated at different horizons for the 19 Eurozone countries based on datasets available from the ECB Statistical Data Warehouse. The 1-year NMD pass-through rates for the corporate segment were shown to be higher (29.71%) than for the retail segment (19.61%), in accordance with expectations that the corporate segment is more competitive. The highest corporate pass-through rates in the Eurozone were observed in Luxembourg (60.31%), followed by the Netherlands (50.03%) and Estonia (48.55%), while the lowest ones were observed in Malta (1.24%), Slovenia (7.54%) and France (8.84%). The highest retail pass-through rates were observed in Luxembourg (46.40%), followed by Greece (38.80%) and Latvia (30.71%), while the lowest ones were observed in France (2.73%), Portugal (4.84%) and Slovenia (7.55%). To analyse the determinants of pass-through rates in the Eurozone, we regressed the estimated 1-year pass-through rates on 9 country-level banking sector aggregates of concentration, profitability and funding, and 3 macroeconomic and socioeconomic variables. Out of the analysed predictors, the ratio of wholesale funding to liabilities proved to be the most significant predictor of the 1-year pass-through rates (*p*-values of 0.25% for retail and 0.37% for corporate in the multivariate regression model identified using the backward variable elimination), with a positive coefficient, indicating that countries where banks rely more heavily on wholesale funding exhibit higher pass-through rates from market interest rate changes to NMD deposit rates. Additionally, the loan-to-deposit ratio was found to negatively predict the pass-through rates in the retail segment (*p*-value = 2.27%), while the average banking sector return on equity was found to positively predict the pass-through rates for the corporate segment (*p*-value = 2.55%). The results of the multivariate regression are robust to multicollinearity issues, as well as to the exclusion of possible outlier countries such as Luxembourg and Greece.

Among the main limitations of the study is that it does not allow us to capture the variability in NMD pass-through rates over time. This is a feature of the method used for the pass-through rate estimation, which estimates the pass-through rates from ECM model parameters, resulting in a kind of "average" values of the pass-through rates over the entire model estimation period.

This prevents us from analysing the pass-through rate determinants using panel regression methods that could allow us to capture the variability of the pass-through rates between different countries as well as over time as the banking sector aggregates and socio-economic variables for each country change. Another limitation of the study is the dependency of the pass-through rates on the frequency of the estimation dataset. In our study, we used monthly interest rate time series, which means that the short-term interest rate adjustment can occur at a monthly frequency only, while the rest of the adjustment effect remains to be captured with the error correction parameter. Different pass-through rates can thus be expected if the frequency of the dataset changes, although we do not expect them to be major. Finally, the use of a simple ECM model with one lag instead of some of its more complex modifications (with multiple lags and asymmetric effects) represents another limitation of our study, which can be, however, viewed as acceptable as it is the most commonly used model in practice.

Appendix 1: Dataset replicability

All the datasets were downloaded from the ECB Statistical Data Warehouse.
For replicability purposes, we provide the time series identification codes used below.
Note: For the country-specific datasets, the following country codes should be used for XX:
XX = {"AT","BE","CY","EE","FI","FR","DE","GR","IE","IT","LV","LT","LU","MT",
"NL","PT","SK","SI","ES")
The time series identification codes of the modelling datasets are:

