MACROECONOMIC DETERMINATS OF NON-PERFORMING LOANS IN THE EURO AREA

UNDERSTANDING THE SHORT-TERM INTEREST RATES AND BASEL III IN THE EURO AREA

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ABSTRACT

This thesis investigates the relationship between short-term interest rates, Basel III, and banks' non-performing loans in the Euro area. It argues that there is a negative relationship between short-term interest rates and $Bank\ NPL_{t+1}$, which indicates an increase in $Bank\ NPL_{t+1}$ when short-term interest rates decrease. In addition, the study reveals a positive relationship between Basel III and $Bank\ NPL_{t+1}$. This confirms the initial hypothesis that Basel III puts significant burden on banks' profitability and therefore increases $Bank\ NPL_{t+1}$. Our emprirical data do not show causal relationship due to endogeneity and multicollinearity. To lay the foundation for the future research, we suggest additional macroeconomic determinants of NPL such as net GDP growth and form of governance as potential independent variables.

1. INTRODUCTION

We were living in an exceptional period of low short-term interest rates, which compressed banks' net profit margins. This created the so-called search for yield (Buch, 2014). Banks lent to risky clients and reduced their provisions for expected non-performing loans (Bikker & Vervliet, 2018). These riskier strategies heightened the vulnerability of the banking system. Yet, the evidence on the cross-country link between short-term interest rates, Basel III and risk-taking behavior is scarce.

After the significant crisis in 2008, the Basel Committee on Banking Supervision introduced new, more stringent requirements, including higher capital requirements. Basel III set the common equity capital requirement at its highest level, standing at 4.5 % of banks' common equity to its risk-weighted assets. It also introduced a new capital conservation buffer equal to 2.5 % of banks' common equity to its risk-weighted assets. These measures aim to strengthen the bank's ability to absorb losses by creating a significant capital cushion (Sironi, 2018). While the heightened capital requirements compel banks to put aside more capital from their retained earnings, they also result in diminished returns on their equity potentially leading to search for yield in risky investments (D'Erasmo, 2018)

Taking an excessive risk can gradually lead to a bad loan portfolio, which is the primary contributor to banks' vulnerability and the fragility of the banking system. With high levels of NPLs, banks face problems with distributing their funds and therefore, banks' surpluses are not allocated to clients with promising investment projects. (Curak et al., 2013).

This thesis focuses on how the balance between short-term interest rates and the regulatory framework of Basel III will influence banks' risk management in the form of credit risk, which we measure in NPLs. The standard argument is that by increasing the capital

requirements, banks' risk-taking is reduced because the associated risk with risky clients discourages equity holders from supporting risky investments, as they would be required to cover potential liabilities with their own equity instead of selling off the banks 'assets in the event of a default. The banks are thus pressured to allocate funds towards less risky assets, typically yielding lower expected returns. However, several strong counterarguments suggest that conversely, higher capital ratio requirements might encourage banks to pursue riskier activities since their traditional business model becomes less profitable (D'Erasmo, 2018). Therefore, bank owners may be eventually incentivized by higher capital requirements to engage in regulatory arbitrage, given the search for yield in riskier investments. Ferri showed that banks underreport their true risk, which enables them to lower their capital requirements while pursuing risky investments (Ferri & Pesic, 2017).

While the literature regarding the Basel III accord is extensive (Sironi, 2018; Härle et al., 2010, D'Erasmo, 2018), the unintended outcomes of heightened banks' risk-taking resulting from stricter capital requirements have not been thoroughly researched. To this aim, we will conduct a comparative analysis of the financial market's risk landscape, pre-and post-implementation of the Basel III. In addition, we will also investigate the short-term low-interest-rate environment under which risk-taking behavior may be used to replace loss returns from net interest rate margins.

We develop two hypotheses: (1) One percentage decrease in short-term interest rates will lead to a percentage increase in $Bank\ NPL_{t+1}$ (2) The full implementation of Basel III interacting with low short-term interest rates will lead to a percentage increase in $Bank\ NPL_{t+1}$.

After elaborating on the primary relationship between the short-term interest rates and $Bank\ NPL_{t+1}$, we also explore other macroeconomic and governance factors that may significantly impact the number of NPLs. For example, real GDP growth is an important determinant and could dramatically affect the level of NPLs in the economy (Glen & Mondragón-

Vélez, 2011). Furthermore, banks' governance is critical to banks' risk-taking behavior. Bank ownership and management structure can substantially influence the bank's risk perception and decision-making (Laeven & Levine, 2009).

