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NON-PERFORMING LOANS AND BANKING EFFICIENCY; EVIDENCE FOR PERIPHERIC AND CENTRAL COUNTRIES

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Abstract

Este estudio analiza el impacto de los créditos morosos en la eficiencia e ineficiencia bancaria tomando datos de diferentes bancos distribuidos por todo el mundo, además de los datos macroeconómicos de los países donde los bancos seleccionados están establecidos. Los resultados muestran como un aumento de los créditos morosos implica un aumento de la ratio Cost to income, aumentando así la ineficiencia bancaria. El análisis robusto sobre el margen de interés neto confirma esta relación entre los créditos morosos y la ineficiencia bancaria ya que un aumento en los créditos morosos supone una disminución del margen de interés neto disminuyendo de esta manera la eficiencia bancaria. Este análisis también estudia si este fenómeno afecta más a los países conocidos como "periféricos" o "centrales". Los resultados obtenidos muestras que los países periféricos si son más ineficientes que los países centrales. Sin embargo, a diferencia de lo esperado los países centrales son más sensibles al impacto de los créditos morosos en la ineficiencia bancaria. Dado el impacto del Covid-19 en la economía mundial, un último análisis es realizado para comprobar la sensibilidad del Covid-19 a los créditos mororos. Los resultados muestran que el impacto Covid-19 no es significativo y este tampoco es sensible al impacto de los créditos morosos en la ineficiencia bancaria.

Palabras clave: crédito moroso, eficiencia bancaria, países periféricos, Covid-19

Abstract

This article analyses the impact of Non-Performing Loans (NPLs) on banking (in)efficiency taking data from 1119 banks of 42 Eurozone and Non-Eurozone countries as well as macroeconomic data from the countries where the chosen banks are established. Our results suggest that Non-Performing Loans increase the cost to income ratio leading to an increase in banking inefficiency. The robustness checks on net interest margin confirm this result. An increase in Non-Performing Loans leads to a decrease in net interest margin which implies a decrease on banking efficiency. This paper also analyzes whether the impact of Non-Performing Loans phenomenon is more significant in the so-called "peripheral" or "core" countries. The results obtained show that peripheral countries are indeed more inefficient than core countries. However, contrary to expectations, core countries are more sensitive to the impact of non-performing loans on bank inefficiency. Given the impact of Covid-19 on the world economy, a third analysis is conducted to test the sensitivity of Covid-19 to non-performing loans. The results show

that the Covid-19 impact is not significant and it is not sensitive to the impact of nonperforming loans on bank inefficiency.

Key words: Non-performing Loans, bank efficiency, periphery countries

TABLE OF CONTENT

1. INTRODUCTION

The banking industry is one of the main sources of financing in almost every country. The banking industry is an important sector for the development and economic growth of a country as they act as intermediaries between borrowers and lenders, they facilitate financial transactions, promote financial stability, and help institutions such as governments, enterprises, or households to allocate their financial resources in the more efficient way. Therefore, the well-functioning of the banking industry is of key importance in order to promote stability and economic growth.

When talking about the well-functioning of the banking industry the subject of efficiency arises. Efficiency is a key factor of the banking industry as it is directly related to profitability and the overall bank sector functioning.

The concept of efficiency was first introduced by Edgeworth (1881) and Pareto (1927). It is defined as the capacity of an institution to attain its normal level of output or production with the minimum input or at the minimum cost. In the case of the banking industry efficiency is of main importance for the success of the different macroeconomic policies established to attain sustainable development, economic growth, and the maximization of national resources (Isrova and Havránek, 2010)

According to this, one of the main challenges affecting banks efficiency is the risk of unpaid debts.

Banks' main business activities consist of borrowing and lending money to clients in order to accomplish their present and future needs. However, this lending activity has some implicit risk. This risk is associated with late repayment or in extreme cases the risk that the loan granted is not going to be repaid by the borrower.

When these loans are not payback within 90 days after the agreed due date with its corresponding instalments this unpaid loan is recognized as a Non-Performing Loan (NPLs), also known as "bad debt".

Non-performing loans may arise due to several reasons such as bankruptcy or unemployment situations that make the clients unable to pay back their debts. However, these situations most of the time came because of economic downturns like the financial crisis of 2008 or the recent Covid-19 crisis. There is some evidence of the challenges faced by the nations related to Covid-19 consequences. Some of these challenges involve financial strength towards the increase in the number of "bad debt" on banks' balance

sheets which threatens their ability to provide credit and support economic recovery (*Resolution Strategies for Non-Performing Loans in the Post-COVID-19 Landscape - OECD*, 2021)

Therefore, the main objective of this paper is to analyze the impact of Non-Performing Loans on bank (in)efficiency, to assess whether an increase in bad debt has a significant impact on banking (in)efficiency. To conduct the empirical analysis this paper took banking efficiency determinants data from the Orbis and macroeconomic data from the World Bank. To build a model in which determinants of banking efficiency and the different macroeconomic variables of 1119 banks and 42 Eurozone and Non-Eurozone member countries for the period comprised between 2018-2021 would form a single panel data. This first study would be tested using the Ordinary Least Square estimator (OLS) with fixed effects for panel data.

The result of this research shows that an increase in non-Performing loans leads to a significant increase in banking inefficiency, this result is robust as the same analysis has been conducted against banking efficiency and the outcomes show that an increase in non-Performing loans lead to a decrease in banking efficiency.

The level of unpaid debt may also depend on the nature of the country. The economic and financial stability, the unemployment rate, the economic growth, or the level of inflation of a nation also determine the non-performing loans ratio of a country. According to the mentioned characteristics countries can be divided into “periphery” and “core” countries. According to this, a second study would be performed in order to analyze the sensitivity of periphery and core countries to the impact of non-performing loans. The econometric results show that the so-called periphery countries are less efficient than the core or central countries. However, contrary to what was expected, the results show that core countries are more sensitive to non-performing loans impact than periphery countries.

Due to the impact of the Covid-19 crisis on the overall economy, a third study would be performed in order to analyze if non-performing loans have a more significant impact on banking inefficiency during the Covid-19 period. The outcomes suggest that the Covid-19 period did not have any impact on banking efficiency. And that the period characterized by the pandemic was not sensitive to non-performing loans, this could be

explained that the measures launched by the governments in order to hinder the economic consequences of the pandemic.

