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MASTER

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MASTER´S FINAL WORK

DISSERTATION

NON-PERFORMING LOANS – THE PORTUGUESE CASE

HUGO MIGUEL PEDREIRA MIXÃO

NOVEMBER 2020

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SUPERVISION:
PEDRO RINO VIEIRA

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RESUMO

O objetivo deste trabalho final de mestrado é identificar e analisar quais as variáveis que têm maior impacto na evolução de Empréstimos não produtivos em Portugal (Non-Performing Loans). O período de análise será entre 2009 e 2019, tendo início após a crise de "subprime" de 2008. Neste âmbito, foram identificadas variáveis macroeconómicas, para capturar o impacto do estado do país, e também microeconómicas, específicas do setor bancário em Portugal.

Os resultados obtidos demonstram que há evidências de uma correlação entre as variáveis selecionadas e a evolução de NPL's em Portugal, no entanto, o impacto destas variáveis está dependente da estabilidade económica do país em análise. Tendo em conta o facto que a definição de NPL's como é atualmente conhecida ter sido apenas definida pela Autoridade Bancária Europeia em 2015 foi realizada uma análise para dois períodos distintos, o primeiro após crise financeira, de 2009 a 2015, e o segundo período entre 2015 e 2019.

Os resultados obtidos sugerem que as variáveis específicas do setor bancário, refletem a estabilidade e aversão ao risco do sistema bancário e/ou dos bancos de forma individual (se analisados singularmente), enquanto as variáveis macroeconómicas a estabilidade económica do país.

Classificação JEL: G20, G21, G28

Palavras-Chave: Empréstimos não-produtivos, determinantes macroeconómicos/microeconómicos, sistema bancário português.

ABSTRACT, KEYWORDS AND JEL CODES

The objective of this final master's work is to identify and analyze which variables have the greatest impact on the evolution of non-performing loans in Portugal. The analysis period will be between 2009 and 2019, starting after the 2008 subprime crisis. In this context, macroeconomic variables were identified to capture the impact of the country's state, as well as microeconomic, specific to the banking sector in Portugal.

The results obtained demonstrate that there is evidence of a correlation between the selected variables and the evolution of NPL's in Portugal, however, the impact of these variables is dependent on the economic stability of the country under analysis. Since the definition of NPL's as it is currently known was only defined by the European Banking Authority in 2015, an analysis was carried out for two different periods, the first after the financial crisis, from 2009 to 2015, and the second period between 2015 and 2019.

The results obtained suggest that the specific variables of the banking sector, reflect the stability and risk aversion of the banking system and / or banks individually (if analyzed singularly), while the macroeconomic variables the economic stability of the country.

JEL Classification: G20, G21, G28

Keywords: Non-performing loans, macroeconomic/microeconomic determinants, Portuguese banking system.

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1. INTRODUCTION

Non-performing loans has been an object of study in the last few years by many researchers, due to its impact in the economy, as they are highly correlated with banks performance and possible failure.

This is a particular important issue on periods of financial crisis, where companies and individuals struggle to fulfill their debt service, consequently impacting the banking sector and their level of impairment. In a period where banks find themselves highly leveraged, a rising level of NPL's can reduce banks profitability and liquidity, constraining the flow of money in the economy, given the reduction on its ability to lend money. A few examples for this situation in Portugal, were the bankruptcy of Banco Espírito Santo in 2016 (nowadays known as Novo Banco) and Banco Banif in 2018, in which "toxic assets" generated a high level of impairment, given the exponential rise in defaults.

This study has the objective to analyze the evolution of non-performing loans in Portugal in the last decade, and to identify its major macro and microeconomic determinants. The starting point for this thesis will be the framework developed in other studies regarding the non-performing loans evolution in eurozone countries, so it is possible to identify similar determinants factors in economies such as the Portuguese.

The development of the non-performing loans ratio in Portugal between 2009 and 2019 will be the target period of analyzes, after the 2008 financial crisis, on an aggregate bank level, through data obtained at Banco de Portugal databases and reports. It will be used a statistical regression, to relate the chosen independent variables, with the NPL's ratio.

This study aims to identify the key factors that affect the level of loan default, without looking individually to each Portuguese bank's specific indicators, such as investment strategies, level of leverage, liquidity ratios and other indicators. Through the analysis of the Portuguese banking system in this period, it is possible to conclude that the NPL's determinants vary on the financial stability of the period of analysis. In a time of financial distress, the level of default tends to be higher on banks with a lower profitability (ROA) and the short-term interest rate have a higher impact than long term interest rates given working capital necessities and companies liquidity.

In periods of financial stability, the ratio of NPL's tend to show a negative correlation with GDP growth since this variable is linked to a rise in incomes and economic growth. On the contrary loans to deposit ratio shows a positive correlation with NPL's, by measuring the bank's liquidity, evidence shows that the more leverage the banking system is the higher the NPL ratio will be.

The thesis starts with a general overview on the subject and the Portuguese NPL's stock development, followed by a literature review on the matter. On section 3, it will be presented the data and methodology used and in section 4 the interpretation of the results obtained. Lastly, section 5 concludes with the main findings as well as limitations and some avenues for future research.

2. LITERATURE REVIEW

2.1. Non-performing loans overview

The international financial crisis in the last decades have made an impact on the banking system worldwide, therefore the amount of non-performing loans on bank's balance sheets have been increasing over the last years, even though banks have been intensively active in attempts to reduce it. Marques, Martinho and Silva (2020), characterized the Portuguese non-performing loans portfolios held by banks to be mostly composed by corporate loans, but in recent years there has also been an increase in private household credit's default, given the 2008 subprime crisis and the deterioration of borrower's ability to pay off these loans.

The high ratios of NPL's in bank's balance sheets have a severe impact on the financial system, possibly restraining the future allocation and transmission process of resources to "in need" corporations, (e.g. Caballero et al. 2008), especially in a time of financial distress and liquidity restraints. Usually a high level of NPL's is a signal of inappropriate credit, Azevedo, N., Mateus, M. and Pina, A. (2018), which in the case of a financial crisis, distressed companies are even more likely to recur to loans in order to stay in business, although soaring difficulties could make the company unable to serve the debt contracted, and consequently defaulting.