In our research, we found that an increase in short-term interest rates correlates with a corresponding decrease in the $Bank\ NPL_{t+1}$. This indicates an inverse correlation, wherein a one percent increase in short-term interest rates corresponds to a significant 386% reduction in $Bank\ NPL_{t+1}$. In our investigation, we also found that the effects of short-term interest rates on $Bank\ NPL_{t+1}$ are significantly dependent of whether Basel III is fully implemented or not. One unit change in the interaction term changes the $Bank\ NPL_{t+1}$ by -217,19 %. Therefore, Basel III does not effectively maintain the stability within the banking sector and rather exacerbate risk-taking behaviors and increases the level of NPLs. However, our ability to infer causal relationships from our results is constrained by the limitations stemming from small dataset, and issues related to endogeneity and multicollinearity.

2. LITERATURE REVIEW

Altunbas (2010) and Buch (2014) discuss the negative effects of short-term low interest rates on banks' profitability, leading to a more intensive search for yield. As a result, the classical moral hazard problem arises. These studies found that subdue low short-term interest rates over an extended period contribute to an increase in banks' risk-taking (Altunbas et al., 2010), (Buch et al., 2014). These findings are particularly interesting for our study. We conducte our research after the financial crisis 2008 and thus bring more updated data. We observe data from 2014 to 2021, characterized by low short-term interest rates. We also define a different risk category since we characterize risk as an increase in $Bank\ NPL_{t+1}$.

Jiménez (2014) finds that the loans issued to risky customers come primarily from lowly capitalized banks rather than highly capitalized banks. We further develop this question and ask

how banks and their risk perception change with higher capital requirements (Jiménez et al., 2014). Bikker & Vervliet (2018) pointed out that banks significantly decrease the level of credit loss provisions in a low-interest rate environment, enabling them to maintain their profits. However, as a result, banks' buffer against credit losses shrinks. This strategy entails increased exposure to risk, reflecting a necessity born out of the prevailing low interest rates and low profitability (Bikker & Vervliet, 2018). Our study is also closely aligned with the study on increasing risk under short-term low interest rates. However, it significantly differs as it investigates capital requirements, which is, unlike loss provisions, a buffer for unexpected defaults.

Alternatively, researchers such as Curak (2013) and (Fofack, 2005) indicate in their case studies that high interest rates are strongly associated with increased NPLs. The authors found a positive correlation between the high interest rates and NPL. This is due to the increased burden of high interest rates on borrowers, particularly those with variable interest rates, which leads to defaults (Curak et al., 2013), (Fofack, 2005). However, there are some other possible explanations for such a relationship. For example, the borrowers who engage in riskier investment projects are precisely those who are inclined to accept the high interest rates since they do not plan to pay the loan back (Mishkin, 2021). Therefore, the high interest rates increase the adverse selection problem and may increase the banks' risk. Our research contributes to the literature by bringing new data on risk for the Eurozone.

D'Erasmo (2018) and Begenau (2015) suggest that higher capital requirements may increase banks' risk-taking by increasing the pressure on banks' profitability as banks are forced to allocate their resources to safer assets. Given their limited liability, this may diminish banks' profitability and create incentives for equity holders to engage in moral hazard (D'Erasmo, 2018), (Begenau, 2015). Our study further empirically elaborates on this relationship by investigating the interaction between short-term interest rates and capital requirements. We believe that our

research is unique since it combines data on Basel III and short-term interest rates that are usually studied separately.

On the other hand, Clerc (2015), argues that higher capital requirements reduce risk features in the banking system. The author believes that the capital ratio of around 10,5 %, significantly above the Basel III capital requirement, is a viable compromise that maintains bank stability without necessitating increased risk-taking to offset diminished profitability (Clerc et al., 2015). Additionally, the Basel Committee on Bank Supervision illustrates that increased capital requirements for globally systemically important banks have been shown to reduce the extent of systemic risk associated with these banks. This suggests that higher capital requirements mitigate the adverse feedback loops between stressed banks, diminishing the detrimental spillover effects on the real economy (Basel Committee & on Banking Supervision, 2022).

3. BASEL III

Even before the financial crisis of 2008, the need for strengthening the Basel II accord was evident. Banks had too high leverage and insufficient buffers, which exacerbated the economic crisis. This dangerous combination was partly addressed by the Basel Committee when it issued several packages in 2009, further improving the banking sector's stability. The packages notably focused on complex securitization positions, off-balance sheet vehicles and trading book exposures. However, to comprehensively address the financial instability and excessive risk, in September 2010, the Basel Committee on Banking Supervision announced higher global minimum capital standards for commercial banks. This reform package is now called Basel III (Bank for International Settlements, 2014).