1-month Euribor:	FM.M.U2.EUR.RT.MM.EURIBOR1MD_.HSTA
Retail NMD interest rates:	MIR.M.XX.B.L21.A.R.A.2250.EUR.N
Corporate NMD interest rates:	MIR.M.XX.B.L21.A.R.A.2240.EUR.N
Herfindahl index (total assets):	SSI.A.XX.122C.H10.X.U6.Z0Z.Z
Return on assets:	CBD2.A.XX.W0.67._Z._Z.A.A.I2004._Z._Z._Z._Z._Z._Z.PC
Return on equity:	CBD2.A.XX.W0.67._Z._Z.A.A.I2003._Z._Z._Z._Z._Z._Z.PC
Cost-to-income ratio [%]:	CBD2.A.XX.W0.67._Z._Z.A.A.I2100._Z._Z._Z._Z._Z._Z.PC
Risk costs to operating income:	CBD2.A.XX.W0.67._Z._Z.A.F.I2525._Z._Z._Z._Z._Z._Z.PC
Net interest income [% of assets]:	CBD2.A.XX.W0.67._Z._Z.A.A.I2410._Z._Z._Z._Z._Z._Z.PC
Loan-to-deposit ratio:	CBD2.A.XX.W0.67._Z._Z.A.A.I3006._Z._Z._Z._Z._Z._Z.PC
Liquid assets [% of assets]:	CBD2.A.XX.W0.67._Z._Z.A.A.I3018._Z._Z._Z._Z._Z._Z.PC
Wholesale funding [% of liabilities]:	CBD2.A.XX.W0.67._Z._Z.A.A.I3050._Z._Z._Z._Z._Z._Z.PC
10-year government bond yield:	IRS.M.XX.L.L40.CI.0000.EUR.N.Z
Household saving rate:	QSA.A.N.XX.W0.S1M.S1._Z.B. B8G._Z._Z._Z.XDC_R_ B6GA_CY._T.S.V.N._T
Total population:	ENA.A.N.XX.W0.S1.S1._Z.POP._Z._Z._Z.PS._Z.N
Working age population:	IESS.Q.XX.S.ACTIVE.TOTAL0.15_74.T

Appendix 2: Derivation of the pass-through rate formula

Step 1 regression:

$$y_t = \beta_0 + \beta_1 x_t + \varepsilon_t$$

Step 2 regression:

$$\Delta y_t = \gamma_0 + \gamma_1 \Delta x_t + \theta_1 \left(y_{t-1} - \beta_0 - \beta_1 x_{t-1} \right) + \epsilon_t$$

Rewriting the Step 2 equation:

$$y_t - y_{t-1} = \gamma_0 + \gamma_1 \left(x_t - x_{t-1} \right) + \theta_1 \left(y_{t-1} - \beta_0 - \beta_1 x_{t-1} \right) + \epsilon_t$$

$$y_t = \gamma_0 - \theta_1 \beta_0 + \gamma_1 x_t + \left(-\gamma_1 - \theta_1 \beta_1 \right) x_{t-1} + \left(1 + \theta_1 \right) y_{t-1} + \epsilon_t$$

Shock at the time *t*:

$$x'_t = x_t + k$$

Shock effect at the time *t*:

$$P_t = \frac{y'_t - y_t}{K}$$

Rewrite equation for *t*:

$$y_t = \gamma_0 - \theta_1 \beta_0 + \gamma_1 x_t + \left(-\gamma_1 - \theta_1 \beta_1 \right) x_{t-1} + \left(1 + \theta_1 \right) y_{t-1} + \epsilon_t$$

$$y'_t = \gamma_0 - \theta_1 \beta_0 + \gamma_1 x'_t + \left(-\gamma_1 - \theta_1 \beta_1 \right) x_{t-1} + \left(1 + \theta_1 \right) y_{t-1} + \epsilon_t$$

$$y'_t = \gamma_0 - \theta_1 \beta_0 + \gamma_1 (x_t + K) \left(-\gamma_1 - \theta_1 \beta_1 \right) x_{t-1} + \left(1 + \theta_1 \right) y_{t-1} + \epsilon_t$$

$$y'_t - y_t = \gamma_1 K$$

$$P_t = \gamma_1$$

$$\Delta P_t = \gamma_1$$

Rewrite equation for $t + 1$:

$$y_{t+1} = \gamma_0 - \theta_1 \beta_0 + \gamma_1 x_{t+1} + \left(-\gamma_1 - \theta_1 \beta_1 \right) x_t + \left(1 + \theta_1 \right) y_t + \epsilon_t$$

$$y'_{t+1} = \gamma_0 - \theta_1 \beta_0 + \gamma_1 x'_{t+1} + \left(-\gamma_1 - \theta_1 \beta_1 \right) x'_t + \left(1 + \theta_1 \right) y'_t + \epsilon_t$$

