



The Effect of Euribor on Banking Profitability: Evidence from the Spanish Banking System

David Boto-García^{*,} Antonio Álvarez^a, José Francisco Baños Pino^a

^a Department of Economics, University of Oviedo, Campus del Cristo, 33006 Oviedo, Spain

* Corresponding author at: davidboto93@gmail.com

Abstract. This paper studies the relationship between the Euribor rate and the return on average assets (ROAA) of the Spanish banking sector. We use quarterly time series data for the period 1995-2016. Our analysis also controls for bank factors, market concentration, the macroeconomic environment and time effects. The main purpose is to examine how the sector's ROAA varies with the slope of the yield curve. We find evidence of an inverse relationship between the Euribor rate and profitability. We also show that banking profitability is pro-cyclical and is positively related to the stock of performing loans and the national 10-year bond yield.

Keywords. banking profitability; time series; Euribor; interest rate spread; Unconventional Monetary Policy; yield curve

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1. Introduction

A solid banking system has a major impact on the performance of the real economy. As proved in the 2008 financial crisis, when banks run into economic difficulties, their problems spread out to the whole economy. Indeed, the potential bankruptcy of the banking sector can lead other sectors to failure, thereby producing systemic crises. This is especially relevant for Spain, since its business structure strongly depends upon bank financing (Hoffman & Sorensen, 2015).

In recent years, the banking business has suffered a strong deterioration in its balance sheets. On the one hand, the number of unproductive assets has significantly increased as a consequence of the 2008 economic crisis. Apart from not producing revenues, these assets also carry non-negligible costs. This has forced the private sector to conduct a slow deleveraging, which in turn has limited loans' growth. Additionally, authorities have increased capital requirements, forcing banks to obtain more profits to attain the same level of profitability. The recovery of profitability to levels prevailing before the Great Recession is one of the great challenges the sector is facing.

The level of profitability of the banking sector is a good indicator of the stability of the financial system. Low levels of profitability can induce banks to assume greater risks (Bikker & Vervliet, 2018), thereby increasing the exposure to systemic crises. In recent years, the European Central Bank (ECB) has developed an expansive monetary policy that has led to a sharp decrease in the

interbank Euribor rate, which has even turned negative.¹ This policy has important consequences for the stability of the banking system because banks substitute wholesale funding with ECB funding (Alvarez et al., 2019). Since most of the asset products' rates are linked to Euribor and given that a recovery to the pre-crisis levels is not expected in the short run, it is unclear how the downturn in the Euribor rate affects bank business and, therefore, the stability of the banking system.

Using aggregate quarterly data for the whole banking sector covering the period 1995-2016, this paper studies the evolution of the Spanish banking sector's average profitability. We specially focus on the effect of the slope of the yield curve (difference between long- and short-run interest rates) on the return on average assets. Our aim is to explore how the Central bank monetary policy in terms of the 12-month Euribor rate has affected bank profits. Our regression analysis also controls for other relevant banking variables like the stock of performing loans or the ECB assets, the macroeconomic environment measured through the Gross Domestic Product, the market concentration of the sector through the Herfindahl-Hirschman index and the C5 ratio, and some time effects.

Banking profitability has been widely studied, both internationally (Molyneux & Thornton, 1992; Garcia-Herrero et al., 2009) and in Spain (Trujillo-Ponce, 2013; Climent & Pavía, 2015). Most of these studies use panel datasets with disaggregated information for each bank. We instead use aggregate time series data taking the return on average assets (ROAA) of the banking sector as our dependent variable. This is because our objective is not to study the determinants of bank profitability, in which case we would need to exploit the cross-sectional variability across banks, but examine how the sector's average profitability relates to interest rates. Our approach has the additional advantage that it avoids the problem of dealing with the great number of mergers between banks that took place during the study period.

There is an emerging body of literature concerned about the impact of interest rates and central banks' regulation on bank performance (e.g., Borio et al., 2017; Chaudron, 2018; López et al., 2020). The paper adds to this line of research by exploring how the sector's profitability has been affected by the slope of the yield curve, measured here as the difference between the 10-year sovereign bond yield and the 12-month Euribor rate. While most studies analyse the role of the spread alone, we conduct two separate analyses, including i) the spread and ii) the two interest rates separately. This allows us to explore the different effects of variations in the slope of the yield curve depending on whether the change is due to variations in the long-term or the short-term interest rate. Furthermore, we also study whether the 12-month Euribor exerts a different effect on the sector's profitability depending on its level.

The paper is structured as follows. In Section 2, we survey the related literature. Section 3 outlines the empirical model, the database and the variables employed. In Section 4, we present the results of the empirical analysis. Finally, Section 5 discusses the main conclusions.

¹ The 12-month Euribor rate (nominal terms) was -0.08% by the end of 2016 after suffering a decrease of 100.76 % since 1995.

2. Literature review

Following the pioneering works by Flannery (1981) and Ho & Saunders (1981), many studies have examined banking profitability determinants, either for a multi-country-setup (Molyneux & Thornton, 1992; Demirgüç-Kunt & Huizinga, 1999; Carbó & Rodríguez, 2007; Albertazzi & Gambacorta, 2009; Dietrich & Wanzenried, 2014; Saona, 2016) or focusing on a single banking system (Athanasoglou et al., 2008; Sufian & Habibullah, 2009; Dietrich & Wanzenried, 2011; García-Herrero et al., 2009). Most of this literature employs panel datasets of banks and relates indicators of profitability to bank-specific characteristics, macroeconomic conditions, and the degree of market concentration in the sector. These studies generally find that bank profits are pro-cyclical and depend on funding costs, the growth of total loans, market concentration and central bank official interest rates.

Because of its important policy implications, there has been a particular interest in disentangling the relationship between market interest rates and profitability. Scholars typically argue that bank net interest margins and, therefore, profitability is higher when the yield curve (the difference between long- and short-term interest rates) is steeper. This is because banks' revenues mainly depend on the margin between borrowing funding in the short-run and lending in the long run. Importantly, this does not only hold in the short run but also considering long time spans (e.g. Busch & Memmel, 2017). Alessandri & Nelson (2015) develop a model of monopolistically competitive banks subject to repricing frictions. Based on panel data for UK banks, they show that both the level and the slope of the yield curve positively contribute to profitability. Similarly, Borio et al. (2017) document a positive relationship between bank returns and the yield curve, which is more significant when rates are low. Egly et al. (2018) find that the yield curve together with real GDP growth exert positive and significant effects on the net interest margin of U.S. commercial banks. Using a panel dataset of banks from OECD countries during the period 2010-2015, Cruz-Garcia et al. (2018) show that both the 3-month Euribor rate level and the slope of the yield curve exert a positive (although at a decreasing rate) effect on the intermediation margin. This suggests that the effect of the interest rates is greater when they are low. Cruz-García et al. (2019) report that if the spread between the long-term and the short-term interest rates were increased by 50 basis points, the return of assets would rise by 25bp.