Base III revised the previous Basel II accord and extended it to multiple areas, all implemented by 2019. The most significant reform was imposing stricter requirements for

regulatory capital quality and quantity, particularly reinforcing common equity's central role. In addition, Basel III requires banks to have a capital conservation buffer and countercyclical capital buffer, which restricts participation by banks in system-wide credit booms to reduce their losses in credit busts. The fundamental goal of the new Basel III accord was to reduce systemic risk in the financial sector and restore its credibility after a significant crisis (Bank for International Settlements, 2014).

In the Euro area, Basel III is implemented primarily through the Capital Requirements Regulation (CRR) and Capital Requirements Directive (CRD). These rules incorporate the international standard of Basel III into the European jurisdiction while allowing it to accommodate the specificities of European banks. Basel III applies to all banks that operate internationally (Sironi, 2018). However, in the EU, it applies to all banks (more than 8,300) and investment firms, including those active only in the EU. These measures are necessary due to the EU single market, which consists of several member states. The European Banking Authority (EBA) is monitoring and assessing the impact of Basel III measures on EU banks (Looney, 2013)

Figure 1 Time process of the Basel III system (Sironi, 2018)

	2011	2012	2013	2014	2015	2016	2017	2018	2019
Leverage Ratio	Supervisory monitoring		Parallel run 1 Jan 2013 – 1 Jan 2017 Disclosure starts 1 Jan 2015					Migration to Pillar 1	
Minimum Common Equity Capital Ratio			3.5 %	4.0 %	4.5%	4.5%	4.5%	4.5%	4.5%
Capital Conservation Buffer						0.625 %	1.25%	1.875%	2.50%
Min. common equity +capital cons. buffer			3.5 %	4.0 %	4.5%	5.125 %	5.75%	6.375%	7.0%
Deductions from Common Equity				20%	40%	60%	80%	100%	100%
Minimum Tier 1 Capital			4.5 %	5.5 %	6.0%	6.0%	6.0%	6.0%	6.0%
Minimum Total Capital			8.0 %	8.0 %	8.0%	8.0%	8.0%	8.0%	8.0%
Minimum Total Capital +conservation buffer			8.0 %	8.0 %	8.0%	8.625 %	9.125%	9.875%	10.5%
Capital instruments that no longer qualify as non-core Tier 1 or Tier 2			Phased out over 10 year horizon beginning 2013						
Liquidity coverage ratio	Observation period				Compulsory				
Net stable funding ratio	Observation period				Compulsory				

Source: Basel Committee on Banking Supervision(2010d).

One of the main concerns of the banking sector is Basel III and its minimum standard equity capital ratio, which, since 2016, have been equaled 4.5 % of common equity. In 2019, the full implementation of the capital conservation buffer (2.5%) on top of the minimum common equity (4.5%) was completed, and therefore, the CET1 requirements amounted to 7 %, see *Figure* 1. These figures for CET1 are calculated by taking a bank's core capital relative to its risk-weighted assets. CET1 represents the most superior form of capital, swiftly absorbing losses as soon as they materialize. The core capital consists of the sum of common shares, stock surpluses, and retained earnings (Sironi, 2018). However, acquiring CET1 capital can take time and effort, particularly for smaller banks. This could pose serious issues for banks' profitability since banks may need more capital in reserve. This might deter banks from utilizing their funds for profit-generating activities or lead to a search for yield by engaging in riskier activities.

4. DATA

In our research, we define banks' risk-taking behavior by bank nonperforming loans to total gross loans. This gives us a percentage number (%) indicating the banks' default rate. According to the World Bank methodology, we define NPL as the value of nonperforming loans divided by the total value of the loan portfolio. According to international standards, loans are categorized as nonperforming if the principal and interest payments are overdue by 90 days or more or if it's anticipated that future payments won't be received in their entirety. As the ratio increases, indicating a more significant proportion of nonperforming assets within the portfolio, the risk associated with the assets also escalates, potentially posing more tremendous challenges to the overall health and stability of the portfolio (The World Bank, 2024).

We use data for all member countries in the Eurozone between 2014 -2021. In 2014, the Eurozone comprised 18 member countries; by 2015, it expanded to 19 member countries. We will observe the Eurozone banks' NPL in a subsequent period to avoid any sort of endogeneity. Therefore, our dependent variable will be denoted by NPL_{it+1}. The total number of NPL observations is 152, which means eight observations for each country. However, six observations were NA, so we replaced them by zero value.