The paper is organized into 5 sections as follows, after this introduction, section 2 presents the related literature review, section 3 would present the hypotheses, the data, and the methodology used to attain the results, section 4 would present the outcomes and a discussion about them. The last section is the overall conclusion of the study.

2. LITERATURE REVIEW

During the last decades, many studies about banks and banking efficiency have been carried out to test the possible drivers of bank failures of institutions. Most of these studies conclude that one of the main obstacles to banking efficiency is the matter of non-performing loans. (Berger and DeYoung, 1997; Williams, 2004; Rossi et al.,2005; Podpiera and Weill 2008)

This section would try to provide a brief literature review to understand the relationship between non-performing loans and bank efficiency.

Issues of non-performing loans and bank efficiency are linked in several ways, as it is proven in the research made by Berger and DeYoung (1997). Bank efficiency and NPLs are mainly related in the sense that banks facing potential failures also present a low level of efficiency and high ratios of NPLs, which implies a negative relationship between NPLs and bank efficiency.

The negative relationship between NPLs and bank efficiency could be explained by some of the assumptions made by Berger and DeYoung (1997). Whose hypotheses stated that those banks owning NPLs issues were far from being in the “best practice frontier” This concept was defined by Berger and Humprey (1992) in the context of measuring efficiency in the banking sector. It represents the set of all most efficient banks, or those achieving the 100% efficiency level.

In their studies, Berger and DeYoung (1997) proved that bad bank management practices and external events negatively affected bank efficiency. These assumptions were named after the “bad management” and “bad luck hypothesis”. In Berger and DeYoung's (1997) seminal paper, the authors wanted to examine the correlation between loan quality, cost efficiency, and capitalization using a sample of US commercial banks from 1985 to 1994. The ratio of non-performing loans is used to measure loan quality and

employs a stochastic frontier approach to estimate an annual efficiency score for each bank. The model featured three different equations estimated by the OLS regression model. The study proves the evidence of the adverse correlation between bank efficiency and non-performing loans, corroborating the "bad management" and "bad luck" hypotheses. As well as manifesting skimping and moral hazard behaviour.

Under the "bad management" hypothesis, Berger and DeYoung (1997) suggest that a decline in bank efficiency is seen as poor managerial performance. Poor managers fail to regulate and monitor the bank's operating expenses, resulting in lower bank efficiency. This could be explained by several poor administrative practices such as choosing a large number of loans with low or negative net present value, lacking proper loan evaluation skills, or struggling to supervise borrowers after the loan is granted. In addition to reducing efficiency, these poor management practices also increase the ratio of NPL (Peristiani and Wizman, 1997; Berger and Hannan, 1998) Thus, under the "bad management "theory specific traits of bank managers have influence over bank efficiency but also, non-performing loans (NPLs).

Looking at the EU Williams (2004) examined a sample of EU saving banks between 1990-1998 providing a robustness test of the Berger and DeYoung (1997) results for US banks. The econometric results show that European saving banks were characterized by bad management (Williams, 2004). This is the only consistent result with Berger and DeYoung's (1997) findings that show how US commercial banks were affected by "bad management" but also by the "bad luck" hypothesis and presenting skimping and moral hazard behaviour. Moreover, Podpiera and Weill (2008) used a data set for all Czech banks from 1994 to 2005. Aiming to investigate the relationship between cost efficiency and NPLs in a transition country. The model featured two models, one to test the effect of cost efficiency on NPLs and a second one to test the effect of NPLs on cost efficiency. The authors concluded that NPLs and cost efficiency affect both the probability of bank failures, supporting the "bad management" hypothesis. Similarly, Abd Karim, et al., (2010), proved the "bad management" hypothesis in Malaysia and Singapore. The results obtained show that an increase in non-performing loans leads to a decrease in cost efficiency, and vice-versa. The study results in supporting the "bad management" hypothesis proposed by Berger and DeYoung (1997).

Partovi and Mateousek (2019), studied the significance of non-performing loans on technical and allocative efficiencies. The authors took a sample of 44 banks running

in Turkey and applied the modified DEA approach proposed by Aparicio et al., (2015) between 2002 and 2017. According to the results obtained, non-performing loans have more significant effects on the estimation of technical efficiency than on allocative efficiency. This fact corroborates the "bad management" theory in the Turkish banking sector. This hypothesis also justifies why State-owned banks in Turkey have a larger amount of non-performing loans than private loans. As their lending practices were not the most adequate in response to the financial crisis. In addition, State-owned bank managers seem to exhibit less care in their strategic and decision-making process. Acknowledging, that different types of banks exercise better performance and can maintain larger reserves to deal with future potential non-performing loans (NPLs)

In Indonesia Setiawan and Putri (2021), used a Vector Auto Regression model (VAR) to research the relationship between non-performing loans on the Islamic bank's efficiency in Indonesia and the effect of Islamic bank's efficiency in Indonesia on non-performing loans. The authors took a sample of Islamic banks in Indonesia for the period between January 2007- September 2012. The findings indirectly support the "bad management" hypothesis. Supporting the assumption that non-performing financing is more affected by internal variables than by external ones. As a result, low efficiency tends to materialize before high non-performing financing.

After having reviewed part of the most interesting literature, it can be concluded that numerous studies show evidence of the impact of "bad management" on non-performing loans because of inadequate management practices.

Regarding the "bad luck" hypothesis, unexpected external events (e.g., the closing of plants) can trigger a rise in non-performing loans. Once a loan becomes non-performing the bank is forced to allocate additional managerial effort and deal with higher operating expenses to handle the problem loan. Among others, these extra operating costs may include monitoring the negligent customer, the value of its collateral, or the charges of analyzing and bargaining potential solutions. As a result, it is expected that as the number of non-performing loans increases, the more likely bank efficiency would suffer a reduction due to the extra cost and efforts required to handle NPLs.

Rossi et al., (2005) analyzed the managerial behaviour and efficiency of Central Eastern European countries (CEEC). Examined the first 8 CEECs annexed to the EU from 1995 to 2002. The research supports the "bad luck" hypothesis. Validating that a high

level of debt as a result of exogenous shocks like environmental conditions, criminal level, or unemployment justifies a decrease in cost efficiency due to the increase in monitoring-related expenses. Similarly, Reddy (2011) examined a sample of 87 Indian commercial banks for the period between 1005 and 2007. The results show evidence of "bad management", "bad luck", and "moral hazard". Moreover, the study outcomes revealed statistical evidence for the "bad luck" theory among all bank groups including public sector banks and private domestic banks. The study also identifies firm statistical evidence of banks responding to decreased cost efficiency by strengthening their capital reserves to allure market participants and regulators.