Particularly during a financial crisis banks have a difficult task to be able to differentiate "bad" from "good" companies, in the sense that a lot of companies are already in a highly levered position and experience difficulties, to serve the existing debt.

This underperforming firms will most likely apply for new loans, which banks are likely to concede in order to prevent the default of the company. This action will allow underperforming companies to extend their activity and possibly have an impact on the cost of capital for "good" companies, which will most likely face a premium (higher) spread.

Accornero, Carpinelli and Sorrentino (2017), concluded that the 2008 crisis have created a problem which they identified as "legacy assets", in this situation the decrease in the quality of the assets (loans) discourages bank lending, strangling the market and therefore increasing the difficulty for recovery. Through the analysis of data between non-performing loans and the supply of credit in Italy between 2008 and 2015, they concluded that the correlation between these is mostly motivated by the demand, even though exogenous shocks can also impact the credit supply. Consequently, adopting a policy to liquidate NPL's could have an adverse effect on the economy, depending on the level of losses these could reduce the banks' capital ratios, and consequently reduce the credit supply.

The increase of these assets has forced financial institutions to adopt policies with the intent of decreasing its weight on the banks portfolio, Balgova, M., Nies, M. and Plekhanov (2016) have evaluated the economic impact of reducing nonperforming loans. Given the results observed, the most effective measures used by countries to reduce de NPL's are a combination of public and market funds, through bailouts and asset management companies. Studies indicate that this combination is more likely to reduce 2 to 3 times the NPL's stock level rather than an individual approach by asset management companies or bailouts.

Chiesa and Mansilla-Fernandez (2018) have studied the effects of NPL's on cost of capital, lending and supply for the euro zone banks between 2002 and 2016. This period allows to study two different timeframes: i) 2002-2007, before the 2008 financial crisis, where banks' lending activity were at a high level of risk; ii) and 2008-2016, during the sovereign debt crisis and its aftermath. The data analyzed suggests that banks with higher levels of NPL's are viewed from an investor standpoint as riskier, therefore they demand a higher return on its investment, representing a higher cost of capital than its peers with

a lower level of NPL's. This results in a limited access to equity and therefore reduces their lending and liquidity.

Cucinelli D. (2015), studied the relationship between NPL's and Italian banks' lending behavior between 2007 and 2013. The research had two basis hypotheses, 1) if an increase in credit risk in the previous period leads to a decrease in credit supply in the following period and 2) if the behavior observed is different between "commercial banks and cooperative banks. This study concluded that credit risk of past years has had an impact on banks behavior, although findings suggest that there is no distinguishable behavior between commercial and cooperative banks during a financial crisis, with both type of banks reducing their lending given the higher credit risk environment.

Fell, Grodzicki, Metzler, and O'Brien (2018), evaluated the relationship between NPL bank's assets quality and its lending activity in the euro zone for the period of 2014-2018. They claim that in a post financial crisis environment, where there is an increasing demand for loans, and even if banks are not facing liquidity constraints, the presence of high NPL's stock may affect the banks' lending activity. They concluded that banks with a high NPL ratio should look to reduce its stock through capitalization and funding to restore loan growth, but these actions may be insufficient and therefore appropriate regulation is needed.

Over the last decades, high levels of non-performing loans have been directly related to macroeconomic shocks, Espinoza and Prasad (2010), studying the determinants of NPL in Gulf Cooperative Council (GCC), support the conclusion that macro-economic shocks and bank's characteristics are determinants for the level of NPL's. Evidence suggests that there is a strong relationship between global financial markets conditions and its effects on NPL, therefore restraining banks activity and limiting credit growth through periods of financial distress.

The moral hazard hypothesis has presented by Berger and DeYoung (1997), suggests that banks with low capital respond to moral hazard incentives by increasing the risk of their loans' portfolio, consequently this riskier approach tens to result in a higher stock of NPL's. This relationship is also suggested by Salas and Saurina (2002), in their study of problematic loans in Spanish commercial and savings' banks between 1985-1997, where they suggest a negative correlation between capital ratio and NPL's. This

represents a riskier behavior through excessive lending, eventually resulting in higher losses.

The moral hazard is directly related with the "too big to fail" problem in the economy, where these banks are more likely to be bailed out by governments and therefore are encouraged to have a riskier behavior. Giannoccolo and Mansilla-Fernandez (2017) suggested that bailed-out banks might be perceived has riskier institutions by investors, which could have a negative impact on the lending activity. Also, this perception of riskier banks by customers and investors could also have an effect on banks deposits, given the banks risk of default, customers are more likely to reduce deposits and to demand a higher interest (Berger et al., 2013), increasing even more the banks financial constraints and exposure to NPL's increasing the risk of default..

Giannoccolo and Mansilla-Fernandez (2017) analyzed the bailout effectiveness in Spain between 2010-2014. Data suggests that bailouts with proper integration policies, improved the stability of the Spanish banking sector. As part of the integration policies, stronger banks absorbed the unhealthy ones, increasing banks concentration.

The big challenge to the banking industry is the lack of regulation regarding non-performing loans, and how to properly address it, to deleverage banks' exposure. But NPL's have also a strong relationship with macroeconomic determinants that have a direct relationship with the risk of default, such as GDP, unemployment, exchange rates, interest rates and inflation.

Salas and Saurina (2002), also studied the GDP impact on debt growth, claiming evidence that in periods of GDP growth, loanees tend to have higher incomes and are able to meet their debt responsibilities. On other hand, a GDP decrease usually results in harsher economic conditions and in an unemployment rate increase, consequently, borrowers will face tighter constraints and decreasing ability to pay off their debt.

Findings suggest that the relationship between high NPL stock levels with macroeconomic determinants tend to increase with positive variations in macroeconomic, Klein (2013), factors such as unemployment, inflation or an exchange rate depreciation. Klein also found evidence that higher profits in the previous periods tend to lead to lower level of NPL while excessive risks would result in higher stock of NPL's.