Figure 2*: Bank NPL before and after the full implementation Basel III system (The World Bank, 2024)*

Country Code	2014	2015	2016	2017	2018
BEL	4.25	3.85	3.48	2.96	2.27
AUT	3.47	3.39	2.7	2.37	1.88
CYP	44.97	47.75	36.7	31.39	19.52
EST	1.39	2.77	2.18	2.38	1.55
FIN	0.85	0.93	1.05	0.73	0.95
FRAU	4.16	4.05	3.7	3.12	2.75
DEU	2.34	1.97	1.71	1.5	1.24
GRC	29.99	35.71	37.36	45.57	41.99
IRL	20.65	16.91	12.63	11.46	5.46
ITA	18.03	18.06	17.12	14.38	8.39
LVA	4.6	4.64	6.26	5.51	5.29
LTU		4.95	3.66	3.18	2.27
LUX	..	..	0.9	0.79	0.9
MLT	9.05	7.1	5.29	4.07	3.36
NLD	2.98	2.71	2.54	2.31	1.96
PRT	10.45	16.74	16.57	13.19	9.43
SVK	5.2	4.71	4.35	3.63	3.12
SVN	11.73	9.96	5.07	3.2	6.01
ESP	6.38	5.09	4.72	4.46	3.69

Country Code	2019	2020	2021
BEL	2.09	2.07	2.03
AUT	1.63	1.58	..
CYP	17.09	15.02	9.00
EST	1.97	1.64	1.09
FIN	1.51	1.45	1.47
FRA	2.47	2.71	2.42
DEU	1.05	..	..
GRC	36.45	26.98	9.16
IRL	3.36	3.36	2.48
ITA	6.75	4.36	3.35
LVA	5.00	3.09	2.47
LTU	1.04	0.97	0.51
LUX	0.74	1.03	1.25
MLT	3.21	3.66	3.44
NLD	1.84	1.88	1.73
PRT	6.18	4.89	3.68
SVK	2.96	2.57	2.12
SVN	3.36	3.02	2.06
ESP	3.15	2.85	2.92

We obtained short-term interest rates from Eurostat's annual data. This short-term interest rate is the EONIA (Euro OverNight Index Average), which is the effective overnight reference rate for the euro. These rates are computed as a weighted average of all overnight unsecured lending transactions in the interbank market initiated within the Euro area (Eurostat, 2024). Short-term interest rates are the ones that primarily manage liquidity in the banking system and influence lending decisions. In other words, banks are funded mainly by short-term debt, which promptly responds to interest rate changes. From 2015 to 2021, the short-term

interest rates were negative, which means that banks were charged for holding excess reserves overnight. This happened due to the expansive monetary policy of the European Central Bank. Through negative short-term interest rates, the ECB encouraged banks to extend more loans to customers instead of holding excessive liquidity. The expansive monetary policy of the ECB did not affect only deposit facilities. The long-term interest rates were also set close to zero value, and between 2016 and 2019, they were zero (Bank, 2024). The total number of observations of short-term interest rates is eight since the same interest rate applies to all banks within the Euro area. The short-term interest rates' units of measurement are percentages per annum. This means that one unit change equals a change of 1 % in short-term interest rates. However, as we plot our data in basis points to enhance readability, one unit change on the plot equals 100 basis points. As the reader can see in Figure 1, there was only one year with positive short-term interest rates in 2014. After 2014, the short-term interest rates were only negative with incremental changes. This results from unconventional monetary policy, which the ECB utilized to stimulate the economy. Negative short-term interest rates aim to disincentivize banks to hold excess liquidity above the minimum requirements.

Figure 3 Short-term interest rates in the Euro Area (Before Basel III \| After Basel III) (Eurostat, 2024)

TIME	2014	2015	2016	2017	2018	2019	2020	2021
Euro Area	0,0937	-0,1078	-0,3201	-0,3548	-0,3628	-0,3918	-0,4617	-0,4827

Finally, our dataset on the Basel III regulatory framework investigates whether the impacts of short-term interest rates vary depending on whether Basel III is fully implemented. We use a dummy variable to represent Basel III's full implementation. The Basel III is indicated as 1 when fully. Conversely, the period before the full implementation of Basel III is marked

by 0. To illustrate the context of this period, *Figure 1* shows the gradual implementation of increasing minimum common equity capital ratio and capital conservation buffer. For the reader, it is essential to note that the minimum common equity capital ratio was already fully implemented by 2015. At that point, the capital conservation buffer was still at 0. Hence, the combined impact of these two factors on common equity began to take effect in 2019.