Abidin et al., (2021), examined the degree of bank efficiency in Indonesia. From a sample of 18 Regional Development Banks (BPD) and 35 Commercial Banks (BUK) functioning in Indonesia between 2017 and 2018. To test its efficiency level the authors divided these 53 banks into two categories, both comprising two sorts of banks (banks from Category 1 and banks from Category 2). In order to determine the level of efficiency in each bank category, the authors used the DEA method. To measure the correlation between efficiency and financial performance the researcher used the Tobit regression analysis.

For category 1 Tobit analysis indicated that ROA was the financial performance variable impacting them. However, the Tobit test also determined that ROA and NPLs were the two variables affecting Category 2 banks. According to Abidin et al., (2021), NPLs affect bank efficiency since a high level of bad debt can result in extra operating expenses for the bank to undertake the decrease of non-performing loans.

Even if the paper does not mention the "bad luck" hypothesis, its conclusion suits perfectly the definition of the "bad luck" hypothesis provided by Berger and DeYoung (1997).

Among others (Klein, 2013; Jakubík and Reininger, 2013; Škarica, 2014; Macit, 2017) findings explore the macroeconomic factors affecting non-performing loans. The results exhibit evidence of how external events such as unemployment, inflation rates, or exchange rates lead to higher non-performing loan ratios while decreasing GDP growth in European countries. Even if the findings suggest that exogenous shock may be behind bank failures, the findings also suggest that policy and regulation could help mitigate the

risk. Measures such as maintaining higher capital ratios to minimize the impact of external shocks or setting limits to loan concentration Rossi (2005)

These two hypotheses “bad management” and “bad luck” and the studies and papers supporting them show enough statistical evidence about the negative relationship between bank efficiency and NPLs. A decrease in bank efficiency for any of the given reasons leads to an increase in the NPLs ratio.

Nevertheless, Berger and DeYoung (1997) also provided evidence about the positive relationship that bank efficiency and non-performing loans may have.

Under the “skimping hypothesis” Berger and DeYoung (1997) suggest that banking efficiency and the number of non-performing loans are affected by the number of means designated to underwrite and monitor loans. Therefore, one of the banking industry's critical decisions involves the trade-off between short-term operating costs and potential loan performance in the future. According to this, if bank managers aim to maximize their long-term profits, they should choose to incur lower costs in the short run. By doing this, bank managers avoid consuming bank resources in the short term as they do not incur in underwriting or monitoring loan borrowers. However, they may have to deal with higher bad debt expenses and their associated costs in the future.

The reason behind the positive relationship is explained by the low cost attributed to screening and monitoring loan customers, which can give a misleading impression about the bank's cost efficiency in the short run as only a few inputs support the same amount of loans and produce the same quantity of outputs in the short term. Despite this, even if the number of non-performing loans seems to remain the same in the short run, in the long run, due to the insufficient resources allocated to monitoring and controlling loan borrowers the number of non-performing loans could increase.

The “skimping hypothesis” results in the same outcomes as the “bad management” and “bad luck” hypotheses. But the difference is that in the “skimping hypothesis” the correlation between bank effectiveness and non-performing loans is positive.

There are not enough studies that support this theory. Researchers consider it difficult to prove that a positive relationship between non-performing loans and bank efficiency could exist. Williams (2004) finds sufficient statistical evidence to reject the skimping behaviour hypothesis for the most cost-efficient banks. Reddy (2011) tested the

skimping hypothesis on the sub-sample of the most cost-efficient banks. Nonetheless, the study has neither found any statistical evidence justifying the presence of skimping behaviour in Indian banks. But the findings of the "skimping theory" propose that as a preventive measure, bank supervisors and researchers should review loan portfolios and their performance to avoid a future increase in non-performing loans.

When managers prioritize business growth, seeking promotion, increasing power, or improving their status within the organization. Agency problems may arise between them and shareholders (Williamsom, 1963).

The last hypothesis presented by Berger and DeYoung (1997); "Moral hazard" has to deal with the issue mentioned above. Moral hazard takes place when one of the partakers accepts higher risk knowing that the future possible consequences won't be handled by himself. The authors described moral hazard as the "classical problem of excessive risk-taking". According to this theory, low-capital banks tend to solve this situation by increasing the riskiness of their loan portfolios, which in the future will result in higher non-performing loans.

The authors specified that "under the moral hazard hypothesis, we expect that low financial capital will Granger-cause high non-performing loans" (Berger and DeYoung, 1997). This hypothesis provides an alternative explanation for NPLs regarding capitalization, so the effects of measured cost efficiency on NPLs could be biased if the potential effects of capital were neglected. Its effects also amplified the impact of the other three hypotheses. In addition, managers may have different motivations that lead them to take higher risks than what is expected to be optimal. (Zhang, Cai, Dickinson, & Kutan, 2016).

In their paper Jansen and Meckling (1976), pointed out the issue between shareholders and creditors in two different situations, i) the agency problem between shareholders and creditors when shareholders are willing to take on additional risk but with the depositor's investments and ii) when managers only look on their behalf and invest in projects that would boost their career. These two "moral hazards" situations lead to an increase in loan lending and as a result an increase in non-performing loan ratios.

Umar and Sun (2016) indicated that moral hazard is a non-directly observed phenomenon. Nevertheless, it is possible to be recognized by other behaviours concerning certain issues. Moral hazard is easily detectable in the banking industry, by paying

attention to the level of risk-taking while lending and granting loans. In order to reduce the risk of non-performing loans, which in turn would affect efficiency it is important to supervise banks for excessive bank risk-taking and encourage more efficient bank practices.

Numerous researchers aimed to investigate the "moral hazard" issue:

Foos et al., (2010), took data from more than 16.000 banks from 1997-2007 to study if loan growth had any impact on the riskiness of individual banks. The researchers aimed to test three hypotheses concerning abnormal loan growth. Whether it affects: i) loan losses of individual banks, ii) individual banks' profitability, and iii) bank solvency. The study performed by the authors suggests that abnormal loan growth leads to higher loan loss provision and NPLs leading to lower relative interest income for banks and capital ratio. Additionally, the authors conclude that there is a nonlinear relationship between loan growth and bank solvency.