$$y'_{t+1} = \gamma_0 - \theta_1\beta_0 + \gamma_1\left(x_{t+1} + K\right) + \left(-\gamma_1 - \theta_1\beta_1\right)\left(x_t + K\right) + \left(1+\theta_1\right)\left(y_t + \gamma_1 K\right) + \epsilon_t$$

$$y'_{t+1} - y_{t+1} = \gamma_1 K + \left(-\gamma_1 - \theta_1\beta_1\right)K + \left(1+\theta_1\right)\gamma_1 K$$

$$P_{t+1} = -\theta_1\beta_1 + \left(1+\theta_1\right)P_t$$

$$\Delta P_{t+1} = -\gamma_1 - \theta_1\beta_1 + \left(1+\theta_1\right)\gamma_1$$

Rewrite equation for $t + 2$:

$$y_{t+2} = \gamma_0 - \theta_1\beta_0 + \gamma_1 x_{t+2} + \left(-\gamma_1 - \theta_1\beta_1\right)x_{t+1} + \left(1+\theta_1\right)y_{t+1} + \epsilon_t$$

$$y'_{t+2} = \gamma_0 - \theta_1\beta_0 + \gamma_1 x'_{t+2} + \left(-\gamma_1 - \theta_1\beta_1\right)x'_{t+1} + \left(1+\theta_1\right)y'_{t+1} + \epsilon_t$$

$$y'_{t+2} = \gamma_0 - \theta_1\beta_0 + \gamma_1\left(x_{t+2} + K\right) + \left(-\gamma_1 - \theta_1\beta_1\right)\left(x_{t+1} + K\right) + \left(1+\theta_1\right)y'_{t+1} + \epsilon_t$$

$$y'_{t+1} = y_{t+1} + \gamma_1 K + \left(-\gamma_1 - \theta_1\beta_1\right)K + \left(1+\theta_1\right)\gamma_1 K$$

$$y'_{t+2} - y_{t+2} = +\gamma_1 K + \left(-\gamma_1 - \theta_1\beta_1\right)K + \left(1+\theta_1\right)\left(y'_{t+1} - y_{t+1}\right)$$

$$P_{t+2} = -\theta_1\beta_1 + \left(1+\theta_1\right)P_{t+1}$$

$$\Delta P_{t+2} = \left(1+\theta_1\right)\Delta P_{t+1}$$

General formulas for $t + k$:

$$P_{t+k} = -\theta_1\beta_1 + \left(1+\theta_1\right)P_{t+k-1}$$

$$\Delta P_{t+k} = \left(1+\theta_1\right)\Delta P_{t+k-1}$$

Appendix 3: Tables with detailed empirical results

Table 8: Step 1 – Cointegration regression of NMD retail interest rates in the Eurozone on 1-month Euribor

Step 1 Regression (Cointegration regression) (Retail)

Equation: ClientRate(t) = beta0 + beta1*MarketRate(t) + Res1(t)

