# Non-Performing Loans Ratio Measurement and Determinants Assessment

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*This article examines what macroeconomic factors affect the NPL ratio and how to better measure this ratio to reduce the valuation bias caused by credit growth over the reporting period. The study is based on current publications in the context of the topic and the macroeconomic indicators available in the Eurostat database for regression analysis during the period 2001-2018. As a result of the study, it is proposed to adjust the traditionally used NPL ratio with credit growth during the reporting period. Statistical tests that were carried out with 623 regression models provide strong evidence to conclude that the adjusted NPL ratio leads to higher explanatory power of macroeconomic indicators and thus increase the level of confidence of NPL ratio predictions.*

*Estimates show that NPL ratio is mostly determined by some key macroeconomic variables, such as loans to GDP ratio, loan growth, unemployment, foreign investment growth, household income growth, inflation rates, and others. Macroeconomic development tendencies must be carefully considered when formulating policies in order to reduce credit risk.*

*Keywords: non-performing loans ratio measures, influencing factors, econometric models*

## INTRODUCTION

Since the last financial crisis, which has had a major impact on the banking sector, much attention has been paid to non-performing loans (NPLs), whose volumes and dynamics have an impact on both the macroeconomic environment, the availability of credit in the financial markets, and all key aspects of bank management such as provisioning in accordance with International Financial Reporting Standards (IFRS 9), developing business strategies and plans, defining risk strategies and risk appetite framework, internal capital adequacy assessment process (ICAAP), recovery plan, etc. Large and/or fast-growing NPLs can affect the bank's short-term and long-term operation through two major channels. First, NPLs cause losses to banks, thereby reducing bank profitability and can affect bank capital when non-performing loans are written off. In severe cases, high NPLs can lead to bankruptcy. Second, high NPLs attract a significant amount of resources, both human and financial, making it difficult for banks to grant new loans to companies and individuals (European Commission, 2018).

According EU Regulation No 680/2014, non-performing loans and advances are those that satisfy any of the following criteria: (a) material exposures which are more than 90 days past due; (b) the debtor is assessed as unlikely to pay its credit obligations in full without realisation of collateral, regardless of the existence of any past due amount or of the number of days past due. (EU, 2014). European Banking Authority (EBA) defines NPL ratio in the following way: "The gross NPL ratio is the ratio of the gross

carrying amount of NPLs and advances to the total gross carrying amount of loans and advances subject to the NPE definition." (EBA, 2018)

Analyzing the causal relationships of NPLs, most studies focus on macroeconomic and bank-specific determinants of NPLs, but little attention is paid to the NPLs measure as such. What does it say? First, it must be understood that the NPL ratio is significantly influenced by credit growth - higher credit growth over the reporting period, at the same NPL amount, leads to a lower NPL ratio, and vice versa, because the denominator of the NPL ratio has changed. In addition, according to studies (Peric, 2017; Shahzad, 2019), credit quality deterioration and NPL status are not 'achieved' within six months and even a year since the issuance of the new loan. A shift in time further weakens the NPL ratio's ability to present a true picture of the real situation. Consequently, especially in periods with different growth rates of loans, the NPL ratio does not fulfill one of the essential criteria to be an unbiased measure of the actual situation. The same applies to comparisons between countries and regions with different growth rates of loans - the NPL ratio does not, by its nature, reflect these different situations. The above problems, at least in part, explain why correlation coefficients with theoretically correct NPL determinants are often lower and more volatile than expected. Therefore, this study seeks to identify ways to improve the NPL ratio information coverage.

## LITERATURE REVIEW

Researchers have accumulated evidence that excessive loans growth and leverage, as evidenced by the rapid rise in the loan-to-deposit ratio, leads to a deterioration in credit quality and NPLs increase (Davis, 2008; Espinoza, 2010; Foos, 2010; Klein, 2013; Peric, 2017; Ozili, 2019; Shahzad, 2019). Some research models include lagged variables of loans growth (Jakubik, 2013; Klein, 2013; Skarica, 2014; Peric, 2017).

Significant growth in non-performing loans is a bad signal, as the increase in NPLs also increases the cost of financing for banks (Bholat, 2018). Often these costs are passed on to bank customers, potentially slowing down economic growth. Louzis et al. (2012), Shahzad et al. (2019) and other researchers confirms close relationship between the NPLs rapid growth and bank solvency.