The Chinese banking sector development has been hindered by a large number of non-performing loans. Zhang et al., (2016) attempted to examine its effects on Chinese banks' behaviour. The authors took a sample of 87 Chinese banks, distinguishing between the city and rural commercial banks and state-owned banks between 2006-2012. To test if Chinese banks present a "moral hazard" problem while making lending decisions. The authors decided to use a one-period lagged non-performing bank ratio as the threshold to study this issue. A threshold level of 4,81% in the non-performing loans ratio has been discovered by the researchers. This implies that banks that used to confront high NPL ratios tend to act according to the "moral hazard" theory: "Banks' excessive risk-taking would temporarily relieve the problem but cause greater losses in the long run" (Zanh et al., 2016, p. 58) The finding of this study substantiates the moral hazard theory, implying that an increase in the non-performing loans ratio means providing riskier loans. Which may be responsible for the failure of the loan quality and financial system instability.

Gupta and Jain, (2022), from a sample of 38 private and public banks, study the presence of moral hazard on banks' lending behaviour and its subsequent increase in NPLs. However, the authors include the systematic importance of a bank to justify the degrees of moral hazard a financial institution may exercise. According to Gupta and Jain, (2022), moral hazard is a consequence of the Too-Big-To-Fail (TBTF) policy. Under TFTF policy, major banks are expected to engage in excessively risky and extended loans

and behave less responsibly than if they would have to answer for their actions. This research provides evidence of the existence of moral hazards as a consequence of their systematic importance. As it is proven that the more covered a bank is by the TBTF policy the riskier its lending behaviour will be. As a result, the NPLs would also increase.

To conclude, this section provides evidence that bank managers tend to operate on their behalf and not for their shareholders' benefit. According to this, "moral hazard" explains why managers act in a particular manner when Non-Performing Loans are increasing.

The empirical literature demonstrates the non-linear relationship between non-performing loans and bank (in)efficiency. However, it leaves an open space to study the impact of non-performing loans on bank (in)efficiency considering the following determinants of bank efficiency: the size of a bank; determined by the number of assets held by a bank, the tier1, the deposit to loan ratio, as well as different macroeconomics variables that may influence banking efficiencies such as the GDP growth and the Real Interest Rate.

Many authors have made empirical studies analyzing the impact of some of the chosen variables on bank efficiency:

When analyzing the impact of the size of the bank on banking efficiency different opinions arise. Some authors believe that bank size has positive implications; the larger the size of a bank, determined by the number of total assets a bank holds, the higher the banking efficiency. This theory is held by several authors (Adb Karim,2001; Mercan et al., 2003; Vu and Nahm,2013). On the other hand, some authors state that the higher the level of assets in a bank the lower its efficiency will be (Işık and Hassan, 2002). Chen et al., (2005) stated that neither larger nor small banks were inefficient but medium size banks. Other authors such as Kasman and Yildirim (2006) and Havrylchyk (2006), stated that bank size is not a determinant of banking efficiency.

Regarding the macroeconomic variables several studies state that economic growth has a positive effect on bank efficiency, according to this an increase in the GDPpc of a country would increase the efficiency of the banking sector (Mensah et al., 2012; Vu and Nahm, 2013; Sulaeman, et al., 2019). On the other hand, the impact of real interest rates on banking efficiency seems to be negative (Sulaeman et al., 2019).

This research also aims to address whether this impact of NPLs is more noteworthy for "core" or "periphery" Europe. It is well known that not all countries that make up the Eurozone share the same characteristics. However, these differences are more noticeable between countries in the "core" and the "periphery" of the Eurozone.

Germany tends to be seen as the leading country of the Eurozone becoming the heart of the "core" group countries in Europe. On the other hand, countries like Portugal, Italy, Greece, and Spain are the ones configuring the "periphery" group countries. Notwithstanding, a different group of countries out of the Eurozone are also part of the European "periphery". Those are countries such as Romania or Bulgaria that form the "Outer Periphery". These countries are considered part of the European "periphery" as much as Member states because their economies are highly dependent on the Eurozone financial sectors' evolution (Bartlett et al., 2016)

The main example in which these differences among countries were exhibited, was how the financial crisis of 2008 was handled by the different countries. For those countries, part of the periphery countries, the consequences, and outcomes of the global financial crisis lasted longer than for those forming the core countries. According to Lapavistas et al., (2010), "core" and "periphery" structural disparities were the consequence of the global financial crisis of 2008. These differences in outcomes were mainly due to the quality of institutions (Christou et al., 2021). According to Christou et al., (2021), institutions are agencies that determine the rules, laws, regulations, and policies that configured private incentives. When these institutions are not strong enough, they dissuade individuals from working, investing, innovating, saving, or solving problems. According to this, it is expected that periphery countries' banking system is less efficient than the banking industries of core countries.

3. HYPOTHESIS DATA AND METHODOLOGY

3.1 Hypothesis

The main aim of this research is to analyze the effect of non-performing loans (NPLs) on bank efficiency, distinguishing between central countries and peripheral countries. According to the examined literature, the subsequent hypotheses are put forward:

Hypothesis 1: The higher the NPLs ratio the lower the bank efficiency

Hypothesis 2: The NPL ratio has a more significant impact on the level of banking efficiency in peripheric countries.

Hypothesis 3: The NPL ratio has a more significant impact during the Covid-19 crisis

3.2 The data

The database is constructed from yearly data from 1119 banks from a sample of 42 Eurozone and non-Eurozone countries, for 2018-2021. The selected years of the study (2018-2021) are considered representative as during these four last years, the economy has passed from a stage of financial stability, as it seems to be almost recovered from the financial crisis of 2008, the shock of the Covid-19, period when the number of unpaid loans started to increase again as in the 2008 financial crisis. And it's slow recovery that we are still suffering today. All the countries included in the sample have been split into "peripheric" and "core" countries depending on the country's development, and economic strength as well as its economic and political power against other countries.

Despite the non-performing loan ratio, contemplated as the main variable of the study. There are some other banks (in)efficiency variables considered to perform this study, to assess how a change in those variables may impact banks (in)efficiency.