These findings are consistent with Makri, Tsagkanos and Bellas (2014) eurozone banking system study between 2000-2008, where evidence showed a strong correlation between NPL's and macro-economic factors, specifically unemployment, GDP and public debt.

Interest rates' influence over NPL's have also been a matter of study, according to Rinaldi, Laura and Sanchis-Arellano (2006) an increase in the interest rate will also determine an increase on NPL's. This effect on the short run may be influenced by inflation, but in the long run inflation tend to stabilize and the effects on the cost of borrowing are reflected by the real interest rate.

Bahruddin, Atirah, and Masih (2018), also studied the relationship between lending interest rate and non-performing loans, this factor has a substantial and positive effect on NPL's ratio, but this is a factor that could be controlled by local regulatory authorities, unlike determinants such as inflation or exchange rates. They concluded that banks through a decrease in the interest rate could improve the quality of credit allocation and reduce the NPL's ratio. Their findings also suggest that this relationship is asymmetric in the short-term, and symmetric in the long run, this conclusion is supported by evidence after the subprime mortgage crisis, in which the level of loans default was extremely high, regardless the banks interest rates.

Table 1 is a summary of the most relevant macroeconomic and bank specific determinants, based on the reviewed literature, for the evolution of nonperforming loans:

TABLE 1 – EXPLANATORY VARIABLES

Explanatory Variable	Expected Relationship	Authors	Year
Interest Rate	Positive (+)	Bahruddin, Atirah, & Masih	2018
Fiscal	Negative (-)	Balgova, Plekhanov & Skrzypinska	2017
CAP	Positive (+) / Negative (-)	Balgova, Plekhanov & Skrzypinska	2017
ROA	Negative (-)	Makri, Tsagkanos & Bellas	2014
ROE	Negative (-)	Makri, Tsagkanos & Bellas	2014
Debt	Positive (+)	Makri, Tsagkanos & Bellas	2014
Inflation	Positive (+) / Negative (-)	Nkusu	2011
Unemployment	Positive (+)	Louzis, Vouldis & Metaxas	2010
GDP	Negative (-)	Espinoza & Prasad	2010
LTD	Positive (+)	Louzis, Vouldis & Metaxas	2010

2.2 Portugal NPL's overview

Portugal was severely hit by the 2008 financial crisis, being one of the countries with the highest NPL stock in Europe, in 2011 was submitted a requested for a bail-out of €78b from the European Union, the European Central Bank and the International Monetary Fund. Since then Portugal have been aiming to deleverage its NPL stock, according to Banco de Portugal "Financial Stability Reports", by June 2017 the Portuguese NPL stock reached €32.5b a significant decrease from the previous year, where it registered €50.5b. This evolution was mostly due to NPL's sales and write-offs, such as the sale of Novo Banco to Lone Star.

The coverage of non-performing loans is more significant in the construction, real estate and manufacturing sectors, mostly in small and medium size companies, which could possibly show a correlation between a company productivity and its outstanding loans.

Azevedo, N., Mateus, M. and Pina, A. (2018), assessed the relationship between banking system credit allocation and firms' productivity, specifically the allocation of

credit to different levels of productivity. They concluded that between 2008 and 2013 there was an increase of loans attributed to "unproductive firms". This problem of credit misallocation, particularly in construction and real estate sectors, increased the difficulty to reallocate bank loans to more productive and less riskier firms. These factors contributed to an adoption of a different approach by Portuguese SME's, by favoring equity and intercompany loans (group loans) rather than contracting new bank debt.

Marques, Martinho and Silva (2020), studied the impact on NPL´s on the credit supply in the Portuguese economy between 2009 and 2018, specifically the relationship between non-financial companies with no overdue loans, using data from the Portuguese Central Credit Register. They concluded that there was no strong evidence that NPL ratios, on a standalone perspective, have had any impacts on banks restrictions for lending activity to corporations. Evidence suggest that this is true for periods of financial crisis, such as 2009-2015, as well as in a post crisis scenario (2015-2018), regardless of companies' size.

3. DATA AND METHODOLOGY

3. 1 Data

The main objective of this study is to understand the variables that impact Portuguese bank's NPL's stock levels. The literature review supports that NPL's are mostly affected by two types of determinants, microeconomic variables (bank specific indicators) and by macroeconomic variables. Therefore, I will collect aggregated data from the Portuguese banking system regarding the sector performance and the level of non-performing loans in the country. The definition of "NPL's" has only been used since late 2015 according to the European Banking Authority (EBA), before, Banco de Portugal used the definition of "credit at risk" which was a close approach from the EBA definition. Since this data is only available from 2008 onwards, the period of analysis will be 2008-2019, on a quarterly and aggregated basis. Moreover, given that the two definitions are not directly comparable to the previous definition of "credit at risk", the data will be split into two different periods. The first period being from the fourth quarter of 2009 until the third quarter of 2015, considering "credit at risk" as the dependent variable, and from the fourth quarter of 2015 until the end of 2019, the dependent variable will be the ratio of non-performing loans, providing a total of 41 observations (quarters).

The data used was extracted from the International Monetary Fund (IMF), the World Bank, Eurostat, Banco de Portugal and OECD.

3. 2 Model

As mentioned before, the objective of this thesis is to study the impact of macroeconomic and microeconomic variables on the ratio of non-performing loans in Portugal. Some similar studies, performed previously, such as Makri, Tsagkanos, Bellas (2014) and Tanaskovic, Jandric (2014) were used as a starting point for this research. Both papers performed a dynamic panel regression for NPL's evolution in European countries based on annual data, for a period of 8-9 years, but as mentioned above, due to the fact that the NPL's definition for Portugal data, has only been used since late 2015, it is a short period of time to perform this analysis, therefore this study will use aggregated data from the sector extracted from Banco de Portugal data base. The choice of using aggregated data for the sector versus data for each Portuguese bank since the objective of this study is to characterize and evaluate the Portuguese banking system as a whole and not to assess each bank individual performance. Although, this analysis could provide valuable insight on the individual banks strategies it will not be pursued on this study. Nevertheless, it will be mentioned in chapter 6 as a "Further Research" possibility.