Macroeconomic conditions form a link between the business cycle and lending, as environmental changes directly affect the borrower's ability to service debt. For example, research has often found that GDP growth shows a negative correlation with NPLs, indicating a countercyclical nature of NPLs (Davis, 2008; Espinoza, 2010; Drehmann, 2011; Nkusu, 2011; Louzis, 2012; Jakubik, 2013; Klein, 2013; Makri, 2014; Skarica, 2014; Beck, 2015; Cifter, 2015, Cucinelli, 2015; Filip, 2015; Tanaskovic, 2015; Anastasiou, 2016; Beaton, 2016; Gila-Gourgoura, 2017; Kupcinskas, 2017; Peric, 2017; Koju, 2018; Petkovski, 2018; Ozili, 2019; Radivojevic, 2019; Ari, 2020; Liu, 2020; Staehr, 2020).

With rising unemployment and falling wages, which are typically seen in times of economic downturns, borrowers face greater difficulties in repaying their debt and, as a result, NPLs increase. Many researchers explicitly include unemployment in their models and find strong positive relationships between unemployment and NPLs (Nkusu, 2011; Louzis, 2012; Klein, 2013; Makri, 2014; Skarica, 2014; Cifter, 2015; Cucinelli, 2015; Filip, 2015; Anastasiou, 2016; Koju, 2018; Kupcinskas, 2017; Petkovski, 2018; Spilbergs, 2020; Staehr, 2020).

In addition to the above, the following are also considered to be important determinants of NPLs:

- inflation, since its growth reduces real wages and hence ability to meet liabilities. This is particularly important in circumstances where inflation exceeds wage growth (Davis, 2008; Nkusu, 2011; Klein, 2013; Skarica, 2014; Filip, 2015; Koju, 2018; Petkovski, 2018; Liu, 2020; Staehr, 2020);
- variable interest rates, which directly affect the ability of borrowers to pay interest, especially when the proportion of variable rate loans is significant (Davis, 2008; Espinoza, 2010; Nkusu, 2011; Louzis, 2012; Beck, 2015; Peric, 2017);
- exchange rate depreciation, which may have a negative impact on NPLs, especially in a country with flexible exchange rate regimes and high amounts of foreign currency loans, may contribute to an increase in NPLs (Jakubik, 2013; Klein, 2013; Beck, 2015; Cifter, 2015 Tanaskovic, 2015; Koju, 2018);

- the house price index - falling house prices are tightly linked to higher default rates (Nkusu, 2011; Beck, 2015; Tajik, 2015; Staehr, 2020);
- foreign direct investment, the growth of which is usually conducive to economic growth and thus has a positive impact on NPLs (Cifter, 2015; Koju, 2018).

## NPL RATIO ADJUSTMENT

### NPL Ratio Measure

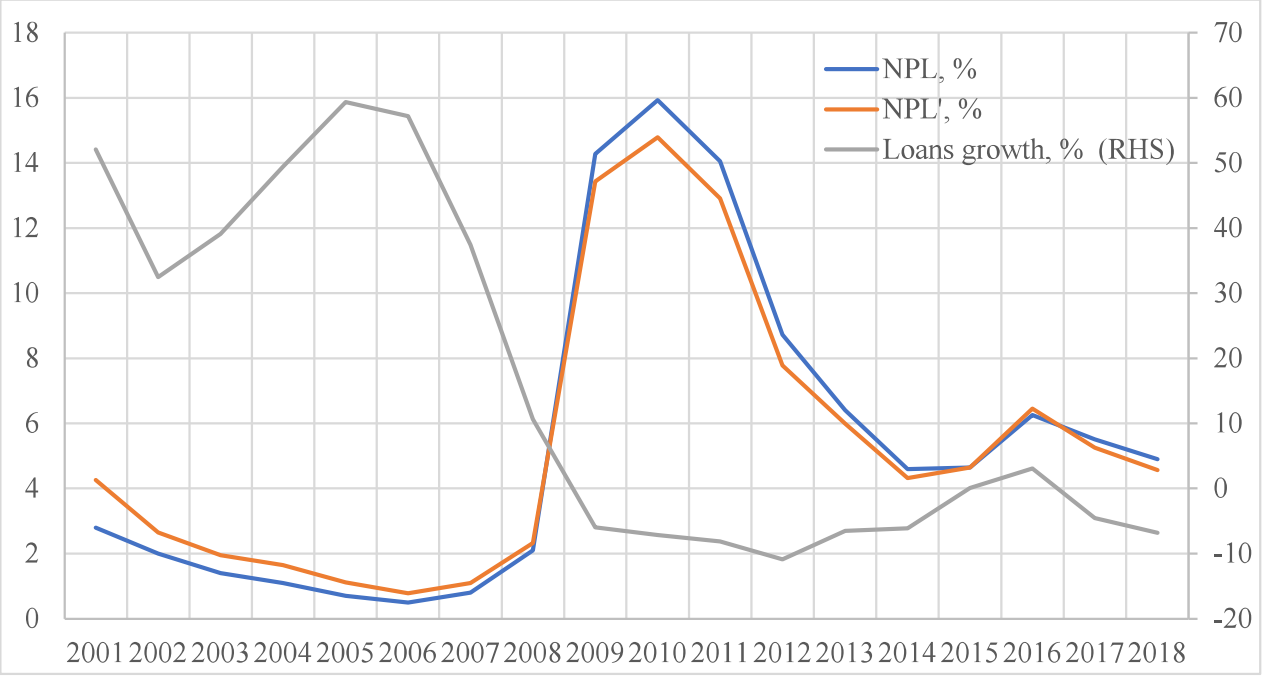
To eliminate the impact of current year loan growth and to reduce the NPL ratio valuation bias, thee proposal is to adjust the NPL ratio with the increase in loan balances ($\frac{Loan_t}{Loan_{t-1}}$) and estimate the adjusted NPL (NPL ') as follows:

$$NPL'_t = NPL_t * \frac{Loan_t}{Loan_{t-1}} = \frac{NPLA_t}{Loan_{t-1}} \quad (1)$$

where $NPL_t$ - the unadjusted NPL ratio at the end of period *t*,
$NPL_t'$ - the adjusted NPL ratio at the end of period *t*,
$NPLA_t$ - the NPL amount at the end of period *t*,
$Loan_t$ - loans outstanding amount at the end of period *t*,
$Loan_{t-1}$ - loans outstanding amount at the end of period *t*-1.

Using adjustment (1), the NPL increases relative to the unadjusted NPL during periods of loan growth and decreases when the loan outstanding amounts decreases. And the faster the increase or decrease, the greater the impact, see. the following Figure 1.

**FIGURE 1**
**NPL, ADJUSTED NPL AND LOANS GROWTH IN LATVIA**



As can be seen from Figure 1, the NPL adjustment provides a more conservative estimate of the NPL ratio in periods of strong credit growth and, conversely, in periods of decline. But does NPLs adjustment provide a better assessment of the influencing factors and a better quality of conclusions about the determinants of NPLs? This issue is relevant in the context of credit policy and credit strategy. To answer this question, the research hypothesized: NPL adjustment provides an opportunity to improve the stability of the regression coefficients and thus to more reasonably explain the effects of the macroeconomic environment.

**NPL Ratio Associations With Risk Drivers**

Based on the literature analysis, factors that could significantly influence the NPL ratio were selected for the hypothesis test and correlations were evaluated based on Eurostat data for Latvia for the period 2001-2018, see the following Table 1.

**TABLE 1**
**MACRO INDICATORS CORRELATION WITH NPL**

| Indicator | Unit of measure | Denotation | Correlation with | |
|---|---|---|---|---|
| | | | NPL' | NPL |
| Household disposable income growth | % | *HDI* | -0,8971 | -0,8859 |
| Unemployment rate | % | *UNPL* | 0,8226 | 0,7982 |
| Net wages growth | % | *NWG* | -0,7812 | -0,7598 |
| Loans to GDP | % | *LtGDP* | 0,6921 | 0,7163 |
| Loans growth | % | *Loan* | -0,6894 | -0,7243 |
| GDP growth | % | *GDP* | -0,6785 | -0,6727 |
| Investments to GDP | % | *INV* | -0,6649 | -0,6582 |
| Private sector debt of GDP | % | *PSD* | 0,6038 | 0,6350 |
| House price index | % | *HPI* | -0,6007 | -0,5892 |
| Loan growth to GDP growth | % | *LgtGDPg* | -0,5950 | -0,6487 |
| Foreign direct investments growth | % | *FDI* | -0,5931 | -0,5858 |

As can be seen from Table 1, in the 9 : 4 cases, the associations of determinants with the adjusted NPL are stronger than those of the unadjusted NPLs. The correlation coefficients in absolute values between 0,5 and 0,9 indicate moderate to strong correlations with the NPL, while their signs are consistent with those found in previous studies.