Notwithstanding this, changes in the slope of the yield curve do not only affect profitability through the intermediation margin but can also have indirect effects through other non-financial revenues (Cruz-Garcia et al., 2018). Accordingly, variations in the spread might have ambiguous effects on profitability. In this sense, the empirical evidence is far from robust. The effect of the slope of the yield curve on profitability seems to also depend on the countries analysed and the time periods covered. Based on separate regressions using annual aggregate data for ten countries during the period 1979-2001, English (2002) show important heterogeneity in the relationship between the yield curve slope and net interest margins. Whereas the effect is negative for Germany, Norway, Sweden and Switzerland, it is positive for the United States and non-significant for the rest. Accordingly, the relationship between the interest rates spread and bank profitability is market-specific. This calls for more country-specific studies.

Following the 2008 economic crisis, many central banks have introduced a negative interest rate policy (NIRP) with the purpose of boosting real spending through increased bank loans' supply and demand. In addition to this, some central banks like the ECB increased their liquidity as a response to the financial turmoil of the Great Recession. An emerging body of literature has started to study the economic impacts of these Unconventional Monetary Policies (UMPs) on the profitability of the banking sector. These policies affect the banking sector through different channels. A summary of their effects on the Euro Area, Japan and the United Kingdom can be found in Dell'Ariccia et al. (2018).

On the one hand, quantitative easing tends to depress long-term interest rates, which flattens the yield curve and reduces the intermediation margin. Since deposit rates are close to the zero-lower bound and banks are reluctant to pass negative rates to their customers, this reduces profitability. As a response to this, banks with a heavy reliance on deposit funding take more risks and lower their lending standards, which in turn threatens their financial stability (Bikker & Vervliet, 2018; Heider et al., 2019). Lambert & Ueda (2014) find that UMPs increase bank medium-term credit risk in the USA, the Euro area and the United Kingdom and have ambiguous effects on bank profitability.

On the other hand, UMPs are expected to increase the demand for credit and to reduce the stock of non-performing loans in a low-interest rates environment, which might increase profitability through a quantity effect. Nevertheless, Borio & Gambacorta (2017) report that the low-interest rates environment is not effective in stimulating lending growth. Using data for 33 OECD countries, Molyneux et al. (2020a) show that bank lending is weaker in NIRP-adopter countries. They document that this adverse effect of the policy is stronger for banks that are more dependent on retail deposit funding and operate in more competitive markets. Using the same dataset, Molyneux et al. (2019) find that the NIRP is negatively associated with banking profitability. Similarly, Mamatzakis & Bermpei (2016) report that central bank's assets and excess reserves negatively affects bank performance. Considering data from 47 countries, Claessens et al. (2018) show that a one per cent drop in interest rates translates into an 8 basis point lower net interest margin. This effect is larger at low rates.

As a response to the low-interest rates environment, banks also change the composition of their income in various ways. Molyneux et al. (2020b) show that banks boost fees from portfolio management, brokerage, consultancy services and current accounts. Brei et al. (2020) report that the low-interest rate environment has caused banks to shift their activities from interest-generating to fee-related and trading activities.

Other studies do not find a significant relationship between the NIRP and bank profits. Altavilla et al. (2018) report that the monetary policy easing has not significantly affected banks' profits and that the negative effect of low rates on profits is counterbalanced by improved macroeconomic conditions. Exploiting a large dataset involving 5,200 banks from 27 European and Asian countries, López et al. (2020) find little overall impact of the current negative nominal rates on bank profitability.

For the Spanish case, some scholars have studied the interrelations between efficiency, technical change and deregulations (Kumbhakar et al., 2001) whereas others have paid attention to the effect of regulatory changes on the banks' negotiating power (Salas & Saurina, 2003). Another stream of research has explored the market failures behind the great difficulties the banking sector went through after the 2008 crisis (Jimeno & Santos, 2014). These studies generally agree that the high exposure to the real estate bubble and the excessive risk-taking through over lending during the boom period are the main causes of the financial difficulties that follow. As discussed in Fernández-Villaverde et al. (2013), political economy factors like governments, developers and the local regulation of *Cajas* further contributed to the huge indebtedness of the Spanish banking system.

Concerning bank profitability, Trujillo-Ponce (2013) finds that the business cycle, the inflation rate and the degree of concentration in the sector positively contribute to profitability, while a high proportion of low-quality assets tends to lower it. Climent & Pavía (2015) study the differences in profitability between firms receiving public aid and those which do not. Revenues from investments and net financial operation results have a positive impact on profitability, whereas staff and administration costs and provisions for depreciation have negative effects. Pérez-Montes & Ferrer Pérez (2018) analyze how bank profits are affected by interest rates. Using aggregate time series data and covering the 2000-2016 period, these authors find a non-linear relationship between interest rates and net interest income, which is positive at low levels.

More recently, Cruz-García et al. (2020b) analyze the determinants of banks' net interest margins. They show that market power and risk aversion increase banking profitability while a higher volume of liquid reserves reduces net interest margins. Tercero-Lucas (2020) examines the effects of non-standard monetary policy measures on the Spanish banking sector profitability. His analysis covers the period 2001-2017 and uses panel data for 54 Spanish banks. He provides robust evidence that ECB's total assets, excess reserves and the slope of the yield curve do not significantly affect banks' return on assets and interest margins.

3. Empirical model and data

3.1. Empirical model

While most studies about banking profitability adopt a firm-oriented approach, we use time series data to study the behavior of the banking sector as a whole. Time series techniques for analyzing the banking industry in Spain have been previously used by Repullo et al. (2010) and Pérez-Montes and Ferrer-Pérez (2018). This avoids the problem of dealing with mergers between entities, which have been very important and numerous in Spain over the study period.²

The general model to be estimated has the following linear form:

$$\Pi_t = \alpha + \beta X_t + \varepsilon_t \quad (1)$$

² Tercero-Lucas (2020) overcomes the problem of mergers in a panel data setting by constructing "new virtual entities" through adding their balance sheets. In our view, treating as a single unit banks that (in the past) behave as separate entities because latter they merged is a strong assumption.

where subscript t indicates time (quarters), for $t = 1995Q1, \dots, 2016Q4$, Π_t is an indicator of the profitability of the aggregate banking sector in period t , X_t includes a set of banking factors together with controls for the macroeconomic environment and an indicator of market concentration, β is a vector of parameters to be estimated, and ε_t is the error term that is assumed to be white noise.

We next proceed to define the variables considered in equation (1) and the data source.

3.2. Variable definition and data source

Banking profitability (Π_t)

Return on average assets (ROAA) is our main measure of profitability. It is defined as the ratio of net before-tax profits to total assets. It reflects how the banks' assets have been managed to produce revenues and are the most used profitability indicator (Molyneux et al., 2019; Mamatzakis & Bermpei, 2016). Some scholars also employ the return on equity (ROE) as the dependent variable (Dietrich & Wanzenried, 2011; Trujillo-Ponce, 2013). For robustness, we also consider ROAE. These two ratios are drawn from the income statement of the Spanish banking sector provided by the Bank of Spain Statistical Bulletin.