On this thesis, the dependent variable is the NPL's ratio in the Portuguese banking system according to Banco de Portugal (EBA), the independent variables are country specific, split between macroeconomic and bank specific indicators.

The standard form of the model is as follow:

$$(1) \qquad NPLi = a0 + aiXi + aiMi + \varepsilon i,$$

where variables in Equation) are *NPL* representing the non-performing loans to total loans, X are microeconomic variables (banks indicators), *M* stands for macroeconomic variables and i for the period (quarter) of analysis.

Based on the reviewed literature, it was selected a set of variables in order characterize the Portuguese banking system steadiness (microeconomic or bank specific variables) in the period of analysis and macroeconomic variables to capture the country environment and financial stability.

Table 2, shows the initial model selected variables, as well as its expected sign of the impact on non-performing loans ratio, Louzis, Vouldis and Metaxas (2010) found that the loans-to-deposit ratio are expected to have a positive influence on NPL's ratio, since it is a strong indicator of bank's liquidity. This was also supported by Makri, Tsagkanos, Bellas (2014), which in addition concluded that indicators such as return on assets (ROA) and return on equity (ROE) are expected to have a negative influence on NPL's, since the bank's profitability is directed related with its risk taking behavior and moral hazard, highly profitable banks are less likely to engage on higher risk loans, while bank's that are less profitable might pursue riskier business given the higher interest, therefore having on a higher probability of default.

TABLE 2 – VARIABLE SELECTION

Type	Variable	Description	Expected Sign
Bank specific	NPL	Total of nonperforming loans / total loans	(+)
	CAP	Total assets / GDP (nominal)	(+)/(-)
	LTD	Loans to deposits ratio	(+)
	ROA	Return on assets	(-)
	ROE	Return on equity	(-)
Macroeconomic	DEBT	Public debt as % of GDP	(+)
	FISCAL	Public administration debt as % of GDP	(-)
	GDP	Percentage growth rate	(-)
	INFL	Average inflation rate	(+)/(-)
	UNEMP	% of unemployment	(+)
	LTI	Long term interest rate	(+)
	STI	Short term interest rate	(+)

As for macroeconomic determinants, Espinoza and Prasad (2010) found that these have an important role on the NPL's level, since they have a direct impact on the banking system stability, therefore it was considered variables that represent the economic situation in Portugal during the period of analysis. The GDP and unemployment levels are two important variables to the NPL ratio, since periods of growing activity are usually related with high levels of GDP growth and low levels of unemployment, therefore it's expected that these variables should have a negative and a positive relationship with NPL's, respectively. It also added an inflation rate variable, which could have either a positive or negative impact on the level of NPL's, since will impact the borrower

capability to pay off its loan (Nkusu, 2011). This model, also includes two variables that address the health of public finance, public debt as percentage of GDP, which should reflect a positive relationship with the NPL's ratio, and the debt of public administrations in percentage of GDP which should have a negative correlation, Makri, Tsagkanos, Bellas (2014).

Also, the inclusion of two interest rates variables, long term and short term, are expected to have a positive impact on non-performing loans, since an increase in interest rates weakens the ability of the borrower, by increasing its debt service. The decision to include a short term and long term is to capture both the short-term pressure on firms' liquidity and the long-term sustainability of firms' debt level, respectively.

Therefore, the primary specification of the model is:

$$(2) \quad NPLi = \beta 0 + \beta 1 CAPi + \beta 2 LTDi + \beta 3 ROAi + \beta 4 ROEi + \beta 5 DEBTi + \beta 6 FISCALi + \beta 7 GDPi + \beta 8 INFLi + \beta 9 UNEMPi + \beta 10 LTIi + \beta 11 STIi + \varepsilon i.$$

4. RESULTS

4.1. Econometric Models

Model 1 – 2009 4Q - 2015 3Q

The program used for the statistical analysis of the models presented was Stata®16, from which we have the model above for the first period of analysis (2009-2015) as presented in the Appendix as Figure 1. In this regression it is possible to observe a R-squared of 0,9948 which shows the independent variables can predict with a high level of accuracy the variance of the non-performing loans. Also, this model shows a low Root Mean Square Error (of 0,26688), which is a good fit indicator.

Although the model shows promising results as mentioned above, we can observe that the variables CAP, ROA, ROE, GDP, INFL and LTI are not statistically significant at a 95% confidence interval, contrary to the independent variables LTD, DEBT, FISCAL, UNEMP and STI, that show a statistical significance at 95% confidence level, (p-value<0,05).

To address and detect the risk of heteroskedasticity, I have used the Breusch-Pagan test analysis of p-values ($\alpha < 0,05$) , we can conclude that the model shows

heteroskedasticity, which causes ordinary least squares to no longer produce the best estimators and standard errors computed using least squares can be incorrect.

To correct the independent variables heteroskedasticity, it was used the Huber/White/sandwich estimator, the output of this regression is presented in Figure 2, from which it is possible to observe the generated robust standard errors and that now the LTD is no longer statistically significant at 95% confidence level, only remaining the variables DEBT, FISCAL, UNEMP and STI.

The model was also tested for multicollinearity in order to prevent that the regression model estimations of the coefficients become unstable and the standard errors for the coefficients get highly inflated. In Figure 3, we can observe the Variance inflation factor of the independent variables. It is possible to identify that the variables ROE, ROA, LTD, CAP, DEBT, UNEMP, LTI and STI have VIF values higher than 10. The higher VIF values the higher the possibility that the model may have too many variables measuring the same effect, implying that some variables are redundant. For example, variables such as ROA and ROE show the highest VIF value, most likely because the two variables measure the bank's performance. Thus, to avoid collinearity among the variables it is necessary to eliminate variables.

Although Model 1 shows a good fit through R-squared and RMSE observations, it also showed collinearity problems (high VIF mean), I have decided to take a more parsimonious approach by reducing the number of independent variables included in the model. This approach will consider the independent variables which exhibited more promising results. Additionally, since the period of 2009-2015 is characterize as a period of financial distress due to the subprime financial crisis and throughout the sovereign debt crisis, as mentioned previously, I decided to test the impact of both short-term and long term interest on NPL's, consequently generating two possible models for this period:

$$(3)\ NPLi = \beta 0 + \beta 1ROAi + \beta 2FISCALi + \beta 3STIi + \varepsilon i$$

$$(4)\ NPLi = \beta 0 + \beta 1ROAi + \beta 2FISCALi + \beta 3LTIi + \varepsilon i$$

The short-term interest rate has a meaningful impact since companies in financial distress periods are expected to be facing liquidity issues and unable to comply with their debt service are more likely to contract new short-term debt to comply with its financial responsibilities.