Figure 2 shows the associations of the major macro indicators with the adjusted *NPL*. Consequently, we see that household disposal income, net wages, loans and GDP growth as well investments to GDP increase, NPLs in turn decrease. And opposite, as unemployment, loans to GDP and private sector debt of GDP increase, so do *NPLs*. These observed trends, which are based on the historical data of Latvia in 2001-2018, are in line with theoretical researches.

**The Model and Results**

Let $NPL_t$' be dependent variable 'adjusted nonperforming ratio' in year *t*. Further, let $x_{1t},\dots,x_{kt}$ denote independent variables and $b_{it},\dots,b_{kt}$ denote regression coefficients of independent variables, than the model can be expressed as in equation:

$$NPL_t' = f(x_{1t}, \dots, x_{kt}) + \varepsilon_t \quad (2)$$

where ε_t – the error term.

During the research, combining the selected factors, 623 regression models were calibrated which passed the F-test at the confidence level of 0,95 and the Durbin Watson test with α = 0,05. In the next step,

230 models were screened that passed the regression coefficient t-test at a confidence level of 0,95 (α = 0,05).

For research hypothesis testing following null and alternative hypothesis where stated:

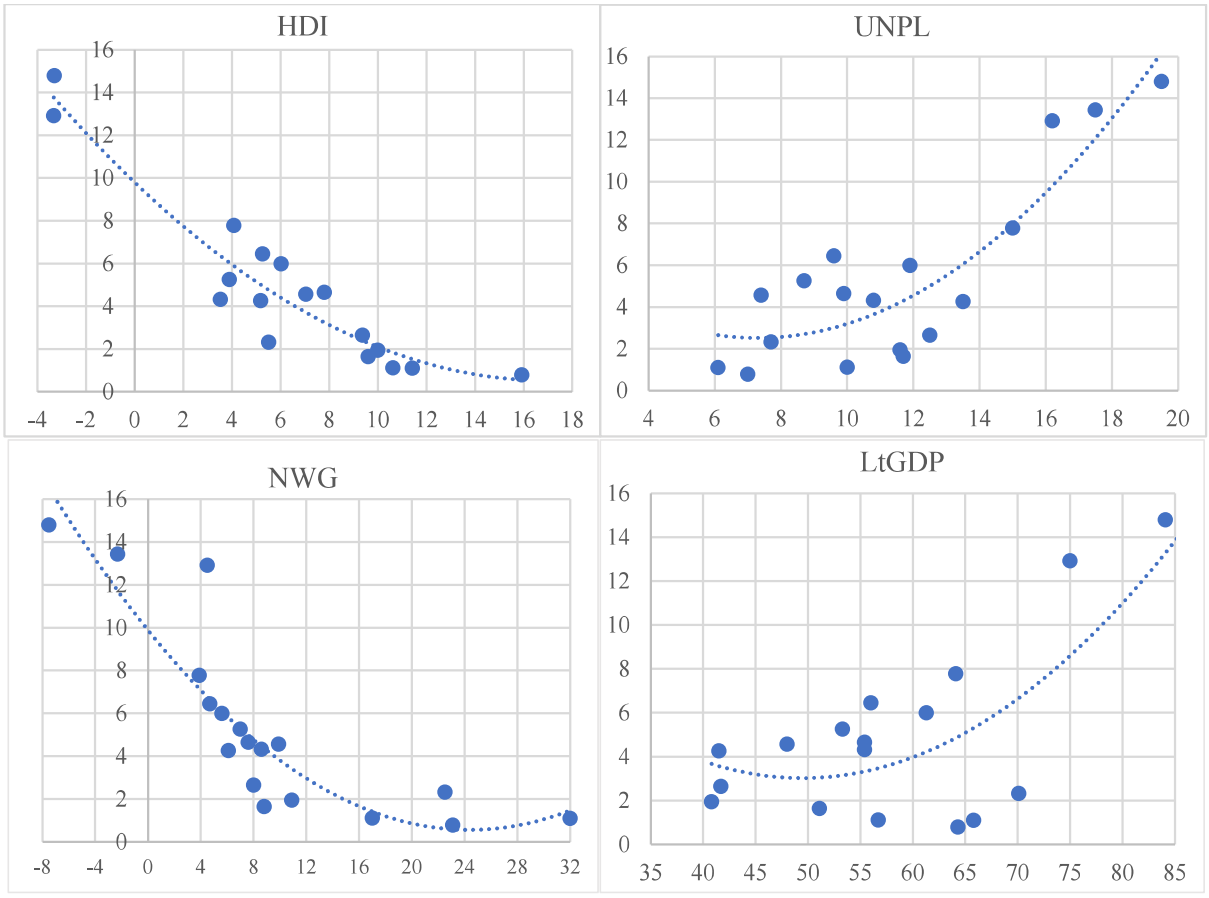
$H_0$: $\bar{p}_i - \bar{p}_i' \leq 0$ (3)