5. RESEARCH DESIGN

We analyze the relationship between short-term interest rates, banks' risk-taking behavior and Basel III in two parts. We assume that an increase in the ratio of nonperforming loans to total gross loans indicates greater risk-taking by banks within the economy. Non-performing loans are analyzed alongside short-term interest rates to uncover their relationship.

We divide the hypothesis H_1 into two parts. $H_{1\mathrm{A}}$: the percentage decrease in short-term interest rates induces more risk-taking and results in percentage increase in NPL. We believe that $H_{1\mathrm{A}}$ will dominate the more pronounced impact of low short-term interest rates, which is $H_{1\mathrm{B}}$: the low short-term interest rates reduce the number of NPL due to the economic boost, higher spending, and increased business profitability. The softened standards of banks, low profitability, and increased risk appetite in $H_{1\mathrm{A}}$ might outweigh the importance of $H_{1\mathrm{B}}$ (Bikker & Vervliet, 2018).

We also investigate the effects of short-term interest rates on banks' risk-taking behavior when Basel III is fully implemented versus when it is not. Our hypothesis H_2: the full implementation of Basel III interacting with low short-term interest rates will lead to a percentage increase in $Bank\ NPL_{t+1}$. We argue that both effects together significantly compress banks' profitability. We build our hypothesis on evidence that Basel III requirements, particularly the increase of common equity, which belongs to the most burdensome

requirements, reduces the banks´ profitability and induces risk taking (D'Erasmo 2018, Begenau 2015).

However, we also consider the opposite effect of Basel III, which is the benefit to financial stability. As Sironi argued, the benefits of financial stability may outweigh the associated costs with Basel III. In addition, banks may have taken the necessary steps much earlier and increase their capital requirement before the full Basel III implementation in 2019. This means that banks could already comply with the latest rule before it was fully implemented, and therefore, they were not significantly affected by the full implementation (Sironi, 2018). This fact could impact our results since the full implementation of Basel III might not affect the interaction term.

To put these hypotheses $H_{1A/B}$ and H_2 into an analytical framework, we use panel linear regression to identify the effects of independent variables β_2 ($Shortterm\ Interest\ Rates_t$) and β_3 ($Shortterm\ Interest\ Rates_t * Basel\ III_t$) on dependent variable Y ($Bank\ NPL_{t+1}$). The β_2 coefficient represents the percentage point increase or decrease in NPL_{t+1} when short-term interest rates change by 1 percentage point. The β_3 coefficient may be interpreted as percentage change of NPL_{t+1} when β_3 changes by one unit.

Equation (1):

$$Bank\ NPL_{t+1} = \alpha_t + \beta_1 * Bank\ NPL_t + \beta_2 * Shortterm\ Interest\ Rates_t + \beta_3 * Shortterm\ Interest\ Rates_t * Basel\ III_t + error_{it}$$

$H_{1A}: \beta_2 < 0$

$H_{1B}: \beta_2 > 0$

$H_2: \beta_2 > 0$

In equation (1) we control for annual time fixed effects (α_t). Therefore, we investigate how changes in the independent variables affect the dependent variable while accounting for time variations. The variation over time refers to the fluctuation in short-term interest rates. Using the time fixed effects allow us to assess the impact of short-term interest rate fluctuations on each specific country.

We create an econometric model where coefficient β_2 measures the sensitivity of $Bank\ NPL_{t+1}$ to changes in short-term interest rates. We expect β_2 to be negative ($\beta_2 < 0$), and thus, we assume an inverse relationship between short-term interest rates and $Bank\ NPL_{t+1}$. This inverse relationship would support hypothesis H_{1A}. This implies that as borrowing costs decrease, banks tend to issue loans to less creditworthy customers in pursuit of higher returns, leading to more defaults. In addition, low short-term interest rates make traditional banking business model less profitable, encouraging banks to seek yields by initiating riskier loans or changing the business model (Buch et al., 2014), (Bikker & Vervliet, 2018).