Although there are some differences between ROAA and ROAE (for example, the former collects off-balance sheet activities whereas the latter varies as a function of the entities capital requirements), their time evolution is similar in our study period. As shown in Figure 1, both variables show a substantial drop in the period 2012-2013. This was the consequence of the passing of two royal decree-laws in February and June 2012 by the Spanish Government that forced banks to raise provisions in the balance sheet. One important part of the assets was related to the real state sector which, after the bursting of the housing bubble, were appraised above market prices.³ In this context, it was necessary to deploy resources towards provisioning to cover losses from asset impairment. The above-mentioned decrees, by requiring provisions classified as a normal risk to cover the exposure of the real state sector, led to a substantial negative value of the ROAA in 2012 and 2013.⁴

³ Martin et al. (2020) show that during the housing boom there was a slowdown in the growth of non-housing credit. As such, banks' assets at that period were heavily dependent on housing credit.

⁴ The effort in provisioning (Provisions over gross margin) in the period 2000-2008 was on average 25%, and it started to grow with the economic crisis. In 2011, it was 79% but in 2012 it reached the value of 253%. This atypical value has a corresponding effect on profits before taxes.

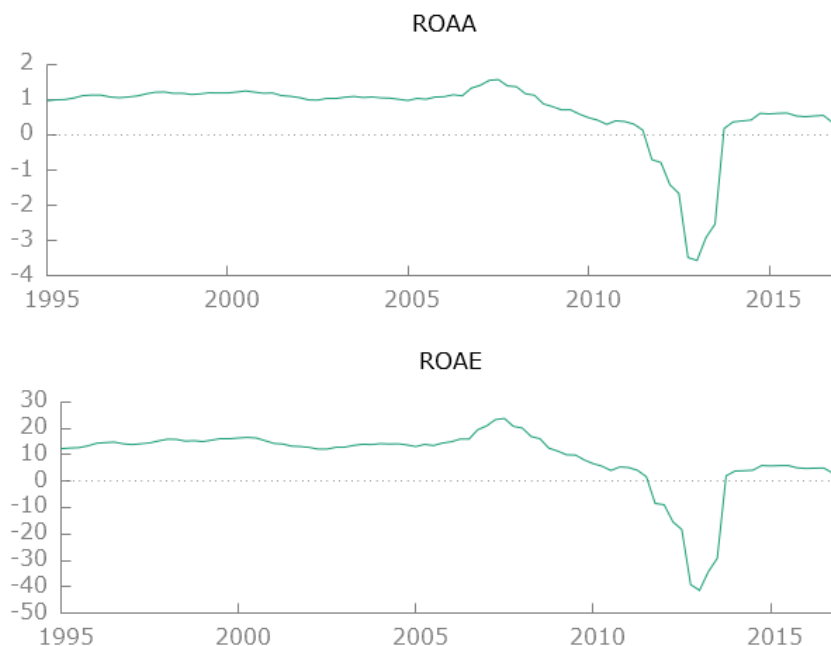


Figure 1. Evolution over time of ROAA and ROAE (in percentage).

Banking factors (X_t)

- **Performing loans:** the main activity of any bank is loan granting. Theory suggests that the greater the number of loans granted, the higher the results, *ceteris paribus*. However, profits do not only depend on the loans' volume but also on their quality. Specifically, the relevant ones are performing loans, namely, those which generate earnings. When customers cannot repay a loan –which results in the loan being catalogued as in default – ,⁵ the asset generates costs related to its management and the required provisioning allowance. Due to these reasons, we employ the stock of total loans once discounted those considered as defaulted. We expect this variable to be positively associated with profitability.

The performing loans variable has been obtained as the difference between the total loans stock and the defaulted loans per quarter. This information is obtained from the Bank of Spain Statistical Bulletin. The original variable has been deflated by the Consumer Price Index (base 2011) and is measured in million euros.

- **ECB Assets:** as discussed in Section 2, the European Central has undertaken several unconventional monetary policies (UMPs). For instance, by providing liquidity in exchange for low-quality assets, banks have been allowed to cleanse deteriorated balance sheets. Mamatzakis & Bermpei (2016) document that increases in the Fed' assets are negatively associated with bank profitability in the USA, while Tercero-Lucas does not find a significant effect of ECB's assets growth on Spanish bank's ROA.

⁵ The Bank of Spain defines defaulted loans as those with any expired amounts, either of the principal, the interests or of the expenditures contractually agreed, with more than three months of delay.

To control for this quantitative easing (liquidity injections), we take the value of ECB assets for the euro area as an indicator of the asset purchase programs. This variable is retrieved from the ECB Statistical database and is expressed in million euros (also deflated by the Consumer Price Index). Since previous literature on its effect is scarce, we do not have a clear expectation about the sign of this variable.

- *12-month Euribor*: banks use Euribor as a reference for fixing the prices of many of their financial products. The effect of a rise in the Euribor rate on profitability may depend on how they are able to shift this increase onto asset prices. On the one hand, because some of the asset products have an interest rate that is linked to Euribor (e.g. mortgages with variable rates), if Euribor rises the interest rates banks charge on their variable-rate loans will also increase, although with a lag as rates on most of these loans are revised every six months. On the other hand, if there is an increase in the funding cost in the inter-bank market, banks may compete with each other to fund themselves via deposits, thus pushing liability rates up. Therefore, the total effect of Euribor on profits will depend on the relative evolution of asset and liability rates. In practice, liability rates tend to reprice faster than asset rates, so it is possible that a decrease in Euribor causes an increase in the slope of the interest rate curve. This does not imply that net interest income will necessarily increase, as it also depends on the "volume" effect. It thus remains to be empirically answered the effect of the Euribor rate on profitability.

Here we employ the quarterly 12-month Euribor rate after discounting the inter-annual inflation rate. The data is drawn from the Bank of Spain, which supplies the value it would have taken in the period 1995-2000 as a weighted average of the national Inter-bank interest rates of the Euro zone countries in that period. For robustness, we also use the 3-month Euribor rate, obtained from the same data source.

- *10-year sovereign bond yield*: banks usually obtain funding in the short-run, but they lend in the long run (maturity mismatch). Consequently, to analyse the effect on profitability of a change in interest rates, it seems better to consider the difference between long-run and short-run interest rates. This is also known as the slope of the yield curve. Indeed, the sector has traditionally considered that the steepness of the yield curve positively contributes to bank results. In this vein, Saunders & Schumacher (2000), Albertazzi & Gambacorta (2009), Alessandri & Nelson (2015) and Borio et al. (2017), among others, find a positive relationship between the slope of the yield curve and banking profitability. The real 10-year Spanish bond yield is the chosen indicator of the long-run interest rate. The data is drawn from the Bank of Spain and is expressed in real terms. In our analysis, we both consider: i) the rates' difference as a single explanatory variable, and ii) both rates separately. In this way, by including the rate for the long-run together with the one for the short-run, we allow for different effects of changes in the slope of the yield curve depending if they are due to shifts in the short-run or in the long-run interest rates.

In line with the literature, we expect profitability to be positively associated with the rate spread. Consequently, we also expect the parameter associated with the 10-year Spanish bond yield to be positive and the one associated with the 12-month Euribor to be negative.