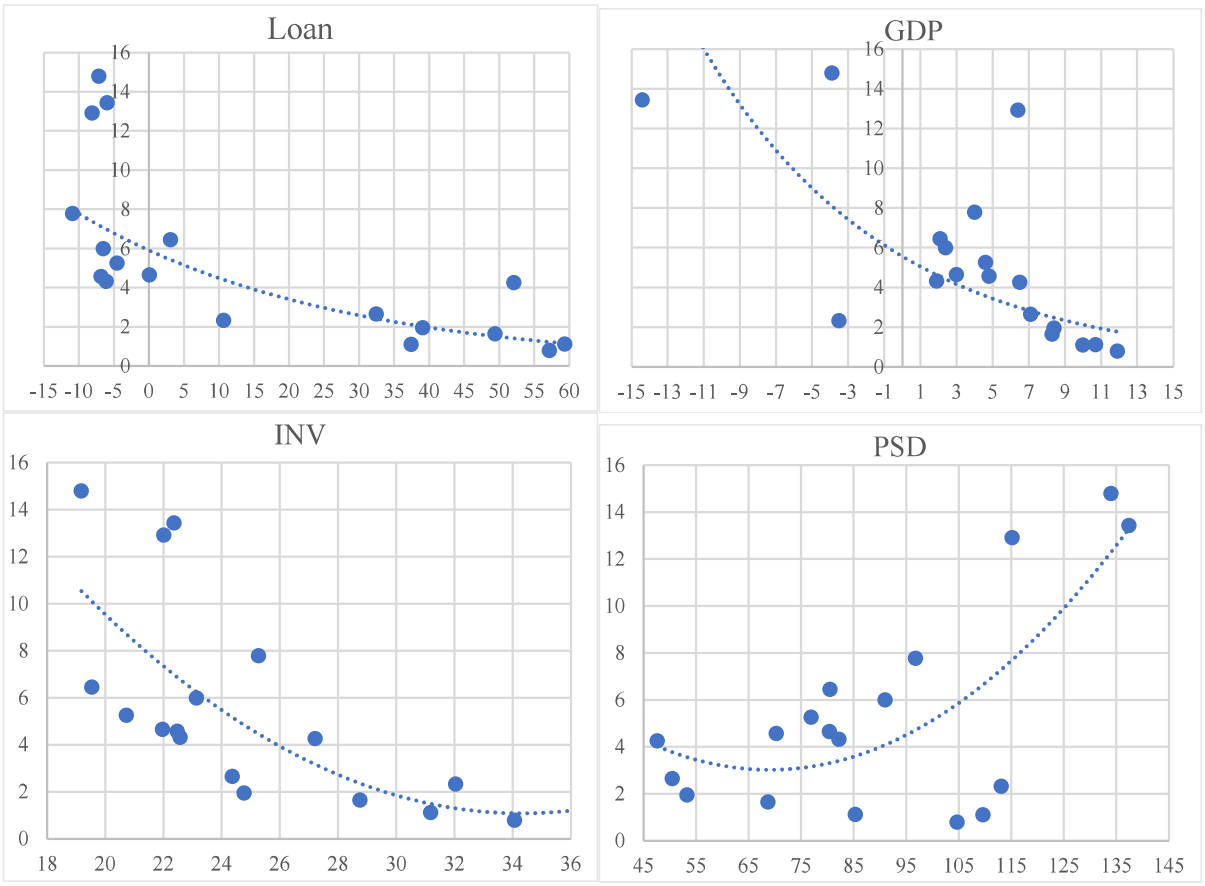
$H_A$: $\bar{p}_i - \bar{p}_i' > 0$ (4)

where $\bar{p}_i$ – the regression coefficients t-test average p-value for models with non-adjusted NPLs;

$\bar{p}_i'$ - the regression coefficients t-test average p-value for models with adjusted NPLs.