In our regression model, the H_2 effects of Basel III are captured under β_3. The coefficient β_3 represents the interaction term in our panel regression equation. Using the interaction term allows us to accurately depict the interplay between Basel III and short-term interest rates. It illustrates the combined effects of these two variables on $Bank\ NPL_{t+1}$. The β_3 investigates whether changes in short-term interest rates may affect $Bank\ NPL_{t+1}$ differently depending on the status of the Basel III: not fully implemented 0, fully implemented 1. We expect the β_3 to be positive ($\beta_3 > 0$), and thus, we assume that with lower short-term interest rates, the fully implemented Basel III puts significant pressure on banks' profitability and induces search for yield with higher risk. Therefore, in our hypothetical scenario ($\beta_3 > 0$), Basel III exacerbate loan defaults. One of the reasons for the positive β_3 could include downward pressure on the yield curve, which could result in the yield search in investing in risky assets (D'Erasmo, 2018).

We limit the inquiry to the time between 2014 and 2021. First, the implementation of the capital conservation buffer alongside the common equity capital ratio commenced in 2016. Second, Basel III was introduced in 2010, so banks started stocking their capital before the gradual implementation began. Thus, this period witnessed the introduction and full implementation of the capital requirements (Sironi, 2018).

6. RESULTS

This section shows the results of the analysis of the linear panel regression in *Figure 4*. These results provide evidence that there is a statistically significant relationship between short-term interest rates and $Bank\ NPL_{t+1}$. It explains a substantial portion of the variance in $Bank\ NPL_{t+1}$, suggesting that the model provides a satisfactory fit to the data and explaining the variance of the dependent variable.

Figure 4 Regression results (Haluška, 2024)

Variable	Estimate	Std, Error	t-value	Intercept
Bank_NPL	0,90816	0,10223	8,8836	5,88E-15***
Short_term_Interest_Rates	-386,15491	78,32544	-4,9301	2,56E-06***
Basel_III_Dummy	-217,19103	44,28745	-4,9041	2,86E-06***
factor(Year)2015	-79,55275	15,87327	-5,0117	1,80E-06***
factor(Year)2016	-161,04027	32,44537	-4,9634	2,22E-06***
factor(Year)2017	-175,67472	35,15362	-4,9973	1,92E-06***
factor(Year)2018	-178,19281	35,76149	-4,9828	2,04E-06***
factor(Year)2019	27,77903	6,43839	4,3146	3,22E-05***

The positive β_1 coefficient implies that for every unit increase in $Bank\ NPL_t$, there is an estimated increase of 0.90816 units in $Bank\ NPL_{t+1}$. The negative β_2 outcome reveals that one percentage increase in short-term interest rates correlates with a percentage decrease in

$Bank\ NPL_{t+1}$ by 386%. This supports the hypothesis H_{1A} and refutes the hypothesis H_{1B}, which indicates that increasing in $Bank\ NPL_{t+1}$ results from increasing in short-term interest rates. Conversely, the negative β_2 confirms the results of studies from Altunbas (2010) and Buch (2014), which found that subdue low short-term interest rates over an extended period contribute to an increase in banks' risk-taking. The negative effect strongly dominates our regression results and may be explained by more aggressive search for yield.

Under the interaction term with short-term interest rates, Basel III does have significant impact on $Bank\ NPL_{t+1}$. The interaction term's result is statistically significant as the p-value does not exceed 0,05. This means our dataset have enough evidence to support hypothesis H_2. This suggests that the impact of short-term low interest rates on Bank NPL (t+1) depends on whether Basel III is fully implemented. Moreover, we can also refute the theory that many banks had already adjusted earlier to increased capital requirements since the effect of full Basel III is statistically significant and by one unit change in β_3 the on $Bank\ NPL_{t+1}$ changes by -217,19103 %. This also shows that Basel III adds additional risk-taking appetite to the effects of short-term interest rates. Therefore, Basel III does not effectively maintain the stability within the banking sector and rather exacerbate risk-taking behaviors and increases the level of NPLs.

Overall, R squared of the model, which measures of the proportion of variability in the dependent variable explained by the independent variables, is in our model reasonably high at approximately 47.85%. We used within-effects model in RStudio instead of OLS pooling model because the withing effects model yielded a higher R-squared value. In addition, the regular OLS model does not account for the heterogeneity across the groups or time (Oscar Torres, 2010).