Macro environment (Z_t)

Among the different macroeconomic indicators, Gross Domestic Product (GDP) is the main magnitude due to the close relationship between business cycle fluctuations and banking profitability (Demirguc-Kunt & Huizinga, 1999; Albertazzi & Gambacorta, 2009; Bolt et al., 2012; Dietrich & Wanzenried, 2014; Almeida & Divino, 2015).⁶

- *Real GDP*: a low economic growth environment reduces lending activity because of the drop in aggregate demand. Conversely, economic expansions increase the demand for credit and other types of financial products. Athanasoglou et al. (2008) find evidence of a positive relationship between bank profits and the business cycle. Bolt et al. (2012) indicate that the degree of pro-cyclicality of bank profits is stronger for deep recessions than under normal economic conditions. Thus, we expect a positive coefficient for this variable.

Real GDP (index) for each quarter has been taken from the Spanish National Accounting (National Statistics Institute) taking December 2010 as the base year, once corrected for seasonal and calendar effects.

Sector concentration (C_t)

In line with the structure-conduct-performance paradigm, the market structure is usually considered as a determinant of banking profitability.⁷ To measure the degree of market concentration, scholars use the Herfindahl-Hirschman index (Djalilov & Piesse, 2016) or concentration ratios such as C3 (Dietrich & Wanzenried, 2014) or C5 (Claessens & Laeven, 2004).

- *C5*: it is defined as the proportion of the total assets under the control of the five largest banks. Therefore, the C5 index can be understood as a proxy of market concentration. Although market concentration does not necessarily imply a greater market power, when a reduced number of banks control a large share of total assets it is more likely that collusive behaviours take place (Gilbert, 1984). Although it is unclear whether structure itself necessarily shapes profitability (Smirlock, 1985), it can contribute to the build-up of monopoly profits. From this perspective, we would expect a positive sign for this variable. Banks assets have been taken at the end of each quarter from the public balance sheets available in CECA (Spanish Savings Banks Confederation) and AEB (Spanish Banking Association). As the information from CECA for the savings banks is only available for the

⁶ The labour market situation or the population (as an indicator of market size) are other variables that some authors have considered. Nevertheless, since demographic changes are mainly due to migratory flows associated with the business cycle and that unemployment directly relates to the aggregate production evolution, we only employ real GDP.

⁷ The reader is referred to Gilbert (1984) for a theoretical characterization and a review of empirical evidence.

period 2002-2014, the calculation of the C5 index was completed using the audit reports of the Spanish Stock Market Commission.

- Herfindahl-Hirschman (HH) index: one drawback of the C5 ratio is that it ignores the possible asymmetry in the proportion of assets controlled by the five largest firms and the asset composition of the remaining banks. Therefore, the HH index is used as an alternative indicator. It is calculated as the sum of the squares of the asset share of each bank. The greater this index, the greater the degree of market concentration. This information is retrieved from the ECB Statistical database.

The definitions, notation and expected sign of the variables defined above are shown in Table 1.

Table 1. Variables, definitions and expected sign.

Variables	Definition	Notation	Expected sign
Dependent:			
Profitability (Π_t)	Net profits before taxes / average total assets	<i>ROAA</i>	
	Net profits before taxes / banks' average equity	<i>ROAE</i>	
Explanatory: (X_t)			
Performing loans	Performing loans stock (million €)	<i>Loans</i>	+
ECB Assets	Volume of ECB assets (million €)	<i>ECB Assets</i>	+/-
12-month Euribor	12-month Inter-bank interest rate in real terms (%)	<i>Eurib_12</i>	-
10-year bond yield	10-year sovereign bond yield real interest rate in real terms (%)	<i>10Y_sb</i>	+
Interest rate spread	Difference between 10-year bond yield and 12-month Euribor (%)	<i>Spread</i>	+
Real GDP	Index. Base 2010	<i>GDP</i>	+
C5	Concentration index of the five largest banks.	<i>C5</i>	+
HH	Herfindahl Hirschman index	<i>HH</i>	+

3.3. Descriptive statistics

Summary statistics of the variables are presented in Table 2. The average return on assets is 0.65%, whereas the average return on equity is notably larger (8.9%). The Spanish banking system granted loans with an average value of 1.3 billion euros, whereas the mean value of the ECB assets is 1.74 trillion euros. The average 12-month Euribor rate (in real terms) is 0.54% during the study period, while the 3-month rate is almost zero (-0.01%) on average. The mean of the 10-year sovereign bond year is 2.20%, being the average spread 1.66%. About 47% of total assets are under the control of the five largest entities. The high mean value of the HH index and its increase over the study period reveals there has been a rise in the market concentration of the Spanish banking industry. As recently shown by Cruz-García et al. (2020c), the consolidation of the sector has increased the dominant position of incumbent banks and led to a rise in market power.

Table 2. Descriptive statistics.

Variable	Unit	Mean	SD	Min	Max
ROAA	%	0.659	0.998	-3.566	1.570
ROAE	%	8.906	12.240	-41.34	23.71
Loans	Million €	1,345,900	485,440	634,960	2,146,900
ECB Assets	Million €	1.74e09	6.90e-08	1.0e09	3.40e09
Eurib_12	%	0.54	1.90	-4.11	5.40
Eurib_3	%	-0.01	1.44	-4.60	2.36
10Y_sb	%	2.20	1.80	-1.05	7.16
Spread	%	1.66	1.28	-0.815	5.37
GDP	Index (2010=100)	89.47	12.09	65.12	104.4
C5	Ratio	0.47	0.06	0.38	0.60
HH	Index	528.90	188.40	213.00	937.00

Table 3 reports the evolution of the explanatory variables by presenting their values in the last quarter of the years 1995, 2000, 2005, 2010 and 2016. The return on average assets (ROAA) remained stable around 1.1% during the decade 1995-2005 but has experienced a notable drop over the last ten years. The 12-month Euribor rate (*Eurib_12*) is the variable that has suffered the largest decline, falling from 4.83% in 1995 to -1.64% (in real terms) by the end of 2016. The 10-year sovereign bond rate (*10Y_sb*) has also substantially changed over time. The stock of performing loans (*Loans*) has continuously increased during the real estate boom but fell after 2010. On the other hand, the high number of bank mergers is the main reason for the increase in the C5 ratio and the HH index in the period 2010-2016.

Table 3. Explanatory variables evolution. December 1995, 2000, 2005, 2010 and 2016.

Variable	1995	2000	2005	2010	2016
ROAA	1.05	1.22	1.07	0.40	0.35
ROAE	13.34	15.32	14.43	5.38	3.105
Loans	669,349	943,320	1,598,220	1,984,730	1,254,060
ECB Assets	-	1.15e09	1.18e-09	1.98e-09	3.40e-09
Eurib_12	4.83	0.92	-0.95	-1.46	-1.64
Eurib_3	1.19	0.98	-1.26	-1.96	-1.88
10Y_sb	5.64	1.24	-0.36	2.38	-0.14
Spread	0.81	0.32	0.58	3.85	1.50
GDP	66.34	81.64	96.29	100.00	103.11
C5	0.38	0.56	0.44	0.45	0.60
HH	213	561	487	528	937

3.4. Time series stationarity

Prior to the empirical analysis, we tested the stationarity of the time series. Since taking natural logs is a type of Box-Cox transformation that is used to achieve variance stationarity and it also facilitates the coefficient interpretation, we first log transformed the variables *Loans*, *ECB's Assets*, *GDP*, *C5* and *HH*.⁸ Because of the quarterly frequency of the data, we then analysed the

⁸ We do not take the logs of the profitability indicators or the interest rates because these variables take negative values in some periods.

existence of seasonal unit roots through the HEGY test (Hylleberg et al., 1990). Finally, the existence of at least two regular unit roots was tested by applying the Dickey and Fuller ADF (Dickey & Fuller, 1979) and Philips and Perron (Philips & Perron, 1988) tests. The reader is referred to Appendix I for details.