These variables are the bank size, measured as the bank's total assets (*lnta*). The tier 1 ratio (*tier 1*) refers to the minimum requirement of capital a bank needs to have regarding its risk profile. This capital is needed to ensure that the bank would be capable to confront any threatening situation. The minimum tier 1 is 6% of the bank risk-weighted assets. A higher tier 1 would imply a higher risk (Grant, 2023). This means that the higher the tier 1 ratio, the lower the banking efficiency as a tier 1 ratio above 6% means that the bank needs to save more capital to face its unexpected situations. And the deposit loan ratio (*DLR*), is computed by dividing the total number of deposits by the total number of loans of a bank, in order to assess its liquidity and risk level. The higher the deposit loan ratio, the higher the bank's efficiency as the liquidity of the bank would be higher and the risk associated with the bank would be lower.

Macroeconomic time series data for every country of the sample has also been included in the model as the efficiency of a bank is also closely related to the economic performance of a country.

In this sense, GDP growth and Real Interest Rate (*RIR*) data will also be used to assess banks' (in)efficiency. Macroeconomic data has been mainly obtained from World Bank.

Consequently, bank efficiency variables data together with the macroeconomic variables data form a single panel using 1163 observations including 420 cross-sectional unit's observables during 4 periods.

The definitions of banking efficiency and macroeconomic variables used in this research are all presented in Table 1. These variables are winsorized at 1% to erase all possible shortfalls that might bias the results.

Table 1

VARIABLE DEFINITION

[1]Table 1 shows every variable used in the model flowed on its acronym and its definition. The definition of the variables shows how they have been obtained and how are we going to interpret them through the study. All banking efficiency variables will be winsorized at 1% to erase all possible shortfalls that might bias the results.

Variable	Acronym	Definition
Banking efficiency variables		
Cost to income ratio	CIR_{it}	This ratio measures the operating expenses of a bank compared to the income generated. It is a measure of banking inefficiency.
Net interest margin	NIM_{it}	This margin is computed as the difference between the investment income and the interest expense divided by the average earnings assets. This margin is used as a measure of banking efficiency
Gross loans NPL ratio	$DNPLs_{it}$	Gross loans ratio is computed as the value of NPLs divided by the total number of loans granted by a bank. DNPLs are the difference between the gross loan NPL ratio and the gross loan NPL ratio lagged one period.
Bank size	$Lnta_{it}$	It refers to the natural logarithm of the bank's total assets
Banks core capital	$Tier1_{it}$	It refers to the amount of capital in a bank's reserves. This capital is used to develop the banks' related activities
Deposit to Loan ratio	DLR_{it}	This ratio is computed as total bank deposits divided by total bank loans. It addresses the liquidity of a bank and its risk
Macroeconomic variables		
Economic growth	$GDPgrowth_{ht}$	This variable is a measure of the economic performance of a country
Real interest Rate	RIR_{ht}	This variable measures the real cost of borrowing or lending money

[1] Note: characters i, h, and t, corresponds to bank, country, and year respectively.

3.3 Measures of banking efficiency

This study uses the cost to income ratio and the net interest margin as a measure of the degree of banking efficiency.

3.3.1 Cost-to-income ratio

The cost-to-income ratio (CIR_{it}) is a measure of the degree of banking inefficiency. The cost-to-income ratio is a key financial measure, mainly used to evaluate banks. It provides a clear view of how inefficient the bank is to the potential investors. The lower the ratio the better.

Cost to income ratio is calculated as follows:

$$Cost\ to\ income\ ratio(CIR_{it}) = \frac{operating\ cost}{operating\ income} \qquad \textbf{(1)}$$

However, in this study, it is going to be used to measure banking efficiency.

The study aims to measure the impact of NPLs as well as the chosen regressors on banking efficiency. The hypothesis says that an increase in NPLS would lead to a decrease in banking efficiency. However, as the dependent variable chosen is the cost-to-income ratio, and it measures banking inefficiency, the results are going to be explained in the following way: An increase of NPLs would lead to an increase in banking inefficiency which corresponds to a decrease in banking efficiency. This increase in the cost-to-income ratio due to an increase in non-performing loans would be explained by the increase in operating costs incurred by the financial institution to manage the situation.

3.3.2 Net interest margin

The net interest margin is another measure of banking efficiency, used as a robustness check of the cost-to-income ratio. The net interest margin is the share of profit that a bank earns on its interest-earnings assets, such as loans.

It is calculated as follows:

$$Net\ interest\ margin\ (NIM_{it}) = \frac{(interest\ income - interest\ expenses)}{average\ earnings\ assets} \qquad \textbf{(2)}$$

Net interest margin constitutes a measure of banking profitability and efficiency. The higher the Net interest income the higher the interest income the bank is earning with respect to its interest expenses, that is the higher the profits.

As mentioned, this measure of bank efficiency is going to be used as a robustness check to the cost-to-income ratio. In this case, as the chosen variable constitutes a measure of banking efficiency, the results are going to be interpreted in the following way: An increase in Non-Performing Loans ($NPLs_{it}$) is expected to lead to a decrease in net interest margin which would imply a reduction in banking efficiency. This reduction in banking efficiency as a result of an increase in the non-performing loans ratio is due to the decrease in net interest income.

3.4 Empirical specification

Through this section, I am going to examine the approaches for recognizing and verifying the hypotheses concerning the impact of non-performing loans (NPLs) on the efficiency of a bank.

The empirical procedure applied in this study involves the use of the Ordinary Least Square (OLS) estimator with fixed effects for panel data:

$$Y_{it} = \beta_0 + \beta_1 NPLs_{it} + \delta X'_{it-1} + \varepsilon_{it} + \alpha_i \quad \textbf{(3)}$$

Y_{it} represents the dependent variable for two indicators. The first corresponds to the cost-to-income ratio, which measures the degree of banking inefficiency. And the second is the net interest margin which will be used as a robustness check, to see whether the conclusions obtained from the first assumption change when changing the dependent variable.

For the explanatory variables, the main indicator is the change in the non-performing loans ratio. *($NPLs_{it}$)* variable is computed as the difference between the NPLs ratio and the NPLs ratio lagged one period. This difference is made to measure the evolution of the NPLs ratio through time, whether the NPL ratio has increased or decreased, indicating also the extent of change of NPLs. Considering the literature introduced in the former section, a test would be executed to determine if a change in the DNPL ratio has a positive impact on the cost-to-income ratio (CIR_{it}), and bank

inefficiency. Followed by a robustness check to test if a change in the NPL ratio has a negative impact on the net interest margin (NIM_{it}), on bank efficiency.