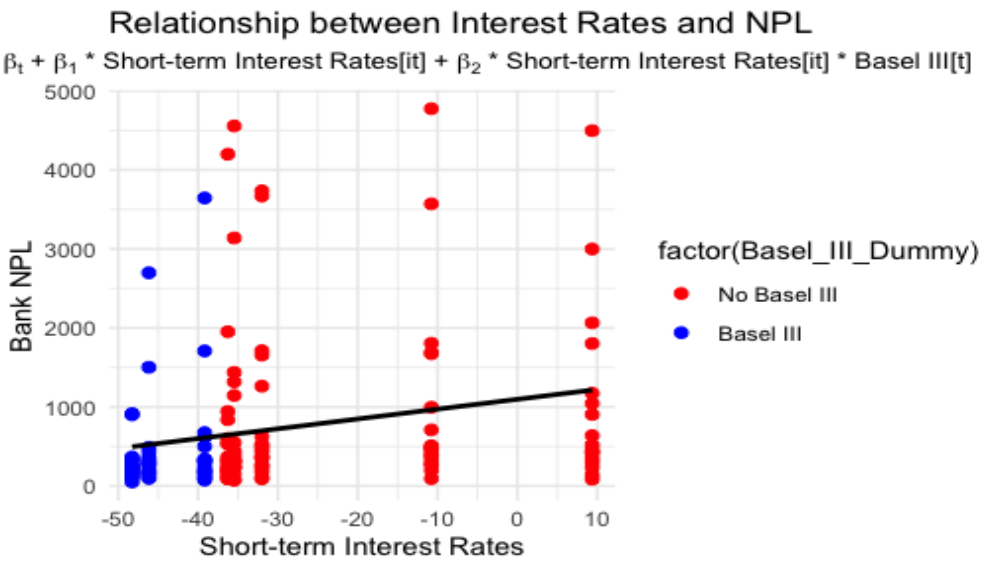

Figure 5 Linear Regression Plot (Haluška, 2024)

The scatterplot *Figure 5* shall be read as follows. The red dots show the period when Basel III was not fully implemented. Conversely, the blue dots mark the entire implementation period of Basel III. The x-axis is the annualized short-term interest rate in the Eurozone. The y-axis is encouraged to be read as bank nonperforming loans to total gross loans percentage ratio. The graph considers data for all periods in all given countries despite missing data in a dataset. In the case of the incomplete dataset, we replace the data with 0. Despite some points ranging from 0 to almost 50, most concentrated around the regression line.

However, certain limitations should be considered when reviewing the data. Predicting the exact timing of a loan default can be challenging, especially in environments characterized by low interest rates. Despite the elevated number of riskier loans, the reduced financial burden due to low interest rates complicates estimating when a default may arise. In addition, this study relies only on a single dataset from the Euro area, where the default rates may be different than in other jurisdictions due to reporting standards or data availability.

Furthermore, our dataset was not very extensive. To draw any conclusive causal inferences from our research, we would require a larger dataset. The small dataset also caused

a significant multicollinearity. This strong correlation between the independent variables in our model is one of the reasons why we have troubles with the estimation of the coefficients. Multicollinearity is the root of the large number results since it reduces precision of the estimates and small changes result in large estimators. When the coefficients strongly correlate among each other it is difficult to interpret the individual effects. Therefore, for the future research it may be beneficial to work with more extensive dataset.

Most importantly, we also consider the threat of endogeneity. One of the endogeneity concerns is reverse causality. For example, when the NPL increases banks may also increase their short-term interest rates to reflect the heightened risk connected with the loans. This would imply bidirectional relationship. As a result, bidirectional relationship may pose certain issues to our causal inference. However, we resolved this by utilizing $t + 1$,which eliminates the reverse causality issue since it investigates the NPL in the next period. Despite that, the treat of endogeneity persists in the form of correlation between the error term and independent variables particularly the short-term interest rates. The unobserved effects such as real GDP growth may influence the variations of the variables leading to a correlation between error term and independent variables. Such a correlation poses a threat to establishing a clear causal relationship. Therefore, our estimated relationship between short-term interest rates and NPL may be biased and not preciously reflect the causal relationship.

Overall, the regression model captures the patterns within the data. The result shows data that confirm the hypothesis $H_{1A}$and H_2. To clarify, we did find support in the available data for the assumption that short-term interest rates induce more risk-taking. Furthermore, Basel III did affect the number of defaults. Hence, we affirm the assumption that higher capital requirements prompt banks to undertake more risk, leading to more defaults in the economy.

7. DISCUSSION OF UNOBSERVED FACTORS

7.1 Risk-taking and GDP

In the pursuit of understanding banks' risk-taking behavior, research should extend to exploring additional macroeconomic determinants that shape bank's risk-taking. While short-term interest rates play a significant role in determining the NPL in our regression, according to some studies (Glen & Mondragón-Vélez, 2011), GDP growth is the primary driver of loan performance. This suggests that any economic drop in the global economy could substantially influence our results of the panel regression analysis. As Beck (2013) shows in his study, a rise in real GDP growth leads to a decline in non-performing loan ratios and vice versa. Therefore, we may also expect an overall negative relationship between GDP growth and NPL in our research (Beck et al., 2013).