Series	StartDate	EndDate	nObs	beta0	beta1	t_beta0	t_beta1	p_beta0	p_beta1	R2	pADF
Retail Rate (Austria)	1/1/2000	9/1/2021	261	0,306	0,319	24,841	58,484	0,00%	0,00%	0,930	0,86%
Retail Rate (Belgium)	1/1/2000	9/1/2021	261	0,200	0,262	13,077	38,620	0,00%	0,00%	0,852	15,66%
Retail Rate (Cyprus)	1/1/2008	9/1/2021	165	0,468	0,358	16,693	16,336	0,00%	0,00%	0,621	20,32%
Retail Rate (Estonia)	3/1/2003	9/1/2021	223	0,067	0,243	5,976	39,522	0,00%	0,00%	0,876	0,10%
Retail Rate (Finland)	1/1/2000	9/1/2021	261	0,187	0,182	20,640	45,416	0,00%	0,00%	0,888	1,14%
Retail Rate (France)	1/1/2003	9/1/2021	225	0,056	0,032	30,075	31,482	0,00%	0,00%	0,816	0,10%
Retail Rate (Germany)	1/1/2000	9/1/2021	261	0,299	0,356	22,346	59,942	0,00%	0,00%	0,933	3,02%
Retail Rate (Greece)	1/1/2000	9/1/2021	261	0,198	0,505	2,699	15,522	0,74%	0,00%	0,482	0,10%
Retail Rate (Ireland)	1/1/2000	9/1/2021	261	0,256	0,127	10,758	12,022	0,00%	0,00%	0,358	5,07%
Retail Rate (Italy)	1/1/2000	9/1/2021	261	0,160	0,267	19,865	74,836	0,00%	0,00%	0,956	1,64%
Retail Rate (Latvia)	1/1/2004	9/1/2021	213	0,194	0,330	11,636	35,537	0,00%	0,00%	0,857	0,10%
Retail Rate (Lithuania)	3/1/2005	9/1/2021	199	0,108	0,130	6,416	13,652	0,00%	0,00%	0,486	1,04%
Retail Rate (Luxembourg)	1/1/2003	9/1/2021	225	0,315	0,498	30,171	86,996	0,00%	0,00%	0,971	0,10%
Retail Rate (Malta)	3/1/2007	9/1/2021	175	0,168	0,219	22,907	47,768	0,00%	0,00%	0,930	0,10%
Retail Rate (Netherlands)	1/1/2000	9/1/2021	261	0,252	0,123	27,326	29,991	0,00%	0,00%	0,776	9,66%
Retail Rate (Portugal)	1/1/2003	9/1/2021	225	0,048	0,051	17,779	34,280	0,00%	0,00%	0,840	0,10%
Retail Rate (Slovakia)	1/1/2008	9/1/2021	165	0,194	0,150	22,846	22,687	0,00%	0,00%	0,759	19,42%
Retail Rate (Slovenia)	5/1/2005	9/1/2021	197	0,086	0,093	17,793	33,895	0,00%	0,00%	0,855	1,32%
Retail Rate (Spain)	1/1/2000	9/1/2021	261	0,151	0,187	14,486	40,457	0,00%	0,00%	0,863	2,05%
Retail Rate (Eurozone)	1/1/2000	9/1/2021	261	0,190	0,233	23,406	64,844	0,00%	0,00%	0,942	0,10%

Source: own elaboration

Table 9: Step 1 – Cointegration regression of NMD corporate interest rates in the Eurozone on 1-month Euribor

Step 1 Regression (Cointegration regression) (Corporate)

Equation: ClientRate(t) = beta0 + beta1*MarketRate(t) + Res1(t)