The expression $\delta X' it - 1_{it-1}$, refers to the control matrix that includes the following one period lagged variables. All The size of the bank ($lnta_{it-1}$), the tier 1 capital ($tier\ 1_{it-1}$) referring to the bank's core capital to deal with client's needs, and the loan to deposit ratio (LDR_{it-1}) to assess the impact of the bank's liquidity on bank inefficiency/efficiency.

Macroeconomic variables are also incorporated to account for the consequences of business cycles on the banking sector's efficiency. These variables are the GDP growth ($GDPgrowth_{ht-1}$) and the Real Interest Rate (RIR_{ht-1}) lagged one period, shown, and described in Table 1.

4 RESULTS

4.1 Descriptive statistics and parametric test

Table 2 shows the descriptive statistics of the variables used to perform the research. Taking into account the inefficiency/efficiency variables the cost to income ratio shows an average of 62.493 fluctuating between -1.7200 and 178.51; and the net interest margin shows an average of 2.7723 fluctuating between -15.430 and 26.060. Once the efficiency variables are covered, the NPLs ratio for the studied countries presents an average of 4.5133 oscillating between 0 and 60.640. Meanwhile, the size of the bank shows an average of 21.020, fluctuating between 14.035 and 28.949. The core capital of the banks has an average of 16.340 oscillating between 9.1600 and 69.150. And the deposits loan ratio shows an average of 1.8637 fluctuations between 0.0000 and 27.667. Regarding the macroeconomic variables GDP growth and the Real Interest Rates have an average of 1.9112 and 1.5358 fluctuating between -15.307 and 21.554 and -12.520 and 10.694 respectively.

Table 2

DESCRIPTIVE STATISTICS

[2]Table 2 exhibit the distribution of the banking efficiency and macroeconomic variables previously described in Table 1. For a sample of 1119 banks including commercial and saving banks distributed among 42 Eurozone and non-Eurozone countries for 2018-2021. All banking efficiency variables have been previously winsorized at 1% in order to erase all possible shortfalls that might bias the results.

Description of the sample (2018-2021)

	Mean	*SD*	*Min.*	*Median*	*Max.*
Bank efficiency variables					
CIR $_{it}$	62.493	26.094	-1.7200	61.350	178.51
NIM $_{it}$	2.7723	4.0919	-15.430	2.9500	26.060
NPLs $_{it}$	4.5133	9.6066	0.0000	1.0900	60.640
Lnta $_{it}$	21.020	2.8104	14.035	20.925	28.949
Tier 1 $_{it}$	16.340	7.7343	9.1600	14.490	69.150
LDR $_{it}$	1.8637	3.3734	0.0000	1.20130	27.667
Macroeconomic variables					
GDP growth $_{ht}$	1.9112	3.9181	-15.307	2.2944	21.554
RIR $_{ht}$	1.5358	2.9208	-12.520	2.2104	10.694

[2] Note: characters i , h, and t, corresponds to bank, country, and year respectively.

4.2 The baseline regression

This section is going to show the econometric results which would demonstrate that hypothesis 1 is true. Table 3 is giving the regression coefficients for equation (3).

Hypothesis 1 has been tested using an OLS regression model with fixed effects for panel data. The estimation outcome shows that a 1% increase in the ($\Delta NPLs_{it}$) ratio of a bank would lead to an increase of 0.47% in the cost-to-income ratio, i.e., it would lead to an increase in banking inefficiency. On the other hand, the same 1% increase in variation leads to a decrease of about 0.016% in net interest margin, i.e., it would lead to a decrease in banking efficiency. These results are robust since the impact of an increase on the ($\Delta NPLs_{it}$), an increase in the amount of non-performing loans with respect to the emitted loans, are the same if we study it from the inefficiency side than from the efficiency point of view.

An increase in the ($\Delta NPLs_{it}$) ratio increases bank inefficiency which is equivalent to a decrease in banking efficiency due to an increase in the ($\Delta NPLs_{it}$) ratio. Therefore, the robustness checks on the net interest margin (NIM_{it}) confirm hypothesis 1.

This increase in banking inefficiency is explained by the increase in the cost-to-income ratio as a result of an increase in the ($\Delta NPLs_{it}$). This increase in the cost-to-income ratio is explained by the additional managerial effort and the higher operating expenses the bank has to deal with in order to manage the increase in the NPLs ratio. This is consistent with the "bad luck "theory supported by many authors (Abidin, 2021; Berger and DeYoung 1997; Reddy, 2011; Rossi et al., 2005).

On the other hand, the decrease in banking efficiency is explained by the decrease in the net interest margin of the bank due to an increase in the ($\Delta NPLs_{it}$) ratio. This decrease in banking efficiency can be explained by the reduction of interest income and the average earning assets as unpaid loans do not generate earnings for the bank but losses. This decrease in net interest income can be explained by the "bad management" and "moral hazard" hypotheses. Poor administrative practices, not performing the correctly required evaluation procedure, granting a large number of loans, or struggling to supervise borrowers once the loan has been granted are some of the characteristics related to the "bad management" hypothesis that may explain the decrease in net interest margin (Berger and DeYoung 1997;Partovi and Mateousek 2019; Setiawan and Putri 2021Williams 2004)

The "Moral hazard" hypothesis may also arise here as a lower net interest margin can also be a consequence of excessive risk-taking activities by the managers, being aware that they won´t be responsible for future problems like unpaid loans (Berger and DeYoung 1997; Foos et al., 2010; Gupta and Jain, 2022).

The estimation also shows the impact of a 1% increase in the remaining variables on banking (in)efficiency.

For ($tier\ 1_{it}$), an increase of 1% in the tier 1 capital of a bank leads to an increase of 0.68% in the cost-to-income ratio leading to an increase in banking inefficiency. And to a decrease of 0.032% of the net interest margin corresponding to a decrease in banking efficiency. The same happens with a 1% increase in the real interest rate. A 1% increase in the real interest rate leads to an increase in the cost-to-income ratio which implies an increase in banking inefficiency. And to a decrease in net interest margin leading to a decrease in banking efficiency (Sulaeman et al., 2019). That is, the robustness check of specification (2), confirms these findings.