From 2014 to 2021, we observed one relatively significant drop in the real GDP growth in the Euro area in 2021 when the GPD growth was – 6,1 %. This drop may not necessarily have immediate effects since governments gave handouts to companies and individuals to offset their incurred costs during the COVID-19 pandemic and repeated lockdowns. Besides that, the Euro area has experienced moderate GDP growth since 2014 (Eurostat, 2024). This means that under the assumption of the negative relationship between real GDP growth and NPL, we would expect the NPL to decrease since higher GDP increases overall borrowers' ability to repay their debts.

7.2 Risk-taking and bank governance

This section illustrates the possible reasoning behind our results from the point of view of the bank's governance. As Laeven (2009) argued in his revolutionary study, the ownership structure interacts with the banking regulations and shapes the risk-taking behavior of individual banks. This argument is based on a standard agency theory, which clearly shows the

relationship between ownership structure and its influence on risk-taking. In our regression analysis, the capital requirements had statistically significant effects on NPL in the interaction term with short-term interest rates. It is important to note that capital requirements influence banks' risk-taking incentives differently. Illustrating the diverse impact capital requirements on banks' risk-taking behavior, one can observe differing effects based on ownership structures, such as the disparity between banks held by large owners and those with more widely held ownership. For example, stricter capital requirements are associated with more risk-taking behavior in banks where large owners can intervene in the bank's business. However, we can observe the opposite associated effects in widely held banks where owners do not have a dominant right to intervene in the bank's business. These two factors constitute two opposing forces which may neutralize the effects of capital requirements (Laeven & Levine, 2009).

In the study conducted by Laeven, for example, the bank risk falls by 0.3 standard deviations if there is a one standard deviation increase in capital (1.25) when the bank is widely held. However, bank risk will rise by 0.2 standard deviations if there is a one standard deviation increase in capital when the bank has an owner where CF equals 50 per cent. This does indicate a tendency of two distinct ownership forces that counteract each other and minimize the impact of capital requirements. In our regression results the positive effect significantly dominates. However, omitting the ownership structure in our model could be one of the reasons for noncausal conclusions about the impact of capital requirements on banks' risk-taking.

8. CONCLUSION

In our study, we investigated one of the most critical macroeconomic determinants of NPLs such as short-term interest rate. We used comprehensive cross-country data, which revealed a negative relationship between short-term interest rates and $Bank\ NPL_{t+1}$. This suggests that as short-term interest rates rise, the quantity of $Bank\ NPL_{t+1}$ decreases. These

results refuted H_{1B}, which claims that the increase in short-term interest rates increases the number of $Bank\ NPL_{t+1}$. In the academic literature, we found evidence for the negative relationship between short-term interest rates and NPLs. One such theory was advocated by Altunbas (2010) and Buch (2014), who argued that subdue low short-term interest rates over an extended period contribute to an increase in banks' risk-taking. Our empirical results strongly indicate that low short-term interest rates are associated with higher NPLs and therefore supported this theory with our empirical data.

In addition to examining the direct impact of short-term interest rates, we incorporated an interaction term in our regression model to assess whether the full implementation of Basel III's stricter capital requirements affected $Bank\ NPL_{t+1}$. Our results revealed that the interaction term was statistically significant, indicating that Basel III did exacerbate risk-taking behavior in the context of rising interest rates. There are several plausible explanations which could shed light on this observation. We argued that short-term interest rates and Basel III together significantly compress banks' profitability. We built our hypothesis on evidence that Basel III requirements, particularly the increase of common equity, which belongs to the most burdensome requirements, reduces the banks´ profitability and induces risk taking (D'Erasmo, 2018). Finally, we also listed other macroeconomic unobserved determinants that could influence our results, such as real GDP growth or the bank´s governance. We could not include these factors in our regression. However, they should be used in the future research as an explicit independent variable.

Our results do not explain causal relationship. Due to several issues such as the treat of endogeneity and significant multicollinearity, we cannot draw a causal conclusion from our results. Therefore, our estimated coefficients are deemed to be biased. In conclusion, our research offers empirical data that can serve as the foundation for future studies on macroeconomic determinants of NPLs.

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