The HEGY tests suggest there is a seasonal unit root associated with frequency π (every two quarterly periods) for *Log Loans*. Consequently, this series has been filtered by Δ_2 so that the transformed series is given by $\text{Log Loans}_t - \text{Log Loans}_{t-2}$. The ADF and PP tests indicate that the variable *10Y_sb* is a stationary process in levels. Conversely, *Log ECB's Assets*, *Eurib_12*, *Eurib_3*, *Spread*, *Log C5* and *Log HH* are $I(1)$ series that need to be differentiated with respect to their first lag to become stationary.

We also document there is a structural break in *ROAA*, *ROAE* and *GDP*. Since the ADF and PP unit root tests may be biased in the presence of a structural break (Perron 1989), we moved to the Zivot and Andrews (1992) test to determine their integration order. This test shows that *ROAA* and *ROAE* are stationary variables, with a structural break in the last quarter of 2011. This can be a consequence of the passing of the previously commented royal decrees-laws in February and June 2012 that forced banks to raise their provisions for impairment losses in the balance sheet. To control for this in the analysis, we add a dummy variable (denoted as *D2012*) that takes value one from the first quarter of 2012 onwards. Finally, the variable *Log GDP* is integrated of order one, presenting a structural break in the last quarter of 2008.

Apart from the above-mentioned transformations, our model specification incorporates i) a time trend, ii) quarter dummies to control for potential seasonal effects, and iii) a dummy variable for the four quarters of 2010 (*D2010*). The latter controls for the most critical phase of the Greek crisis, which threatened to destabilize the European Monetary Union and produced a climate of uncertainty in the European banking system.⁹

4. Results

We divide our empirical analysis into two parts. First, we consider the spread (ΔSpread) as a single regressor capturing the slope of the yield curve together with the other banking factors and controls. Second, we replace this indicator with both the 12-month Euribor rate and the 10-year sovereign bond rate.

4.1. Results using the spread

Table 4 presents the first set of estimation results. In the first column, we regress *ROAA* on the second-lag difference of the log of performing loans ($\Delta_2 \text{Log Loans}$), the ECB assets growth rate ($\Delta \text{Log ECB Assets}$), the first difference of the spread of interest rates (ΔSpread), the GDP growth rate ($\Delta \text{Log GDP}$), the HH index growth rate ($\Delta \text{Log HH}$), a time trend (*Trend*), the quarter dummies

⁹ In January 2010, a report from the European Commission showed that the Greek government had committed *severe irregularities* in sending tax data to Brussels. On April 27, Standard & Poor's downgraded the Greek bond to the 'junk bond' category. After the bankruptcy of the Greek economy, the European Commission, the European Central Bank and the International Monetary Fund contributed with more than 10,000 million euros to rescue Greece during 2010.

(Q1, Q2 and Q3) and the dummy variables that control for the Greek crisis ($D2010$) and the structural break ($D2012$). The second column adds an interaction term between the HH index growth rate and the dummy for the structural break ($\Delta \text{Log HH} \times D2012$). This is because the far-reaching restructuring process undergone by the Spanish banking industry to correct the imbalances generated during the real estate boom led to an intense wave of corporate mergers between entities.¹⁰ As discussed in Cruz-García et al. (2020a), this balance-sheet clean-up dictated by the two previously commented royal decree-laws affected the sector's market power. Therefore, the interaction term aims to explore whether the effect of market concentration on ROAA has changed in the 2012-2016 period. Column 3 replaces the Herfindahl-Hirschman index by the C5 ratio. Similar to column 2, in column 4 we include an interaction term between the concentration ratio and $D2012$ ($\Delta \text{Log C5} \times D2012$). Finally, column 5 expands the model in column 4 by including ΔEurib_3 together with ΔSpread .

All the regressions are estimated by OLS. Since it is possible that the error term is heteroskedastic and serially correlated, we use robust standard errors, following Newey & West (1987). We find that the spread is (marginally) positively associated with ROAA when we consider the HH index, but it turns to be non-significant when the market concentration is measured through C5. Since the use of the latter indicator provides a better model fit according to AIC and R^2 , from these regressions we would conclude that the spread is not significantly associated with the sector's profitability. Interestingly, when we add ΔEurib_3 to the specification we find that ROAA decreases as the 3-month Euribor rate rises (conditional on the spread). Nonetheless, this latter regression needs to be interpreted with caution. The reason is that the 3-month and the 12-month Euribor rates are highly correlated ($\text{corr}=0.89$), so interpreting the ΔEurib_3 coefficient, *ceteris paribus*, is cumbersome.

Concerning the rest of variables, the stock of performing loans has a (marginally) positive effect on profitability. Therefore, the higher the volume of performing loans, the higher the sector's profitability. Since we have taken differences with respect to the second lag, a marginal change in its inter-quarterly rate of growth increases ROAA by around 7.3 percentage points (hereafter pp). By contrast, the ECB's assets growth is not significantly related with the sector's average profitability. This result is consistent with Tercero-Lucas (2020).

We also find that ROAA is positively associated with the GDP growth. A 0.1-point increase in the GDP growth rate from one quarter to the following (mean $\Delta \text{Log GDP}=0.005$) translates into an increase of about 7.6 pp in ROAA. This adds more evidence on the pro-cyclicality of banking results, in line with Albertazzi & Gambacorta (2009) and Trujillo-Ponce (2013). This finding could support the argument that regulation should focus on forcing banks to increase their capital buffers via reserves (or generic provisions) in expansionary periods.

¹⁰ The merger process has been quite dynamic and caused that a substantial share of the sector's assets has ended up under the control of the biggest banks. The C5 ratio (HH index) was 0.48 (596) by the end of 2011 but reached 0.58 (839) by the end of 2014 and 0.60 (937) by the end of 2016. Except for *Banco Santander* that did not participated in the merging process during the study period, big banks have absorbed the business activity of small banks that were heavily exposed to the real estate boom and were in a delicate economic position.

Table 4. Estimation results using the spread of the interest rates.