Series	StartDate	EndDate	nObs	beta0	beta1	t_beta0	t_beta1	p_beta0	p_beta1	R2	pADF
Corporate Rate (Austria)	1/1/2000	9/1/2021	261	0,245	0,485	13,444	59,990	0,00%	0,00%	0,933	5,08%
Corporate Rate (Belgium)	10/1/2006	9/1/2021	180	0,150	0,428	23,195	111,396	0,00%	0,00%	0,986	0,10%
Corporate Rate (Cyprus)	1/1/2008	9/1/2021	165	0,252	0,223	19,744	22,313	0,00%	0,00%	0,753	10,08%
Corporate Rate (Estonia)	3/1/2003	9/1/2021	223	0,071	0,496	4,439	56,095	0,00%	0,00%	0,934	0,10%
Corporate Rate (Finland)	1/1/2003	9/1/2021	225	0,098	0,442	8,034	66,071	0,00%	0,00%	0,951	0,24%
Corporate Rate (France)	1/1/2003	9/1/2021	225	0,174	0,097	34,210	34,697	0,00%	0,00%	0,844	0,10%
Corporate Rate (Germany)	1/1/2000	9/1/2021	261	0,165	0,461	16,581	104,632	0,00%	0,00%	0,977	0,10%
Corporate Rate (Greece)	1/1/2000	9/1/2021	261	0,227	0,267	8,197	21,699	0,00%	0,00%	0,645	0,10%
Corporate Rate (Ireland)	1/1/2000	9/1/2021	261	0,165	0,092	10,331	12,986	0,00%	0,00%	0,394	4,05%
Corporate Rate (Italy)	1/1/2000	9/1/2021	261	0,360	0,422	16,821	44,418	0,00%	0,00%	0,884	13,06%
Corporate Rate (Latvia)	1/1/2004	9/1/2021	213	0,081	0,348	7,871	60,282	0,00%	0,00%	0,945	0,10%
Corporate Rate (Lithuania)	3/1/2005	9/1/2021	199	0,071	0,149	9,014	33,455	0,00%	0,00%	0,850	0,10%
Corporate Rate (Luxembourg)	1/1/2003	9/1/2021	225	0,164	0,605	9,805	66,252	0,00%	0,00%	0,952	0,10%
Corporate Rate (Malta)	3/1/2007	9/1/2021	175	0,157	0,269	18,473	50,436	0,00%	0,00%	0,936	0,10%
Corporate Rate (Netherlands)	1/1/2000	9/1/2021	261	0,331	0,578	22,912	90,386	0,00%	0,00%	0,969	0,65%
Corporate Rate (Portugal)	1/1/2003	9/1/2021	225	0,069	0,231	9,905	60,399	0,00%	0,00%	0,942	0,10%
Corporate Rate (Slovakia)	1/1/2008	9/1/2021	165	0,068	0,316	6,933	41,204	0,00%	0,00%	0,912	0,10%
Corporate Rate (Slovenia)	5/1/2005	9/1/2021	197	0,109	0,090	14,895	21,711	0,00%	0,00%	0,707	0,10%
Corporate Rate (Spain)	1/1/2000	9/1/2021	261	0,269	0,261	15,266	33,506	0,00%	0,00%	0,813	5,66%
Corporate Rate (Eurozone)	1/1/2000	9/1/2021	261	0,177	0,327	27,916	116,349	0,00%	0,00%	0,981	0,10%

Source: own elaboration

Table 10: Step 2 – Error correction model between NMD retail interest rates in the Eurozone and 1-month Euribor

Step 2 Regression (Error Correction Model) - Immediate short-term effect & No constant (Retail)

Equation: dClientRate(t) = gamma1*dMarketRate(t) + theta1*Res1(t-1) + Res2(t)

