

A COMPARATIVE ANALYSIS OF NON-PERFORMING LOANS' SENSITIVITY AND
ADAPTATION TO ECONOMIC SHOCKS IN UKRAINE

by

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Abstract

In 35 years of independence, Ukraine has already experienced several economic and financial crises. The Ukrainian banking system bore the consequences, thereby improving its operational mechanisms for managing NPLs, but some banking groups handled crises better than others. This project studies how different types of banks in Ukraine – state-owned, foreign, and private – react to economic crises, analysing the relationship between credit risk and macroeconomic instability. This research aims to answer the question: How do the sensitivity and speed of adaptation of non-performing loans to shocks in the real and financial sectors differ across banks in Ukraine? The literature from previous years studies how external shocks, crises, and internal decisions affect bank stability and the level of NPLs. This study will cover the same topics but will focus on and build models for Ukraine. Given the number of financial crises Ukraine faces, it is a highly relevant field of study. In this research, the Autoregressive Distributed Lag (ARDL) model will be used to analyse time-series data from the 2008-2025 period to estimate the long-run elasticity of NPLs with respect to Real GDP and the Financial Stress Index. The findings may be valuable to NBU in understanding which banks need more attention and support to maintain economic stability.

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List of Abbreviations

ARDL Autoregressive Distributed Lag

ECT Error Correction Term

FSI Financial Stress Index

GDP Gross Domestic Product

IRF Impulse Response Function

NBU National Bank of Ukraine

NPI Non-Performing Loans

OLS Ordinary Least Squares

Chapter 1. Introduction

In 2015, the National Bank of Ukraine implemented a banking sector reform, which resulted in a cleansing of the banking system. It resulted in the removal of more than 80 so-called “zombie” banks (banks that were de facto dead but continued to exist legally), in order to make space for more solid institutions (Hlazunov and Verchenko 8). However, it was not only a cleanup but a redesign of the country’s banking system. The research paper is not about banks that have collapsed or those that have survived; it is about looking at the negative effects of credit risk, which can lead to bank insolvency.

This study examines and compares the effects of economic and financial crises on the level of NPL, and how these crises affect the materialisation of credit risk. As all bank have their own rules, business models, and governance structures, the results may differ. According to Klein (4-6), the main reasons for NPLs are GDP contraction and exchange rate volatility. However, what is not included is the idea that banks are different, and perceiving them as one whole thing may be wrong. This research accounts for this difference by using the Autoregressive Distributed Lag model, which is well-suited to Ukrainian volatile economic data (Zomchak and Lapinkova 51). This model will help to understand which types of banks are better/worse at maintaining their stability in crisis-like situations.

Sinay (676) and Zainol et al. (693) found that bank internal efficiency and external economic conditions affect the mitigation of non-performing loans, suggesting that foreign institutions are better at dealing with problem loans than slow, bureaucratic state-owned banks. According to Kollmann (78-79), risky business models that value higher profit over safer approaches lead to bank vulnerability. When a macroeconomic shock occurs, borrower income decreases, leading banks to lose their loans, which in turn triggers a crisis. This research examines how external shocks to GDP and financial stress affect credit risk across different groups of banks, and whether the assumptions and tests made by the aforementioned authors apply to Ukraine.

This study also uses the ARDL model to estimate the number of quarters it takes for each bank type to return to the long-run after a shock.

Chapter 2. Literature review

The main question in the vast majority of Non-Performing Loan research is identifying the causes of their occurrence. Most studies and the existing literature on Non-Performing Loans focus solely on the economic cycle and traditional economic vulnerabilities, such as GDP growth, inflation, and the unemployment rate. How exactly do macroeconomic factors and financial stress ruin the quality of banking sector credit portfolios?

But taking into account the current situation – frequent crises – there is a need to shift the research focus. The main question of this work lies not in the simple existence or the causes of NPL, but in how the banking system's institutional heterogeneity modifies the response to macroeconomic shocks.

Modern economic literature establishes that Non-Performing Loans not only contribute to a bank's internal stability problems, but also reflect the general health state of a country's economy. When an economic crisis occurs, its impact is immediately reflected in the balance sheets of financial institutions. Nkusu explored these dynamics deeply, focusing on “feedback loops” that connect financial vulnerability to macroeconomic dynamics (3-4). The author used panel data analysis and Vector Autoregressive (VAR) models across 26 countries with developed economies. The study shows that declines in GDP growth, rising unemployment, and contracting asset prices lead to a rapid, statistically significant rise in NPLs. This author's study concludes that when a large number of NPLs accumulate on balance sheets, they become the primary factor that slows down the economy. This leads to a decline in banks' profits and a halt to new credit extensions, making it hard for private-sector development and pushing GDP even lower. These findings confirm that GDP remains a significant factor in explaining and predicting NPLs' behaviour.

Pesola introduced the concept of "combined shock" and mathematically demonstrated this point using the example of Nordic economies, arguing that a severe debt crisis rarely results from a single factor, such as GDP alone (25). In reality, the economy collapses when there is an auxiliary factor: a

real-sector shock plus an abrupt jump in exchange or interest rates. These results scientifically demonstrate the need to include more than one factor in econometric models; in this case, the GDP indicator and FSI.