	(1)		(2)		(3)		(4)		(5)	
	Coefficient	Robust SE	Coefficient	Robust SE	Coefficient	Robust SE	Coefficient	Robust SE	Coefficient	Robust SE
Δ_2 Log Loans	7.353*	3.931	7.183*	3.996	6.507*	3.775	6.154*	3.408	6.328**	3.150
Δ Log ECB Assets	0.144	0.299	0.148	0.294	0.166	0.299	0.150	0.275	0.084	0.264
Δ Spread	0.343*	0.197	0.357*	0.185	0.312	0.193	0.247	0.196	0.212	0.177
Δ Eurib_3									-0.237*	0.128
Δ Log GDP	74.637***	22.301	76.241***	22.030	76.717***	23.297	72.009***	22.201	69.337***	23.540
Δ Log HH	1.506	1.324	1.243	1.186						
Δ Log HH x D2012			1.508	3.945						
Δ Log C5					-2.132	1.755	-0.349	1.023	0.537	0.958
Δ Log C5 x D2012							-	6.633	-	6.046
D2010	-0.505**	0.244	-0.519**	0.241	-0.518**	0.243	-0.495**	0.234	-0.610***	0.206
D2012	-1.572***	0.480	-1.622***	0.463	-1.591***	0.485	-1.319***	0.470	-1.331***	0.426
Q1	-0.012	0.151	-0.037	0.160	0.073	0.145	0.016	0.138	0.051	0.127
Q2	0.053	0.146	0.050	0.147	0.068	0.141	0.145	0.119	0.176	0.138
Q3	0.139	0.170	0.142	0.167	0.145	0.170	0.161	0.170	0.210	0.162
Trend	0.023**	0.009	0.023**	0.009	0.023**	0.009	0.021**	0.009	0.021**	0.008
Constant	-0.714	0.523	-0.728	0.509	-0.718	0.529	-0.589	0.506	-0.615	0.500
R^2	0.649		0.644		0.650		0.681		0.711	
AIC	149.45		151.29		149.27		143.48		137.25	

Note: (*), (**) and (***) indicate significance at 10%, 5% and 1% level respectively.

Regarding the sector's competitive structure, neither the HH index nor the C5 ratio are statistically significant. Although it is customary to associate a highly concentrated sector with greater profitability, there is no empirical evidence to support this positive relationship. This is consistent with Athanasoglou et al. (2008), Garcia-Herrero et al. (2009) and Dietrich & Wanzenried (2011), who did not find either a significant effect of the HH index on ROA. However, we document a negative and significant effect of the interaction between the C5 ratio and D2012. This implies that concentration negatively affected profitability from 2012 onwards. Llorens et al. (2020) show that more productive Spanish banks absorbed less productive ones for strategic reasons such as acquiring the branches where they were underrepresented. Until some time elapses for the sector to generate the corresponding synergies that dimensional gains offer, the absorption of firms with serious imbalances could hamper the proper functioning of the absorbing bank. As shown by Smirlock (1985), mergers do not always lead to efficiency and profitability improvements, at least in the short run. Furthermore, the rise in assets' concentration and the drop in the number of banks on operation might have increased competition in the sector among leading banks through reducing information costs for consumers. Overall, the intensive merging process appears to have produced a negative effect on the sector's ROAA, everything else being equal.

The negative and significant coefficient of the dummy variable that captures the structural break ($D2012$) can be interpreted as a fall in ROAA from 2012 onwards because of the duty for banks to increase the share of provisions imposed by the regulatory decrees. The estimation results also show that the most critical phase of Greek crisis ($D2010$) had a significant negative effect, possibly because of the distrust on the stability of the European Monetary Union if Greece were rescued.

The seasonal dummy variables are never significant. Therefore, ROAA does not significantly differ per quarter. As for the positive and significant coefficient of the time trend, this variable merely controls for stationary deviations of the regressors around its deterministic trend. In any case, it suggests ROAA has slightly increased, on average, during the study period.

4.2. Results using the two rates

Table 5 reports the second set of estimation results including both $\Delta Eurib_{12}$ and $10Y_{sb}$ as separate regressors instead of $\Delta Spread$. As before, the first column considers $\Delta Log HH$ as the indicator of market concentration. The second column adds an interaction term between $\Delta Log HH$ and $D2012$. The third column replaces $\Delta Log HH$ by $\Delta Log C5$. The fourth column adds the interaction between $\Delta Log C5$ and $D2012$. Finally, as a robustness check, the fifth column replaces $\Delta Eurib_{12}$ by $\Delta Eurib_3$ (see below). The estimates are very similar across the different specifications. Based on the AIC criterion and the R^2 , the regression in column 4 seems to fit the data best.

The 12-month Euribor rate ($\Delta Eurib_{12}$) exerts a positive and significant effect on ROAA, *ceteris paribus*. Using the specification in (4), a marginal drop in the inter-quarterly differential of the 12-month Euribor increases ROAA by 0.32 pp. This negative effect might be due to two reasons. First, the Euribor has fallen during the study period, resulting in banks suffering a reduction in their interest income as many of their asset products are linked to it (e.g., variable interest rate mortgages). Second, the fall in Euribor has also produced a decrease in financial costs due to the drop in deposit prices. Since banks reprice liabilities faster than assets, this allows the difference between the lending and the deposit rate to increase when Euribor falls.

Kumbhakar & Lozano-Vivas (2004) find that the deposit market is less competitive than the loan one, which therefore makes the effect of a change in interest rates on liabilities to be greater. This is due to the existence of switching costs (Klemperer, 1987), by which consumers do not change bank in the case of a drop in deposit rates because they are linked to the firm via asset products, or just because the volume of their deposits does not compensate the transaction costs of opening a new account elsewhere (Kim et al., 2003).

Trujillo-Ponce (2013) also finds a negative relationship between the interest rate and the profitability of Spanish banks (both ROA and ROE). This author argues that "this inverse relation may be caused by a temporary lag when modifying the interest rates applied to customers in such a way that interest rate variations are more rapid for liability products than asset ones. Hence, the banking interest rate margin increases with a drop in the reference interest rates and decreases with an increase in the latter".

Table 5. Estimation results using both *Eurib_12* and *10Y_sb*.

	(1)		(2)		(3)		(4)		(5)	
	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE	Coefficient	SE
$\Delta_2 \text{ Log Loans}$	9.576**	3.838	9.559**	3.849	9.191**	3.745	8.333**	3.339	8.693**	3.397
$\Delta \text{ Eurib}_{12}$	-0.324**	0.151	-0.326**	0.153	-0.320**	0.152	-0.323**	0.155		
$\Delta \text{ Eurib}_3$									-0.303**	0.150
<i>10Y_sb</i>	0.182**	0.081	0.182**	0.081	0.186**	0.081	0.161**	0.075	0.165**	0.077
$\Delta \text{ Log GDP}$	66.817	23.227	67.095***	23.629	68.513***	23.766	65.645***	23.629	63.424***	22.808
$\Delta \text{ Log HH}$	0.447	0.660	0.400	0.627						
$\Delta \text{ Log HH} \times$ <i>D2012</i>			0.646	3.270						
$\Delta \text{ Log C5}$					-1.633	1.208	0.224	0.916	0.229	0.974
$\Delta \text{ Log C5} \times$ <i>D2012</i>							-	5.139	-0.228***	5.189
<i>D2010</i>	-0.687***	0.225	-0.689***	0.226	-0.696***	0.226	-0.686***	0.225	-0.635	0.208
<i>D2012</i>	-1.656***	0.453	-1.673***	0.455	-1.660***	0.452	-1.384***	0.430	-1.302***	0.4000
<i>Q1</i>	0.066	0.115	0.056	0.121	0.122	0.113	0.065	0.103	0.033	0.106
<i>Q2</i>	0.110	0.131	0.111	0.131	0.115	0.129	0.179	0.126	0.155	0.119
<i>Q3</i>	0.127	0.113	0.128	0.113	0.132	0.113	0.161	0.116	0.148	0.120
Trend	0.023**	0.009	0.023**	0.009	0.023***	0.008	0.021**	0.008	0.019**	0.007
Constant	-0.990	0.641	-0.992	0.640	-0.997	0.640	-0.840	0.612	-0.752	0.585
R^2	0.712		0.709		0.715		0.748		0.744	
AIC	149.39		151.34		148.68		138.77		140.07	

Note: (*), (**) and (***) indicate significance at 10%, 5% and 1% level respectively.