Series	nObs	gamma1	theta1	t_gamma1	t_theta1	p_gamma1	p_theta1	R2	pass1M	pass1Y	pass10Y
Retail Rate (Austria)	260	0,168	−0,090	8,644	−4,947	0,00%	0,00%	33,27%	18,15%	27,04%	31,92%
Retail Rate (Belgium)	260	0,083	0,004	10,149	0,616	0,00%	53,87%	26,50%	8,19%	7,43%	−2,00%
Retail Rate (Cyprus)	164	0,030	−0,020	1,806	−2,766	7,28%	0,63%	−2,70%	3,69%	10,05%	32,88%
Retail Rate (Estonia)	222	0,182	−0,177	4,601	−4,367	0,00%	0,00%	12,76%	19,29%	23,71%	24,29%
Retail Rate (Finland)	260	0,173	−0,052	11,051	−2,603	0,00%	0,98%	37,27%	17,33%	17,73%	18,23%
Retail Rate (France)	224	0,009	−0,123	1,867	−4,076	6,33%	0,01%	8,09%	1,20%	2,73%	3,20%
Retail Rate (Germany)	260	0,133	−0,092	10,847	−8,692	0,00%	0,00%	51,13%	15,32%	28,54%	35,56%
Retail Rate (Greece)	260	0,184	−0,081	4,758	−13,257	0,00%	0,00%	36,44%	21,01%	38,80%	50,50%
Retail Rate (Ireland)	260	0,169	−0,020	7,427	−1,800	0,00%	7,30%	19,06%	16,80%	15,98%	13,05%
Retail Rate (Italy)	260	0,210	−0,070	16,284	−3,785	0,00%	0,02%	57,64%	21,38%	24,32%	26,73%
Retail Rate (Latvia)	212	0,140	−0,161	3,292	−5,453	0,12%	0,00%	17,95%	17,05%	30,71%	33,02%
Retail Rate (Lithuania)	198	−0,141	−0,124	−4,455	−5,484	0,00%	0,00%	16,38%	−10,74%	7,50%	13,03%
Retail Rate (Luxembourg)	224	0,322	−0,129	13,467	−4,924	0,00%	0,00%	50,77%	34,44%	46,40%	49,78%
Retail Rate (Malta)	174	0,111	−0,063	4,604	−1,518	0,00%	13,08%	9,90%	11,75%	16,95%	21,92%
Retail Rate (Netherlands)	260	0,048	−0,034	4,736	−2,669	0,00%	0,81%	10,22%	5,07%	7,35%	12,15%
Retail Rate (Portugal)	224	0,025	−0,177	3,251	−5,361	0,13%	0,00%	17,70%	3,00%	4,84%	5,09%
Retail Rate (Slovakia)	164	0,063	−0,012	6,879	−0,955	0,00%	34,11%	18,34%	6,44%	7,55%	13,09%
Retail Rate (Slovenia)	196	0,019	−0,096	2,166	−4,464	3,15%	0,00%	12,51%	2,57%	7,08%	9,28%
Retail Rate (Spain)	260	0,060	−0,060	4,680	−4,162	0,00%	0,00%	14,31%	6,80%	12,63%	18,67%
Retail Rate (Eurozone)	260	0,114	−0,092	13,983	−7,949	0,00%	0,00%	46,65%	12,52%	19,61%	23,34%

Source: own elaboration

Table 11: Step 2 – Error correction model between NMD corporate interest rates in the Eurozone and 1-month Euribor

Step 2 Regression (Error Correction Model) - Immediate short-term effect & No constant (Corporate)

Equation: dClientRate(t) = gamma1*dMarketRate(t) + theta1*Res1(t-1) + Res2(t)

Series	nObs	gamma1	theta1	t_gamma1	t_theta1	p_gamma1	p_theta1	R2	pass1M	pass1Y	pass10Y
Corporate Rate (Austria)	260	0,346	−0,040	15,967	−2,922	0,00%	0,38%	51,66%	35,12%	39,95%	48,35%
Corporate Rate (Belgium)	179	0,305	−0,183	9,431	−2,904	0,00%	0,41%	34,00%	32,72%	41,70%	42,79%
Corporate Rate (Cyprus)	164	0,050	−0,034	2,547	−1,856	1,18%	6,53%	0,79%	5,60%	10,92%	22,02%
Corporate Rate (Estonia)	222	0,455	−0,110	10,110	−3,431	0,00%	0,07%	32,05%	45,94%	48,55%	49,55%
Corporate Rate (Finland)	224	0,404	−0,074	16,250	−3,179	0,00%	0,17%	55,25%	40,68%	42,67%	44,17%
Corporate Rate (France)	224	0,038	−0,150	2,377	−4,111	1,83%	0,01%	8,12%	4,71%	8,84%	9,67%
Corporate Rate (Germany)	260	0,265	−0,116	13,763	−5,185	0,00%	0,00%	46,38%	28,82%	41,65%	46,10%
Corporate Rate (Greece)	260	0,157	−0,097	5,423	−8,098	0,00%	0,00%	21,28%	16,77%	23,46%	26,66%
Corporate Rate (Ireland)	260	0,104	−0,026	5,782	−1,986	0,00%	4,81%	13,07%	10,40%	10,08%	9,21%
Corporate Rate (Italy)	260	0,416	−0,017	19,597	−1,487	0,00%	13,82%	63,13%	41,60%	41,70%	42,09%
Corporate Rate (Latvia)	212	0,360	−0,386	7,368	−7,043	0,00%	0,00%	29,95%	35,51%	34,76%	34,76%
Corporate Rate (Lithuania)	198	0,010	−0,471	0,255	−8,152	79,87%	0,00%	25,59%	7,52%	14,87%	14,87%
Corporate Rate (Luxembourg)	224	0,509	−0,281	6,679	−5,379	0,00%	0,00%	18,61%	53,58%	60,31%	60,50%
Corporate Rate (Malta)	174	0,089	0,030	3,744	0,852	0,02%	39,53%	10,26%	8,38%	1,24%	−604,16%
Corporate Rate (Netherlands)	260	0,343	−0,088	16,403	−5,260	0,00%	0,00%	55,97%	36,41%	50,03%	57,77%
Corporate Rate (Portugal)	224	0,250	−0,225	9,074	−4,985	0,00%	0,00%	39,57%	24,61%	23,21%	23,12%
Corporate Rate (Slovakia)	164	0,272	−0,115	8,620	−2,980	0,00%	0,33%	29,63%	27,71%	30,56%	31,57%
Corporate Rate (Slovenia)	196	−0,026	−0,160	−1,343	−4,898	18,09%	0,00%	11,00%	−0,77%	7,54%	8,97%
Corporate Rate (Spain)	260	0,212	−0,033	10,540	−2,470	0,00%	1,41%	34,99%	21,38%	22,83%	26,04%
Corporate Rate (Eurozone)	260	0,228	−0,095	17,190	−3,953	0,00%	0,01%	53,21%	23,71%	29,71%	32,69%