On the other hand, a 1% increase in the deposit to loans ratio (DLR_{it}) leads to a decrease in the cost-to-income ratio which means a decrease in banking inefficiency, and an increase in the net interest margin leading to an increase in banking efficiency. These results make sense as an increase in the deposit to loans ratio means that the bank has more deposits than loans, indicating that the banks have more liquidity and are less risky.

And a 1% increase in GDP growth ($GDPgrowth_{ht-1}$) also leads to a decrease in the cost-to-income ratio (CIR_{it}) decreasing banking inefficiency and leading to an increase in the net interest margin which implies an increase in the banking efficiency sector (Mensah et al., 2012; Vu and Nahm, 2013; Sulaeman, et al., 2019). An increase in these two variables has a positive impact on banking efficiency.

However, the amount of the bank's total assets ($lnta_{it-1}$) findings with respect to banking (in)efficiency cannot be confirmed by the robustness check on net interest margin as the result of an increase in the bank total assets leads to a decrease of the cost to income ratio, decreasing inefficiency (Adb Karim,2001; Mercan et al., 2003). But the same increase in banks' total assets leads also to a decrease in the net interest margin, which implies a decrease in banking efficiency (Işık and Hassan, 2002; Akin et al., 2009) That is, the impact of the size of the bank on banking (in)efficiency is not as clear as the impact of the previous variables.

Table 3

THE IMPACT OF BANK NPLs ON BANK (IN)EFFICIENCY

[3]Table 3 exhibits the impact of a variation increase in Non-Performing Loans is regressed against banking (in)efficiency. Items from (1) to (8), show that the econometrics results are consistent they are all estimated using the Ordinary Least Square (OLS) method for lineal regression analysis for panel data with [4]fixed effects for the period comprised between 2018 and 2021. The ($\Delta NPLSs_{it}$) refers to the difference between the NPLs gross loan ratio and the NPL gross loan ratio lagged one period. The remaining banking efficiency variables all lagged one period.

OLS WITH FIXED EFFECTS

	CIR_{it} (1)	CIR_{it} (2)	CIR_{it} (3)	CIR_{it} (4)	NIM_{it} (5)	NIM_{it} (6)	NIM_{it} (7)	NIM_{it} (8)
Banking efficiency variables								
$\Delta NPLs_{it}$	0.124* (0.0801)	0.138* (0.0656)	0.504*** (9.86e-09)	0.466*** (1.61e-07)	0.009* (0.0841)	–0.008 (0.1114)	–0.005 (0.2713)	–0.015*** (0.0069)
$Ltier\ 1_{it-1}$			0.602*** (6.21e-06)	0.679*** (1.52e-07)			–1.151*** (2.39e-32)	–0.032*** (0.0001)
$Llnta_{it-1}$			–13.09*** (8.64e-15)	–13.357*** (8.89e-12)			–0.045*** (1.26e-09)	–0.540*** (2.02e-05)
LDR_{it-1}			1.444* (0.0557)	–0.777 (0.3834)			0.052 (0.2169)	0.029 (0.6177)
Macroeconomic variables								
$GDPgrowth_{ht-1}$		0.265*** (4.51e-05)		−0.013 (0.8709)		0.038*** (2.26e-15)		0.034*** (3.05e-10)
RIR_{ht-1}		−0.050 (0.6658)		0.255893** (0.0386)		−0.029*** (0.0009)		−0.017** (0.032)
N	1902	1410	1495	1163	1907	1412	1495	1163
Breusch-Pagan test	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

[3] Note: *, **, *** refers to a minimum 10%, 5%, and 1% significance respectively. Characters i, h, and t, corresponds to bank, country, and year respectively.

[4] NOTE: to decide between Random effects and Fixed effects, the Haussman test has been run. As the p-value is significant i.e < 0.05 the null hypothesis its been rejected, (Ho: preferred model is the random effect), then the preferred model is the alternative, the fixed effect.

Hausman test (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.0000
F-test (p-value)	6.6e-239	2.2e-261	7.3e-280	3.3e-247	0.000	0.000	0.000	0.000
Durbin-Watson test	1.949	1.903	1.826	1.910	1.662	1.745	1.519	1.615

4.3 "Pheriphery" vs "core" countries

This section explores the statistics confirming the second hypothesis.

In order to provide evidence for hypothesis 2, the sample data has been segregated by country type. By creating a new variable *(P_h),* which would split the sample into periphery and core countries. *(P_h)* would take the value of 1 if the country is periphery and the value of 0 if it is core

$$Ph = \begin{cases} h = 1, if\ periphery \\ h = 0, otherwise \end{cases}$$

The variable (P_h) would show which type of country is more inefficient. Nonetheless, to asses which type of country is more sensitive to the impact of NPLs on bank efficiency a new variable called (*periphery_NPL*$_{i,h,t}$) would be created. This variable measures the sensitivity of NPLs on periphery countries.

Table 4 shows the econometric results of adding these two new variables (P_h) and (*periphery_NPL*$_{i,h,t}$) to the existing equation (3) against the cost to income ratio to test the impact of periphery countries on banking inefficiency and the sensitivity level of NPLs on periphery countries on banking inefficiency.

$$CIR_{it} = \beta_0 + \beta_1 NPLs_{it-1} + \delta X'_{it-1} + P_h + periphery\_NPL_{i,h,t} + \varepsilon_{it} + \alpha_i \quad (4)$$

Hypothesis 2 has been tested using an OLS estimator with fixed effects. The estimation outcome shows that an increase of 1% in the (ΔNPL_{it}) leads to an increase in banking inefficiency of about 0.383%. Regarding the impact of periphery and core countries, the results

show that periphery countries are more inefficient than core countries. An increase of 1% in periphery countries leads to an increase of 5.086 % in bank inefficiency.

However, the estimation results show that contrary to what was expected, periphery countries are not that sensitive to non-Performing loans. The results show that with 1% significance, core countries are more sensitive to non-Performing loans than periphery countries. A 1% variation increase in (*periphery_NPL*$_{i,h,t}$,) leads to a decrease in banking inefficiency of 1.338.