The model in equation (3) considering the variable STI, display a higher R-squared than the model in equation (4), (0.7911>0.6711, as shown in Figures 9 and 13 respectively) , as well as a better RMSE (1.308<1.6414), therefore being a better fit than the alternative. It is important to mention that, in both, models all variables are statistically significant at a 95% confidence level (independent variables p-value<0,05) and also have a mean VIF inferior to 10, (Figures 11 and 15), therefore eliminating the collinearity issues observed in the previous model. Since both models show a high prediction accuracy, it was used the Akaike's and Schwarz's Bayesian information criteria, to select the most appropriate model. In Figures 12 and 16, it's possible to observe that the model in equation (3) show AIC of 84.62 and a BIC of 89.33, inferior to the model in equation 4, (AIC equal to 95.52 and BIC equal to 100.23), hence being the best model for the estimation.

Below, in table 3, it is possible to compare, the different coefficients outputs and significance for a 95% c.i. for the beginning and final model regressions for the 2009-2015 period:

TABLE 3 – MODELS 1 & 2 VCE ROBUST FOR 2009-2015

	Model 1		**Model 2**	
	Coefficient	**P>|t|**	**Coefficient**	**P>|t|**
CAP	0,031	0,238	-	-
LTD	(0,085)	0,051	-	-
ROA	1,719	0,355	(1,663) **	0,005
ROE	(0,126)	0,317	-	-
DEBT	0,091**	0,003	-	-
FISCAL	(0,140) **	0,001	(3,099) **	0,001
GDP	(0,070)	0,305	-	-
INFL	(0,110)	0,228	-	-
UNEMP	(0,602) **	0,000	-	-
LTI	0,087	0,287	-	-
STI	(1,693) **	0,001	(0,312) **	0,018

Note: "significant at * 0,1, ** 0,05 and *** 0,01 level"

The model chosen for observation, equation (3) for the 2009-2015 period, has eliminated the variables fitting and collinearity issues observed in the initial model, stated in equation (2).

Model 1 – 2015 4Q - 2019 4Q

In the second period of analysis, the model regression output are presented in the Appendix as Figure 5, it is possible to observe a R-squared of 0.9938 and a Root Mean Square Error of 0.56519, which are good indicators of a good fitting model, but taking a closer look on the independent variables, it's possible to verify that none of the variables have a p-value inferior to 0.05, which means they are not statistically significant at a 95% confidence level. Even applying the Huber/White/sandwich estimator to correct for the model heteroskedasticity, the independent variables remain not statistically significant at a 95% c.i. The model also shows a mean VIF of 109.83, revealing a high collinearity between the variables included, except for FISCAL, STI and INFL which display VIF values inferior to 10.

As mentioned previously, the definition of non-performing loans, have changed according to the EBA, this is used since 2015, with the previous period of analysis using a definition of credit risk. This fact, associated with intentional strategies taken by regulatory authorities to deleverage NPL's levels, have had an impact on the relevance of the variables selected.

For the 2015-2019 period, it was considered the following model:

$$(5)\ NPLi = \beta 0 + \beta 1 LTDi + \beta 2 GDP + \beta 3 LTIi + \varepsilon i$$

Below, in table 4, it is possible to compare, the different coefficients outputs and significance for a 95% c.i. for the beginning and final model regressions for the 20015-2019 period:

TABLE 4 - MODELS 1 & 3 VCE ROBUST FOR 2015-2019

	Model 1		Model 3	
	Coefficient	P>|t|	Coefficient	P>|t|
CAP	0,238	0,198	-	-
LTD	0,388	0,223	0,778**	0,000
ROA	14,171	0,173	-	-
ROE	(1,162)	0,186	-	-
DEBT	0,017	0,941	-	-
FISCAL	(0,180)	0,239	-	-
GDP	0,676	0,504	(0,687) **	0,019
INFL	0,908	0,170	-	-
UNEMP	(0,208)	0,787	-	-
LTI	1,122	0,167	1,474**	0,005
STI	(6,962)	0,104	-	-

Note: "significant at * 0,1, ** 0,05 and *** 0,01 level"

The model in equation (5) analyzed for a total of 17 observations (quarters), displays a high R-squared (0.9674) and a RMSE equal to 0.8011 as seen in Figure 17, good indicators for the regression. Although the independent variable GDP shows to be not statistically significant at 95% c.i., this stands corrected once applied the Huber/White/sandwich estimator to eliminate models heteroskedasticity, with all independent variables LTD, GDP and LTI showing p-values inferior to 0.05, consequently considered statistically significant at 95% c.i..

To address the collinearity issue in this model, it was used VIF observation, through which it´s possible to observe that all independent variables have a VIF inferior to 10, with the model displaying a mean VIF of 4.61.

The model chosen for observation, equation (5) for the 2015-2019 period, through the elimination of variables, has corrected fitting and collinearity issues observed in the initial model, stated in equation (2).

4.2. Empirical Results

In the results obtained for the first period of analysis, 2009-2015, it is possible to observe a negative correlation between non-performing loans and the model's independent variables (see Appendix Figure13). The macroeconomic variable, STI (short interest), shows the highest absolute value, meaning that it's the variable with most impact on the NPL's ratio. This negative correlation can be interpreted as that a decrease in the short-term interest will contribute to a growth on the NPL's ratio. Despite the Central banks approach, the adoption of a lower interest rate policy to reduce uncertainty and avoid an exponential increase in default's, the level of nonperforming loans in this period kept on rising. It's important to keep in mind that this period of observation is posterior to the 2008 financial crisis, and as studied by Bahruddin, Atirah, and Masih (2018), the relation between interest rates and non-performing loans is asymmetric in the short-term, since despite the banks lower interest rates policies, the level of non-performing loans tend to increase in the short-term due to the severe economic conditions in a financial crisis.