Bank margins also benefit from a fall in interest rates (for new operations) due to a *composition effect* derived from the transfer of fixed-term deposits to sight deposits. When the remuneration of the deposits is quite small, customers prefer the flexibility of money at sight despite its minimal return, which results in the average deposit rate being lower. During the study period, interest rates fell during two or more consecutive years in 1995-1999, 2001-2005, 2008-2010 and 2012-2016. As shown in Table 6, in all these periods, liability interest rates fell more than asset rates.

Table 6. Drop in the synthetic Asset and Liability rates.

	Periods in which a fall in the interest rates took place			
	1995-1999	2001-2005	2008-2010	2011-2016
Drop in asset rates (%)	-49.2	-66.3	-20.8	-43
Drop in liability rates (%)	-62	-70.9	-32.5	-71

Asset interest rates also drop less than deposit rates due to the existence of floor clauses in a great share of mortgage loans. Indeed, mortgages represent a large percentage of household

loans, being the vast majority (around 90% during the real estate boom) at a variable interest rate. A high percentage of the variable-rate mortgages contained floor clauses, which limited the possibility of lowering the monthly payments paid by consumers when the reference rate fell below that fixed by the clause.

It is important to highlight that Euribor does not only affect pre-tax profits, and hence ROAA, in the upper part of the income statement (that is, the Net Interest Income), but it also influences the Gross Margin via capital gains (or losses) in the trading of financial assets, especially fixed-income portfolios. Since the price of some financial assets is inversely related to the interest rate and given that from 2009 onwards, Euribor has continuously decreased, the incentive to gain profits through the sale of the large amounts of fixed income assets in the banks' balance sheets experienced a great increase, with the corresponding positive effect on earnings. This further reinforces the negative sign obtained.

The sign of the parameter associated with the 10-year sovereign bond yield is positive whilst that of the Euribor is negative. Both signs make sense. Since the price of liabilities is usually linked to short-term interest rates (most of bank funding is short-term), an increase in short-term interest rates (*ceteris paribus* the remaining rates on the curve) increases the funding costs of banks and damages profitability. Moreover, asset prices are usually linked to longer term interest rates because banks invest in long-term assets. Therefore, an increase in long-term interest rates encourages banks to formalize operations at higher interest rates, thereby improving their profitability.

The sign and significance of the rest of the variables are similar to Table 4, so we abstract from commenting on them again. We performed some robustness checks and model extensions. First, some authors like Albertazzi & Gambacorta (2009) and Borio et al. (2017) use the 3-month interbank rate instead of the 12-month one. Accordingly, column 5 replaces $\Delta Eurib_{12}$ by $\Delta Eurib_3$. As shown, both the signs and the magnitude of the estimated parameters remain unchanged compared to column 4. Second, we repeated the regressions presented in Tables 4 and 5 using ROAE as the dependent variable. The results are consistent with the ones reported and are available from the authors upon request. Third and more importantly, during the study period the deflated 12-month Euribor rate has been positive and negative, and the inter-month variability has also been positive and negative. Studies concerned about the linkages between Euribor and banks' profitability have shown that the relationship might be non-linear, so that the effect is greater when the interests are low (Borio et al., 2017; Cruz-Garcia et al., 2018; Pérez-Montes and Ferrer-Pérez, 2018). To inspect in more detail the role of Euribor on ROAA, we take the model specification in Table 5 column 4 and add i) an interaction term between $\Delta Eurib_{12}$ and a dummy for whether $Eurib_{12} > 0$ (*Euribor. positive*), and ii) an interaction term between $\Delta Eurib_{12}$ and a dummy for whether $Eurib_{12}$ is above the study period mean, which equals 0.549 (*Euribor. abovemean*).

The coefficient estimates of these additional regressions are presented in Appendix II Table A5. Interestingly, we find that the negative effect of the 12-month Euribor rate on ROAA, conditional on $10Y_{sb}$, becomes lower in magnitude i) when the Euribor is positive, and ii) when

the Euribor is above the study period mean. Indeed, in the latter case the overall effect is even positive. This tentatively suggests that the detected negative effect of Euribor on ROAA mainly holds at low levels. Put another way, drops in the 12-month Euribor rate conditional on $10Y_sb$ (i.e. rises in the slope of the yield curve) positively affect the sector's profitability at low levels but are negligible at high levels. This is consistent with evidence presented in Borio et al. (2017), Cruz-García et al. (2018) and Pérez-Montes and Ferrer-Pérez (2018).

5. Conclusions

This study contributes to the literature by uncovering the relationship between Euribor interest rate and the banking sector's average returns. A time series regression model with quarterly data is specified where the return on average assets (ROAA) is explained by banking factors, GDP, indicators of market concentration and time effects. The main purpose is to study how ROAA varies with changes in the slope of the yield curve, which is given by the difference between the 10-year sovereign bond yield and the 12-month Euribor rate. Focusing on the Spanish case and considering a longer time span than related studies (22 years), a novel aspect of this research is that we distinguish the effect of variations in the slope of the yield curve depending on whether they stem from the long or the short interest rate.

When we specify the spread as a single regressor, we do not detect a significant relationship with ROAA. However, when considering both rates in the model, we find that the sector's profitability increases with the long-term interest rate and decreases with the 12-month Euribor rate. Because Euribor is a reference for fixing asset and liability interest rates, a fall (increase) in this rate increases (reduces) the lending minus deposit spread, *ceteris paribus*. This negative relationship appears to indicate that banks are able to take advantage of the possibility of lowering the rates on deposits faster than those on loans. Interestingly, we also find that the negative effect of the Euribor is moderated when this rate is positive and above its mean. This suggests that the negative relationship encountered mainly holds at low levels of Euribor.

The results also indicate that ROAA is positively related to the stock of performing loans and GDP, as expected. We do not find evidence that market concentration exerts a significant effect on profitability, on average, but we document that the intense merging process that took place after 2012 is associated with a lower sector's profitability (at least in the short run). The greater market concentration has potentially increased competition due to the drop in customer search costs.

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APPENDIX I. Time-series stationarity.

To avoid spurious regression, time series must be stationary (Granger & Newbold 1974). Non-stationarity in the mean is caused by the existence of a time trend. A deterministic trend is not problematic since it can be included in the model as a regressor. However, stochastic trends (unit roots) are the main cause of the spurious regression problem.

Because our time series have quarterly periodicity, as a first step we test the existence of unit roots in the seasonal frequencies. We first conduct the HEGY test developed by Hylleberg et al. (1990).¹¹ Table A1 presents the results. The auxiliary regressions incorporate a constant, trigonometric terms and a time trend. From the results in this table we conclude: i) *Log Loans* is $I(1)$ with frequency each two periods (quarters), ii) *Euribor_3* and *Euribor_12* could be $I(0)$ or $I(1)$, and iii) the rest of variables seem to be $I(1)$. Accordingly, the transformation Δ_2 is applied on *Log Loans*.