**FIGURE 2**
**MACROECOMOMIC INDICATORS AND ADJUSTED NPL TRENDS**






The following table summarizes the regression coefficients *t*-test *p*-values means and *t*-statistics for all 623 calibrated statistically significant models, as well as for the 230 screened. As shown in Table 2, for both regression model groups, *t*-stat > $t_{crit}$ at a confidence level of 0,95 and thus null hypothesis can be rejected and alternative hypothesis accepted. From this analysis we see that there is strong evidence to conclude that adjusted *NPL* provide higher explanatory power of determinants included in regression models. This conclusion is supported also by low (<0,01) *t*-test *p*-values.

**TABLE 2**
**REGRESSION COEFFICIENTS STATISTICS AND T-TEST RESULTS**

| Models | With NPL | | With NPL' | | *t*-statistic | df | $t_{crit}$ | *p*-value |
|---|---|---|---|---|---|---|---|---|
| | Mean | Variance | Mean | Variance | | | | |
| All 623 | 0,077223 | 0,018263 | 0,073685 | 0,014548 | 2,5092 | 1797 | 1,6457 | 0,0061 |
| Selected 230 | 0,005318 | 0,000146 | 0,004364 | 0,000084 | 2,7874 | 470 | 1,6481 | 0,0028 |

**Top 10 Best Fit Model's Statistics and Discussion**

The following Table 3 summarizes the coefficients of determination, *F*-statistics and *p*-values for top 10 statistically significant models.

**TABLE 3**
**TOP 10 REGRESSION MODEL'S STATISTICS**

| # | Variables | $R^2$ | $F$ | $p$ - value |
|---|---|---|---|---|
| 43 | *NWG, LtGDP* | 0,9125 | 78,238 | <0,0001% |
| 44 | *NWG, PSD* | 0,9106 | 76,387 | <0,0001% |
| 550 | *UNPL, HDI, LgtGDPg* | 0,9074 | 45,756 | <0,0001% |
| 551 | *NWG, Loan, PSD* | 0,8990 | 41,555 | <0,0001% |
| 435 | *HDI, LtGDP, Loan* | 0,8723 | 31,874 | <0,001% |
| 562 | *NWG, Loan, LTR* | 0,8683 | 30,765 | <0,001% |
| 387 | *INV, Loan, LTR* | 0,8605 | 28,775 | <0,001% |
| 490 | *LtGDP, HCPI, FDI* | 0,8575 | 28,093 | <0,001% |
| 546 | *LtGDP, FDI, HPI* | 0,8544 | 27,380 | <0,001% |
| 76 | *LtGDP, HCPI* | 0,8012 | 30,232 | <0,001% |

As one can see, the top 3 regression models explain more than 90%, while the top nine regression models explain at least 85% of the total NPL 's variability. This result is relatively high compared to the results reported in the studies (Espinoza, 2010; Foos, 2010; Nkusu, 2011; Klein, 2013; Skarica, 2014; Beck, 2015; Cucinelli, 2015; Filip, 2015; Tanaskovic, 2015; Beaton, 2016; Gila-Gourgoura, 2017; Kupcinskas, 2017). The *F*-test results show that the statistical stability of all top 10 models is high (<0,001%), but the probability of statistical error of the first four models is even lower than 0,0001%.

The following Table 4 summarizes the regression coefficients and *t*-test *p*-values for top 10 statistically significant models.

As one can see from Table 4, the regression coefficients *t*-test *p*-values for all top 10 models do not exceed 2,02%, but 23 out of 27 are less than 1%, indicating strong relationship between adjusted NPL's and relevant macro indicators. Meanwhile, the regression coefficient signs are as expected and consistent with those reported in most published studies. The most common macro indicators included in the top 10 models are "Loans to GDP", "Net wages growth" and "Loans growth", whose change per unit determines the change in adjusted NPL's by an average of 0,182 – 0,302; (-0,347) to (-0,176) and (-0,084) to (-0,043), depending on the other macro indicators included in a particular model, respectively.