Bank specific indicators, that measure a bank performance, such as return on assets (ROA), are expected to have a negative and significant correlation with NPL's, as mentioned in Table 2, since an increase in the bank's profitability should have a negative impact on the non-performing loans stock. The negative coefficient of (1,663), supports this hypothesis, connecting the banks performance to its risk behavior, as higher profitable banks have less interest in pursuing higher risk credits, opposite to low-performance banks, that are more likely to engage on riskier investments/loans, in order to achieve a higher profit.

The independent variable FISCAL, shows a negative correlation between the independent variable FISCAL and NPL's, supporting Balgova, Plekhanov and Skrzypinska (2017) conclusions that countries in a time of financial crisis, independent of its nature (either sovereign or banking) usually adopt a strategy of public bailouts and NPL's deleverage, through the sale of these assets, therefore contributing to NPL reduction. The coefficient for this independent variable is (3,099), therefore being the variable in the model with the most impact on the NPL's ratio.

The 2015 4Q- 2019 4Q, just as the previous period of analysis, this interval also includes an interest rate, in this case a long-term interest rate (LTI independent variable), which displays a positive correlation with the ratio of NPL's (as expected on Table 2) and a coefficient of 1.4738, being the variable observed with the highest impact on non-performing loans ratio. This positive correlation between long term interest rate and NPL's, supports Bahruddin, Atirah, and Masih (2018) conclusion that in the long run a high level interest rates are related with a higher level of default, since higher costs of financing endanger the company's financial stability.

GDP is the only independent variable that shows a negative correlation with the NPL's ratio (as expected on Table 2) in this period of analysis, supporting Espinoza and Prasad (2010) conclusion, that a high GDP growth is a strong indicator of economic growth and may offer further data about the effect of macroeconomic conditions on household and firms, thus having a reduction impact on the nonperforming loans stock.

Lastly, the bank specific indicator selected for this period was the loans to deposit ratio (LTD variable), which displayed a positive correlation with the dependent variable, also as expected on Table 2. With a coefficient of 0,778, it supports the theory that highly leveraged banks tend to have a higher non-performing loans ratio, which could be interpreted as an indication of the banks risk attitude. Banks with a higher LTD are more leveraged and tend to look for higher profits arising the risk of moral hazard.

5. CONCLUSIONS

This thesis started off with a large and comprehensive econometric model which included both macroeconomic and microeconomic (bank specific) variables, that were identified and largely supported by the reviewed literature as determinants on non-performing loans. After an initial regression and analysis of the model's accuracy and independent variables significance, the model was restricted to a smaller number of variables in order to avoid variables that measured the same effects on non-performing loans, splitting into two timeframes of analysis with different variables.

The first period being from the fourth quarter of 2009 until the third quarter of 2015, and the second period from the fourth quarter of 2015 until the fourth quarter of 2019. The reason behind the selection of different variables for the two periods, is that the results obtained supports the theory that the level of NPL's is mostly impacted by the economic environment in the period of analysis.

The first period analyzed, is immediately afterwards the 2008 financial crisis, it's possible to conclude that variables ROA, FISCAL is both negatively correlated with the NPL's ratio, as expected. On the contrary STI has a signal opposite to expectation, which can be explained by the financial crisis environment, we can conclude from this that the level of non-performing loans will rise during a financial crisis independent of the interest rates movement.

The second period analyzed, is more financially stable, which allows to take a more in-depth conclusion of the non-performing loans evolution supported by the reviewed literature. As expected, GDP shows a negative correlation with NPL while variables such as LTD and LTI displays a positive correlation.

The findings for non-performing loans in the Portuguese banking system mostly coincides with the literature, regarding the relevant variables that influence its evolution, largely impacted by interest rates and bank specific variables, that could allow to interpret the bank's risk aversion.

6. LIMITATIONS AND FURTHER RESEARCH

This thesis has a limitation given the evolving definition of non-performing loans, this, does not allow to have comparable values Portugal NPL's for the period of analysis. Also the increasing pressure from regulatory authorities to deleverage the NPL's ratio in Portugal has an impact in our analysis, specifically since 2016, when the NPL ratio reached €50.5bn[1] and then started to sharply decrease mainly through write-offs and NPL's transactions, where the banks sold these assets, to other interested parties with a haircut value. These factors influence the analysis performed since the reduction in NPL's ratio is not done through the decreasing number of default loans, but through eliminating these from the banks' balance sheet.

The data used for bank specific indicators was aggregated representing the Portuguese banking system in order to assess the impacts as whole, nonetheless, the study of each Portuguese bank individual performance, could provide insight on the impact of bank specific determinants on the NPL's stock level, based on bank's strategies and risk behavior.

This is a topic of high interest and discussion nowadays, particularly with the impact of COVID-19, where most companies are facing operational problems and consequently liquidity issues. These issues have been mitigated through government incentives such as the simplified layoff of employees and the application of moratoriums to outstanding loans (suspending capital reimbursements and interest payments). As a topic of further investigation, work could be performed on the impacts of COVID-19 on the NPL's stock and ratio, but also on the results from the measures taken to avoid these, specifically to assess the success of these actions in avoiding companies or individuals (for example house mortgages) from default.