Table 4

THE IMPACT OF NPLS ON PERIPHERY COUNTRIES ON BANK (IN)EFFICIENCY

Table 4 exhibits the impact of periphery countries on banking (in)efficiency as well as the level of sensitivity of periphery countries towards NPLs regressed against Cost to income ratio *(CIR).*

OLS WITH FIXED EFFECTS

	CIR$_{it}$ *(1)*
ΔNPL$_{it}$	0.383***
	(0.007)
P$_h$	5.086***
	(0.001)
periphery_NPL$_{i,h,t}$	−1.338***
	(0.000)
Ltier 1 $_{it}$	0.661***
	(1.53e-16)
Llnta $_{it}$	−1.201***
	(2.82e-07)
LDR $_{it}$	0.367
	(0.308)
GDPgrowth $_{ht}$	0.380**
	(0.019)
RIR $_{ht}$	0.227
	(0.376)
F-test	1.26e-39
(p-value)	
Durbin-Watson test	0.203136

4.4 “Covid-19” vs “non-Covid-19”

Due to the relevance of the Covid-19 crisis during the selected period (2018-2021) and its impact on the overall economy, I have decided to realize a third study, in which I am going to analyze the sensitivity of NPLs during Covid-19 pandemic. That is if banking (in)efficiency was more affected by NPLs during the Covid-19 period than during the non-Covi-19 period.

In order to provide evidence about this 3 Hypothesis two new variables have been created. One is a dummy variable (*Covid*$_{it}$), which would take the value of 1 if the data are for

the years after 2020, and the value of 0 if the data are for the years before 2020, as shown in the expression below.

$$Covid\ t = \begin{cases} t = 1, \geq 2020 \\ t = 0, otherwise \end{cases}$$

This variable would show how Covid-19 impacted banking (in)efficiency. A second variable would be created to assess the sensitivity of NPLs during Covid-19 on banking (in)efficiency (*Covid_NPL $_{it}$*). These two variables would be added to the existing equation (3) as follows.

$$CIR_{it} = \beta_0 + \beta_1 NPLs_{it} + \delta X'_{it-1} + Covid_{it} + Covid\_NPL_{it} + \varepsilon_{it} + \alpha_i \quad \textbf{(5)}$$

The econometric results of hypothesis 3, would be estimated using an OLS estimator with fixed effects against the cost to income ratio (*CIR_{it}*). The estimation outcome shows that an increase of 1% in the variation of NPLs leads to an increase in bank inefficiency of 0.393%. Regarding the impact of the Covid-19 crisis we can see that the results are not significant, as they are not significant to the study, we can conclude that the Covid-19 crisis had no effect on banking (in)efficiency. The econometric results, contrary to the expected outcome, show that Covid-19 period was not sensitive to non-performing loans. A 1% increase in *(Covid_npl$_{it}$)* decreases banking inefficiency by 1.627%. One of the main reasons behind the lack of sensitivity of the Covid-19 crisis non-performing is the European Comission´s NPL action plan, this plan aimed to guarantee that households and business with difficulties to face their debts during the Covid-19 continue to have access to their fundings. By developing secondary markets, proposing reforms to strengthen the corporative insolvency and debt recovery within the EU, executing public support measures, and by collaborating with the asset management companies (Directorate-General for Financial Stability, Financial Services and Capital Markets Union, 2020).

Table 5

THE IMPACT OF COVID-19 ON BANKING (IN)EFFICIENCY

Table 5 exhibits the impact of the Covid-19 crisis on banking (in)efficiency as well as the level of sensitivity of the Covid-19 crisis towards NPL regressed against Cost to income ratio *(CIR).*

OLS WITH FIXED EFFECTS

	CIR_{it} (1)
ΔNPL_{it}	0.393***
	(0.006)
$Covid_{it}$	−1.222
	(0.331)
$Covid\_npl_{it}$	−1.627***
	(1.08e-06)
$Ltier\ 1_{it}$	0.721***
	(2.97e-20)
$Llnta_{it}$	−1.189***
	(4.04e-07)
LDR_{it}	0.341
	(0.346)
$GDPgrowth_{ht}$	0.178
	(0.377)
RIR_{ht}	0.311
	(0.292)
F-test	1.04e-37
(p-value)	
Durbin-Watson test	0.203

5 CONCLUSION

This paper analyses the sensitivity of banking inefficiency (CIR_{it}) to the increased variation of non-performing loans and the sensitivity of banking efficiency (NIM_{it}) to an increased variation of non-performing loans, in order to prove that the effect of the variation increase in the non-performing loans ratio would affect the same, bank inefficiency and bank efficiency. According to this, a single dataset is built by combining bank determinants data obtained from Orbis, and macroeconomic data obtained from the World Bank in order to see how the changes in the overall economy impact baking (in)efficiency. 1119 banks and 42 Eurozone and Non-Eurozone member countries data for the period comprised between 2018-2021 construct this dataset.

The main findings of this research confirm the hypothesis that an increase in the non-performing loans ratio increases or decreases bank inefficiency and bank efficiency respectively. This increase/decrease in banking inefficiency/efficiency can be a consequence

of “bad luck”, “bad management” or “moral hazard” (Berger and DeYoung, 1997; Williams, 2004; Rossi et al.,2005; Podpiera and Weill 2008)

A second study has been performed in order to assess the sensitivity of periphery and core countries against an increase variation of non-performing loans and its impact on bank inefficiency. The results of this second study did not confirm the initial hypothesis. The outcome indicates that periphery countries are more inefficient than core countries. Nevertheless, core countries are more sensitive to the impact of non-performing loans than periphery countries.

To finish with the empirical analysis concerning the impact of non-performing loans on bank inefficiency, a third study has been performed to measure the sensitivity of Covid-19 against an increased variation of non-performing loans and its impact on bank inefficiency. The results did not confirm the third hypothesis either. According to them, the Covid-19 crisis had no effect on banking inefficacy and the impact of non-performing loans on banking inefficiency seems to be more significant during the period without Covid-19. This result may be explained by the measures implemented by the governments in order to mitigate the economic and financial consequences of the pandemic on the banks’ financial statements.

To date, this is one of the first papers analyzing the impact of non-performing loans on banking (in)efficiency, considering the nature of the country (periphery or central) and the impact of Covid-19. However, this study is limited to the impact on banking (in)efficiency. Due to the close relationship between efficiency and profitability, it would have also been interesting to redo this study considering the impact on bank profitability.

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