**TABLE 4**
**TOP 10 MODEL'S REGRESSION COEFFICIENTS AND T-TEST P-VALUES**

| Model 43 variable | Regression coefficient | $p$ - value | Model 44 variable | Regression coefficient | $p$ - value |
|---|---|---|---|---|---|
| NWG | -0,3142 | 0,00002% | NWG | -0,3467 | 0,000004% |
| LtGDP | 0,1819 | 0,00015% | PSD | 0,0901 | 0,000182% |
| Model 550 variable | Regression coefficient | $p$ - value | Model 551 variable | Regression coefficient | $p$ - value |
| UNL | 0,4669 | 0,30017% | NWG | -0,3111 | 0,00080% |
| HDI | -0,3050 | 0,19438% | Loan | -0,0430 | 1,21938% |
| LgtGDPg | -0,3203 | 0,77603% | PSD | 0,0736 | 0,00685% |
| Model 435 variable | Regression coefficient | $p$ - value | Model 562 variable | Regression coefficient | $p$ - value |
| HDI | -0,3778 | 0,08546% | NWG | -0,1764 | 0,48534% |
| LtGDP | 0,3020 | 0,93635% | Loan | -0,0838 | 0,04360% |
| Loan | -0,1096 | 1,97106% | LTR | 0,5979 | 0,04730% |
| Model 387 variable | Regression coefficient | $p$ - value | Model 490 variable | Regression coefficient | $p$ - value |

| | | | | | |
|---|---|---|---|---|---|
| INV | -0,3433 | 0,75501% | LtGDP | 0,2319 | 0,00043% |
| Loan | -0,0722 | 0,43429% | HCPI | -0,4519 | 0,17191% |
| LTR | 0,7844 | 0,00260% | FDI | -0,1098 | 1,68956% |
| Model 546 variable | Regression coefficient | *p* - value | Model 76 variable | Regression coefficient | *p* - value |
| LtGDP | 0,2518 | 0,00014% | LtGDP | 0,2516 | 0,00038% |
| FDI | -0,5157 | 2,01247% | HCPI | -0,6128 | 0,00905% |
| HPI | -0,4607 | 0,15385% | | | |

## CONCLUSIONS

Numerous studies on non-performing loans have been conducted since the global financial crisis, with particular attention to their macroeconomic determinants. Studies reveal that one of the important factors is the rapid loan growth in pre-crisis years, which in Latvia exceeded 48% on average in years 2001-2006. Such rapid credit growth does not allow for an objective assessment of the true quality of credit with the widely used NPL ratio. As research shows, only 1-2 years later the true ability of borrowers to make loan payments without delay appears.

This study proposes adjusting the traditionally used NPL ratio with credit growth during 12 month period. Therefore, the NPL amount at the reporting date is divided by the total outstanding loan amount one year in advance (1). The research demonstrates that the adjusted NPL ratio reduce the NPL ratio valuation bias and is more conservative in the assessment of credit quality in years of strong credit growth and thus provides more critical information for making credit decisions.

To evaluate the impact of the NPL ratio adjustment on credit risk drivers associations with macroeconomic indicators, combining 13 macro indicators selected based on literature research and correlation analysis results, 623 statistically significant regression models were generated in this study and compared with analogous regression models, where the non-adjusted NPL was included as the dependent variable. *p*-values difference in between regression coefficients *t*-test average *p*-value for models with non-adjusted and adjusted NPLs *t*-test at significance level of 0,95 provides sufficient evidence that the adjusted NPL ratio shows stronger associations with key macroeconomic indicators. Therefore, it can be concluded that the adjusted NPL ratio provides better possibilities to explain risk drivers impact on credit quality.

The quality of NPLs analysis can be improved by using multiple models in parallel to estimate expected levels of credit risk as a weighted average of multiple outcomes, for example, taking in account the availability and reliability of macro indicators forecasts, and the preference of each model to soft criteria and other considerations.

Similarly, before using developed and calibrated models, it is important not only to check their statistical stability, but also to carefully evaluate model residuals, as research (Spilbergs, 2020) shows that each model has different behaviors during different economic cycles and should not be ignored.

According to the study, the most influential macroeconomic indicators of credit quality are "Loans to GDP", "Loans growth", "Net wages growth" and others. In this respect, the study largely coincides with the previous and described in the literature.

It is important also to remember that once created econometric models cannot be considered to be of good quality over a longer period of time, as the environment is changing and therefore needs to be regularly checked and, if necessary, recalibrated.

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