1 "Financial Stability Report" Banco de Portugal

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8. APPENDIX

Figure 1 - Model 1 2009-2015 Regression results

Source	SS	df	MS	Number of obs	=	24
				F(11, 12)	=	208.01
Model	162.964907	11	14.8149916	Prob > F	=	0.0000
Residual	.8546759	12	.071222992	R-squared	=	0.9948
				Adj R-squared	=	0.9900
Total	163.819583	23	7.12259058	Root MSE	=	.26688

NPL	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CAP	.0308387	.0248234	1.24	0.238	-.0232468	.0849242
LTD	-.0845887	.0347612	-2.43	0.032	-.1603268	-.0088506
ROA	1.719484	1.429297	1.20	0.252	-1.394687	4.833655
ROE	-.12639	.0955495	-1.32	0.211	-.3345744	.0817944
DEBT	.0908495	.0235695	3.85	0.002	.039496	.1422031
FISCAL	-.1402853	.048197	-2.91	0.013	-.2452974	-.0352731
GDP	-.0703643	.0488306	-1.44	0.175	-.176757	.0360284
INFL	-.1097767	.09238	-1.19	0.258	-.3110555	.0915022
UNEMP	-.6021416	.1629302	-3.70	0.003	-.957136	-.2471472
LTI	.0873086	.0659685	1.32	0.210	-.0564243	.2310416
STI	-1.693154	.3922927	-4.32	0.001	-2.547886	-.8384213
_cons	9.743349	3.919747	2.49	0.029	1.202954	18.28374

Figure 2 - Model 1 2009-2015 Regression results VCE (robust)

Linear regression

Number of obs	= 24
F(11, 12)	= 454.51
Prob > F	= 0.0000
R-squared	= 0.9948
Root MSE	= .26688

NPL	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
CAP	.0308387	.0248498	1.24	0.238	-.0233043	.0849818
LTD	-.0845887	.0389732	-2.17	0.051	-.169504	.0003267
ROA	1.719484	1.785647	0.96	0.355	-2.171106	5.610074
ROE	-.12639	.1211263	-1.04	0.317	-.3903016	.1375216
DEBT	.0908495	.024237	3.75	0.003	.0380415	.1436575
FISCAL	-.1402853	.0336816	-4.17	0.001	-.2136712	-.0668993
GDP	-.0703643	.0656111	-1.07	0.305	-.2133186	.07259
INFL	-.1097767	.0865055	-1.27	0.228	-.2982559	.0787025
UNEMP	-.6021416	.1068641	-5.63	0.000	-.8349784	-.3693048
LTI	.0873086	.0782937	1.12	0.287	-.0832786	.2578959
STI	-1.693154	.3882521	-4.36	0.001	-2.539082	-.8472249
_cons	9.743349	3.518862	2.77	0.017	2.076406	17.41029

Figure 3 - Model 1 2009-2015 Variance inflation factor (VIF)

Variable	VIF	1/VIF
ROE	223.23	0.004480
ROA	216.80	0.004613
LTD	153.22	0.006527
CAP	89.58	0.011164
DEBT	46.12	0.021683
UNEMP	38.95	0.025672
LTI	15.20	0.065810
STI	12.17	0.082155
INFL	6.11	0.163797
FISCAL	4.56	0.219475
GDP	4.20	0.237877
Mean VIF	73.65	

Figure 4 - Model 1 2009-2015 Akaike's and Schwarz's Bayesian information criteria

Akaike's information criterion and Bayesian information criterion

Model	N	ll(null)	ll(model)	df	AIC	BIC
.	24	-57.10307	5.966517	12	12.06697	26.20361

Note: BIC uses N = number of observations. See [R] BIC note.

Figure 5 - Model 1 2015-2019 Regression results

Source	SS	df	MS	Number of obs	=	17
				F(11, 5)	=	72.46
Model	254.604002	11	23.1458183	Prob > F	=	0.0001
Residual	1.5971748	5	.319434959	R-squared	=	0.9938
				Adj R-squared	=	0.9801
Total	256.201176	16	16.0125735	Root MSE	=	.56519

NPL	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
CAP	.2379538	.1693787	1.40	0.219	-.197448	.6733556
LTD	.3878162	.250033	1.55	0.182	-.254914	1.030546
ROA	14.17064	8.404932	1.69	0.153	-7.434921	35.77621
ROE	-1.161811	.7369693	-1.58	0.176	-3.05625	.7326292
DEBT	.0168646	.2727868	0.06	0.953	-.6843562	.7180855
FISCAL	-.1804583	.1616059	-1.12	0.315	-.5958795	.2349628
GDP	.6764032	1.112939	0.61	0.570	-2.184497	3.537303
INFL	.9078804	.5440631	1.67	0.156	-.4906785	2.306439
UNEMP	-.2079945	.6120311	-0.34	0.748	-1.781271	1.365282
LTI	1.122499	.7244576	1.55	0.182	-.7397783	2.984777
STI	-6.962293	6.014893	-1.16	0.299	-22.42407	8.499483
_cons	-77.71652	20.31011	-3.83	0.012	-129.9253	-25.50772

Figure 6 - Model 1 2015-2019 Regression results VCE (robust)

Linear regression

Number of obs	=	17	
F(11, 5)	=	405.11	
Prob > F	=	0.0000	
R-squared	=	0.9938	
Root MSE	=	.56519	

NPL	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
CAP	.2379538	.1603441	1.48	0.198	-.1742239	.6501314
LTD	.3878162	.2789147	1.39	0.223	-.329157	1.104789
ROA	14.17064	8.923557	1.59	0.173	-8.768089	37.10938
ROE	-1.161811	.7577793	-1.53	0.186	-3.109744	.7861232
DEBT	.0168646	.2152321	0.08	0.941	-.536407	.5701363
FISCAL	-.1804583	.1350743	-1.34	0.239	-.5276779	.1667613
GDP	.6764032	.9407916	0.72	0.504	-1.741979	3.094785
INFL	.9078804	.5668297	1.60	0.170	-.5492017	2.364962
UNEMP	-.2079945	.7312131	-0.28	0.787	-2.087638	1.671649
LTI	1.122499	.6937707	1.62	0.167	-.660895	2.905894
STI	-6.962293	3.513974	-1.98	0.104	-15.99525	2.070664
_cons	-77.71652	23.65349	-3.29	0.022	-138.5198	-16.91329

Figure 7 - Model 1 2015-2019 Variance inflation factor (VIF)

Variable	VIF	1/VIF
ROA	340.05	0.002941
ROE	299.20	0.003342
CAP	255.56	0.003913
DEBT	110.79	0.009026
UNEMP	84.09	0.011892
GDP	32.92	0.030378
LTD	32.57	0.030708
LTI	30.93	0.032332
FISCAL	9.12	0.109613
STI	7.86	0.127202
INFL	5.04	0.198555
Mean VIF	109.83	