Source: own elaboration

Table 12: Aggregate statistics of banking sector performance for Eurozone countries (ECB Statistical Data Warehouse)

Potential predictors of the NMD pass-through rate in the Eurozone								
Predictor	**StartDate**	**EndDate**	**nYears**	**nObs**	**Mean**	**St.Dev**	**Min**	**Max**
Herfindahl Index	2020	1997	24	19	0,12	0,08	0,02	0,32
Return on Assets	2020	2007	14	19	0,23	0,49	−0,97	1,09
Return on Equity	2020	2007	14	19	1,61	6,77	−19,36	9,54
Cost-to-income [%]	2020	2007	14	19	−59,70	11,34	−88,50	−37,51
Risk-costs-to-op-income	2020	2014	7	19	−18,53	19,06	−75,73	−4,08
Net interest income [% assets]	2020	2007	14	19	1,59	0,54	0,67	2,67
Loan-to-deposit ratio	2020	2014	7	19	87,35	15,76	59,03	118,27
Liquid assets [% assets]	2020	2014	7	19	19,12	6,37	7,39	30,85
Wholesale funding [% assets]	2020	2016	5	19	40,54	10,82	20,56	71,72
Household saving rate	2020	1999	22	19	9,97	4,60	2,18	17,38
10-Year Gvt. bond yield	2020	2001	20	19	3,51	1,07	2,32	6,87
Working age population rate	2020	2009	12	19	0,49	0,03	0,42	0,55

Source: own elaboration

Table 13: Univariate regression between banking sector aggregates and 1-year pass-through rate (retail, without Luxembourg and Greece)

Univariate regression - 1-year NMD pass-through rate (Retail, without LU and GR)							
Equation: PassThrough1Y(i) = const + slope*X(i) + Res(i)							
Predictor	**const**	**slope**	**t_const**	**t_slope**	**p_const**	**p_slope**	**R2**
Herfindahl Index	0,163	−0,117	3,853	−0,419	0,16%	68,09%	1,16%
Return on Assets	0,141	0,028	5,442	0,576	6,81E−5	57,29%	2,17%
Return on Equity	0,147	0,001	6,267	0,229	1,51E−5	82,21%	0,35%
Cost-to-income	0,143	−0,000	1,193	−0,044	25,15%	96,58%	0,01%
Risk-costs-to-op-income	0,163	0,001	4,618	0,540	0,03%	59,71%	1,91%
Net interest income	0,166	−0,011	2,099	−0,236	5,32%	81,65%	0,37%
Loan-to-deposit ratio	0,187	−0,000	1,439	−0,300	17,06%	76,82%	0,60%
Liquid assets	0,116	0,002	1,455	0,421	16,62%	67,96%	1,17%
Wholesale funding	0,049	0,003	0,449	0,917	65,99%	37,38%	5,30%
Household saving rate	0,151	−0,000	2,551	−0,051	2,21%	96,02%	0,02%
10-Year Gvt. bond yield	0,203	−0,016	1,767	−0,482	9,76%	63,65%	1,53%
Working age population rate	0,015	0,272	0,040	0,367	96,84%	71,85%	0,89%