Once having explored seasonal unit roots, unit roots in the zero frequency are analysed using the Augmented Dickey Fuller test (Dickey & Fuller, 1979) (hereafter ADF). This test assumes that the series follows an autoregressive process of order k and hypothesizes that there is a unit root, namely, the time series is DS (*difference stationary*).¹² There are three possible specifications for the test: i) with a constant term, ii) without a constant term and iii) with a constant and a time trend. Under the alternative hypothesis, in the two first specifications the series would be stationary around a constant mean. In the third case, it would be stationary around a deterministic trend (linear or polynomial) or process TS (*trend stationary*). We run the ADF test on each time series based on an auxiliary OLS regression with a constant term, a time trend and k lags.¹³ Alternatively, the Phillips & Perron test (PP test) (Phillips & Perron, 1988) is used.¹⁴

Table A2 show the results of the ADF and PP tests for the variables, both in levels and first differences (to detect potential double unit roots). From this output we conclude: i) *10Y_sb* is stationary in levels; ii) *Log ECB Assets*, *Eurib_12*, *Eurib_3*, *Spread*, *Log C5*, *Log HH* are $I(1)$, so we take their first differences; iii) *Log GDP* could be $I(1)$ or $I(2)$; and iv) *ROAA* and *ROAE* could be $I(0)$ or $I(1)$.

To properly address whether *Log GDP* is $I(1)$ or $I(2)$, in Table A3 we run Dickey & Pantula test (Dickey & Pantula, 1987). The double unit root hypothesis is rejected, so *Log GDP* is assumed to be stationary in first differences. As for whether *ROAA* and *ROAE* are $I(0)$ or $I(1)$, Zivot & Andrews (1992) propose a test that analyses the stationarity by endogenously determining a possible point of structural break in the series. Since *ROAA* and *ROAE* appear to have a structural break in its time evolution (see Figure 1), in Table A4 we present the Zivot & Andrews (1992) tests for these variables. The results indicate that *ROAA* and *ROAE* can be considered as stationary processes

¹¹ These authors derive the auxiliary regressions and the corresponding critical values for each statistic. A t-test statistic is used for unit roots in the zero and π frequencies. The null hypothesis of a unit root in the complex-conjugate frequencies employs a F-type statistic.

¹² Non-stationary process with a stochastic trend which requires to be d times differentiated as to support a stationary and invertible ARMA representation.

¹³ The election of the number of lags is conducted by the AIC criterion so that the optimal k satisfies that $AIC_k < AIC_{k-1}$ (Dickey and Pantula 1987).

¹⁴ The main difference with ADF is the assumption regarding the distribution of the error term in the auxiliary regression. PP assumes the same basic specification of the ADF test but considers that the error term is not a random noise – it can be serially correlated –but a stationary ARMA process.

if the structural break from the first quarter 2012 onwards is controlled for in the regression. **Table A1.** HEGY tests for seasonal integrability.

H ₀ : SI (1,1)	$\pi_1=0$ (zero frequency)	$\pi_2=0$ (π frequency)	$\pi_3=\pi_4=0$ ($\pi/2$ frequency)	Integrability conclusion
ROAA	-3.23	-4.59***	60.27***	Possibly I(1)
ROAE	-2.97	-4.50***	57.85***	Possibly I(1)
Log Loans	-0.46	-1.09	12.39***	I(1) with frequency each two quarters
Log ECB Assets	-0.37	-3.97***	20.16***	Possibly I(1)
Eurib_12	-2.92**	-5.26***	39.29***	I(0) or I(1)
Eurib_3	-4.06***	-2.92***	18.09***	I(0) or I(1)
10Y_sb	-2.45	-3.53***	35.56***	Possibly I(1)
Spread	-2.15	-5.08**	43.75***	Possibly I(1)
Log GDP	-2.03	-4.64***	28.89***	Possibly I(1)
Log C5	-1.35	-5.33**	36.50***	Possibly I(1)
Log HH	-1.65	-5.00***	37.22***	Possibly I(1)

Note: (*), (**) and (***) indicate significance at 10%, 5% and 1% level respectively.

Table A2. ADF and Phillips-Perron tests for unit roots.

Variable	ADF Test		PP Test		Decision
	Levels	First-differences	Levels	First-differences	
ROAA	-3.40**	-7.14***	-2.67	-7.34***	I(0) or I(1)
ROAE	-3.26*	-7.00***	-2.59	-7.19***	I(0) or I(1)
Log ECB Assets	-0.72	-13.96***	-1.14	-14.45***	I(1)
Eurib_12	-2.57	-8.47***	-2.83	-8.71***	I(1)
Eurib_3	-2.44	-8.86***	-3.09	-9.05***	I(1)
10Y_sb	-2.97**	-9.74***	-2.99**	-9.78***	I(0)
Spread	-1.99	-7.80***	-2.19	-8.12***	I(1)
Log GDP	-2.10	-1.51	-1.08	-2.52	I(1) or I(2)
Log C5	-0.74	-8.73***	-1.39	-9.00***	I(1)
Log HH	-1.38	-3.49**	-1.76	-10.17***	I(1)

Note: (*), (**) and (***) indicate significance at 10%, 5% and 1% level respectively.

Table A3. Dickey and Pantula (1987) test for the existence of a double unit root.

Variable	H ₀ :	t-statistic	Conclusion
Log GDP	I(2)	-1.97**	I(1)

Note: (*), (**) and (***) indicate significance at 10%, 5% and 1% level respectively.

Table A4. Zivot & Andrews' test for unit root with structural break.

Variable	t-statistic	Structural break	Conclusion
ROAA	-5.84***	2011:4	I(0) with structural break from 2011:4
ROAE	-6.35***	2011:4	I(0) with structural break from 2011:4
Log GDP	-5.21**	2008:2	I(1) with structural break from 2008:2

Note: (*), (**) and (***) indicate significance at 10%, 5% and 1% level respectively.

APPENDIX II. Model extensions.

Table A5. Coefficient estimates for model extensions.

	(1)		(2)	
	Coefficient	SE	Coefficient	SE
Δ_2 Log Loans	7.812***	2.931	7.264**	2.880
Δ Eurib_12	-0.507**	0.195	-0.437**	0.172
Δ Eurib_12 x Euribor. positive	0.375**	0.186		
Δ Eurib_12 x Euribor. abovemean			0.447**	0.195
Δ 10Y_sb	0.182**	0.072	0.160**	0.072
Δ Log GDP	70.624***	22.676	67.294***	22.346
Δ Log C5	0.119	1.023	-0.030	1.053
Δ Log C5 x D2012	-22.881	4.823	-22.558***	5.248
D2010	-0.809***	0.217	-0.694***	0.209
D2012	-1.501***	0.399	-1.381***	0.407
Q1	0.075	0.098	0.103	0.099
Q2	0.198	0.122	0.211*	0.123
Q3	0.097	0.098	0.158	0.106
Trend	0.021**	0.007	0.018**	0.007
Constant	-0.909	0.568	-0.725	0.557
R^2	0.763		0.709	
AIC	134.20		151.34	

Note: (*), (**) and (***) indicate significance at 10%, 5% and 1% level respectively.