Figure 8 - Model 1 2015-2019 Akaike's and Schwarz's Bayesian information criteria

Akaike's information criterion and Bayesian information criterion

Model	N	ll(null)	ll(model)	df	AIC	BIC
.	17	-47.18033	-4.01965	12	32.0393	42.03786

Figure 9 – Model 2 2009-2015 Regression results

Source	SS	df	MS		
Model	129.60027	3	43.2000901	Number of obs	= 24
Residual	34.2193131	20	1.71096566	F(3, 20)	= 25.25
				Prob > F	= 0.0000
Total	163.819583	23	7.12259058	R-squared	= 0.7911
				Adj R-squared	= 0.7598
				Root MSE	= 1.308

NPL	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ROA	-1.663279	.5312553	-3.13	0.005	-2.771458	-.5551002
STI	-3.099471	.635646	-4.88	0.000	-4.425405	-1.773536
FISCAL	-.3124894	.1158483	-2.70	0.014	-.5541448	-.0708341
_cons	12.28119	.6688348	18.36	0.000	10.88602	13.67635

Figure 10 - Model 2 2009-2015 Regression results VCE (robust)

Linear regression

Number of obs	=	24
F(3, 20)	=	31.48
Prob > F	=	0.0000
R-squared	=	0.7911
Root MSE	=	1.308

NPL	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ROA	-1.663279	.5209186	-3.19	0.005	-2.749897	-.5766622
STI	-3.099471	.8090576	-3.83	0.001	-4.787135	-1.411806
FISCAL	-.3124894	.1215118	-2.57	0.018	-.5659585	-.0590203
_cons	12.28119	.7759069	15.83	0.000	10.66267	13.8997

Figure 11 - Model 2 2009-2015 Variance inflation factor (VIF)

Variable	VIF	1/VIF
STI	1.33	0.751701
ROA	1.25	0.802063
FISCAL	1.10	0.912571
Mean VIF	1.22	

Figure 12 - Model 2 2009-2015 Akaike's and Schwarz's Bayesian information criteria

Akaike's information criterion and Bayesian information criterion

Model	N	ll(null)	ll(model)	df	AIC	BIC
.	24	-57.10307	-38.31136	4	84.62272	89.33494

Figure 13 - Model 2 2009-2015 (LTI) Regression results

Source	SS	df	MS		
Model	109.933173	3	36.644391	Prob > F	0.0000
Residual	53.8864105	20	2.69432052	R-squared	0.6711
Total	163.819583	23	7.12259058	Root MSE	1.6414

	Number of obs =	24
	F(3, 20) =	13.60
	Prob > F =	0.0000
	R-squared =	0.6711
	Adj R-squared =	0.6217
	Root MSE =	1.6414

NPL	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ROA	-2.474459	.6095688	-4.06	0.001	-3.745997	-1.20292
LTI	-.3003274	.1075405	-2.79	0.011	-.524653	-.0760019
FISCAL	-.5387692	.1406145	-3.83	0.001	-.8320859	-.2454526
_cons	13.58271	1.146729	11.84	0.000	11.19068	15.97474

Figure 14 - Model 2 2009-2015 (LTI) Regression results VCE (robust)

Linear regression

Number of obs	= 24
F(3, 20)	= 26.38
Prob > F	= 0.0000
R-squared	= 0.6711
Root MSE	= 1.6414

NPL	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ROA	-2.474459	.6403405	-3.86	0.001	-3.810185	-1.138732
LTI	-.3003274	.1114142	-2.70	0.014	-.5327333	-.0679215
FISCAL	-.5387692	.165423	-3.26	0.004	-.8838355	-.193703
_cons	13.58271	1.60198	8.48	0.000	10.24104	16.92438

Figure 15 - Model 2 2009-2015 (LTI) Variance inflation factor (VIF)

estat vif

Variable	VIF	1/VIF
LTI	1.07	0.936802
ROA	1.04	0.959351
FISCAL	1.03	0.975426
Mean VIF	1.05	

Figure 16 - Model 2 2009-2015 (LTI) Akaike's and Schwarz's Bayesian information criteria

Akaike's information criterion and Bayesian information criterion

Model	N	ll(null)	ll(model)	df	AIC	BIC
.	24	-57.10307	-43.76042	4	95.52084	100.2331

Figure 17 - Model 3 2015-2019 Regression results

Source	SS	df	MS	Number of obs	=	17
				F(3, 13)	=	128.73
Model	247.857887	3	82.6192958	Prob > F	=	0.0000
Residual	8.34328902	13	.641791463	R-squared	=	0.9674
				Adj R-squared	=	0.9599
Total	256.201176	16	16.0125735	Root MSE	=	.80112

NPL	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
LTD	.7783312	.1495976	5.20	0.000	.4551453	1.101517
GDP	-.6872723	.3421449	-2.01	0.066	-1.426431	.0518868
LTI	1.473806	.4698007	3.14	0.008	.4588629	2.488748
_cons	-59.89308	13.26908	-4.51	0.001	-88.55918	-31.22699

Figure 18 - Model 3 2015-2019 Regression results VCE (robust)

Linear regression

Number of obs	=	17
F(3, 13)	=	189.04
Prob > F	=	0.0000
R-squared	=	0.9674
Root MSE	=	.80112

NPL	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
LTD	.7783312	.1496424	5.20	0.000	.4550485	1.101614
GDP	-.6872723	.2578243	-2.67	0.019	-1.244268	-.1302767
LTI	1.473806	.4365969	3.38	0.005	.5305955	2.417016
_cons	-59.89308	13.36706	-4.48	0.001	-88.77086	-31.0153

Figure 19 - Model 3 2015-2019 Variance inflation factor (VIF)

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estat vif
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Variable	VIF	1/VIF
LTI	6.47	0.154468
LTD	5.80	0.172347
GDP	1.55	0.645797
Mean VIF	4.61	

Figure 20 - Model 3 2015-2019 Akaike's and Schwarz's Bayesian information criteria

Akaike's information criterion and Bayesian information criterion

Model	N	ll(null)	ll(model)	df	AIC	BIC
.	17	-47.18033	-18.07203	4	44.14406	47.47691