Source: own elaboration

Table 14: Univariate regression between banking sector aggregates and 1-year pass-through rate (corporate, without Luxembourg and Greece)

Univariate regression - 1-year NMD pass-through rate (Corporate, without LU and GR)							
Equation: PassThrough1Y(i) = const + slope*X(i) + Res(i)							
Predictor	**const**	**slope**	**t_const**	**t_slope**	**p_const**	**p_slope**	**R2**
Herfindahl Index	0,213	0,497	2,900	1,026	1,10%	32,12%	6,56%
Return on Assets	0,250	0,102	5,616	1,225	4,92E−5	23,96%	9,09%
Return on Equity	0,261	0,009	6,805	1,709	5,94E−6	10,81%	16,30%
Cost-to-income	0,179	−0,002	0,841	−0,470	41,33%	64,50%	1,45%
Risk-costs-to-op-income	0,315	0,002	5,059	0,793	1,41E−4	44,00%	4,03%
Net interest income	0,360	−0,052	2,575	−0,620	2,11%	54,48%	2,50%
Loan-to-deposit ratio	−0,226	0,006	−1,183	2,676	25,50%	1,73%	32,31%
Liquid assets	0,469	−0,010	3,508	−1,495	0,32%	15,57%	12,97%
Wholesale funding	−0,061	0,009	−0,335	1,903	74,21%	7,64%	19,45%
Household saving rate	0,195	0,008	1,886	0,868	7,88%	39,93%	4,78%
10-Year Gvt. bond yield	0,641	−0,107	3,511	−2,033	0,31%	6,01%	21,60%
Working age population rate	−0,282	1,139	−0,443	0,879	66,43%	39,31%	4,90%

Source: own elaboration

Table 15: Multivariate regression between banking sector aggregates and 1-year NMD pass-through rate (without Luxembourg and Greece)

Multivariate regression - 1-year NMD pass-through rate (without LU and GR)						
Equation: PassThrough1Y(i) = const + XVec(i)'*CoeffVec + Res(i)						
Segment	**Retail**			**Corporate**		
Predictor	**coeff**	**t-val**	**p-val**	**coeff**	**t-val**	**p-val**
Constant	0,074	0,055	95,89%	0,413	0,267	80,28%
Herfindahl Index	0,238	0,191	85,76%	3,910	2,751	5,13%
Return on Assets	0,088	0,399	71,05%	−0,231	−0,917	41,10%
Return on Equity	0,014	0,581	59,23%	0,065	2,303	8,27%
Cost-to-income	−0,006	−0,471	66,21%	−0,035	−2,239	8,87%
Risk-costs-to-op-income	−0,009	−0,833	45,16%	−0,026	−2,073	10,68%
Net interest income	0,041	0,271	80,00%	0,398	2,281	8,47%
Loan-to-deposit ratio	−0,009	−0,924	40,76%	−0,024	−2,290	8,39%
Liquid assets	0,020	0,881	42,80%	0,016	0,621	56,83%
Wholesale funding	0,014	1,596	18,58%	0,024	2,429	7,20%
Household saving rate	0,006	0,242	82,05%	−0,004	−0,168	87,51%
10-Year Gvt. bond yield	−0,161	−0,739	50,07%	−0,457	−1,840	13,96%
Working age population rate	−0,550	−0,329	75,84%	−2,701	−1,418	22,92%

Source: own elaboration

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