The majority of modern research states that the banking system does not react to crises in the same way. Empirical evidence suggests that institutional heterogeneity depends on the type of ownership the bank has. In transitional economies like Ukraine, there are three groups of banks' business models: state-owned, private, and foreign. Operating under different business models, these three types of banks face distinct regulatory requirements.

The research by Hlazunov, Dadashova, and Lukianenko examines how bank ownership type influences banks' responses to monetary and macroprudential policy impulses (11). By implementing the ARDL evaluation method, the authors found that banks with foreign capital have the fastest speed of adjustment to new economic conditions. More specifically, while private and state banks face structural delays, foreign banks remain the most flexible. This research highlights why it is important to analyse the banking system not only as a single entity but also by ownership type.

Zainol et al. provide an institutional explanation for differences in the speed of adaptation across the aforementioned segments (693). The authors' study found that it takes much longer to recognise and write off NPLs for banks under the supervision of both local National Bank and international parent offices. A conservative approach to risk assessment slows the asset clean-up procedure, as shown by the authors' calculations.

To better understand the dynamics of how financial pressure shifts portfolio quality, Nikolaidou and Vogiazas analysed the relationship between financial stress and portfolio quality in Eastern European countries (88). Using the ARDL analysis, the authors concluded that financial stress acts as an accelerator of credit risk, causing private banks to lose stability much more quickly than those with foreign or state support. Without support, banks with private capital are forced to cover all losses with their own resources, which leaves them vulnerable.

Additionally, Sinay (684) found that the subsidiaries of international financial groups are better protected from local macroeconomic shocks and devaluation. An empirical analysis of bank resilience in transition economies found that foreign banks, compared to private banks, exhibit lower amplitude. In the end, cleaning up the final portfolio takes longer simply because there are no mechanisms for rapid administrative write-offs.

This validates with the work of Kollmann et al., who investigated the paradox of how state banks manage to quickly recover their balance sheets after major crises (77). Traditional management theory suggests that because state banks are perceived as more bureaucratic and less efficient, they should adapt slower than their market competitors. The authors showed that this rapid recovery is driven by the direct influence of the government's recapitalisation programs. However, under these programs, the government essentially covers the bank's capital shortage using budget funds. This concludes that the quick return of state-owned banks to stability is not due to market mobility but rather a result of administrative and fiscal support. Nationalisation serves as a good example, completely separating an institution from normal market cycles. In such scenarios, NPL volumes depend on historical legal disputes and changes in accounting rules rather than current GDP trends.

Chapter 3. Data and Methodology

RESEARCH QUESTION

This is the question that current research is investigating: How do the sensitivity and speed of adaptation of non-performing loans to shocks in the real and financial sectors differ across state-owned, private, and foreign banks in Ukraine?

Hypotheses

To address the expected outcomes, the following hypotheses were developed:

Hypothesis 1: Changes in real GDP and the FSI are the main triggers determining the dynamics of non-performing loans in Ukraine.

Hypothesis 2: The impact of macroeconomic and financial shocks on credit risk is different and depends on the type of bank.

Hypothesis 3: Private banks have a higher rate of return in the normal state after shocks compared to foreign and state-owned banks.

Hypothesis 4: The credit risk of PrivatBank is detached from the market cycle and is driven by historical decisions and legal changes.

To assess quantitative sensitivity to NPL and the speed of adaptation, the ARDL model is applied. Such a method is used because of the specificity of Ukraine's financial sector, one of the main factors being the number of crises and the ongoing war. Classical econometric methods require all data to have the same structure (integrated first-order), which does not apply to the data in this research. The ARDL method can estimate short-term and long-term relationships with both stationary data in levels and first-order integrated data. In this research, GDP growth and FSI exhibit level properties, while NPLs data are typically of an integrated first-order type. According to the research by Nikolaidou and

Vogiazas, the ARDL method is highly effective for analysing credit risk in Eastern European countries (94).

There are two stages for the econometric analysis of the study: the Bounds Test and the Error Correction Model. The first stage tests for cointegration in long-term relationships among the variables, while the second stage shows the effects of macroshocks, separated into long-run elasticities and short-run balance sheet adjustments.

To sum up, this research combines the approaches used in the previously mentioned studies and broadens them by dividing the banking sector into types, rather than treating it as a single entity. The results help to identify which banking model displays the highest resilience and structural efficiency within the Ukrainian economy. The following sections provide a detailed description of the specific variables selected for the empirical analysis.

Dependent Variable

The dependent variable in this study is Credit Risk, operationalised as the Non-Performing Loans ratio, expressed as a percentage of the total credit portfolio. This metric is a primary indicator of asset quality and shows the level of credit risk across the banking sector by tracking the share of loans that have become delinquent due to borrower insolvency.

Independent Variables

The empirical models include two independent variables. The first is Economic Shock, which is measured as the percentage change in Real GDP from quarter to quarter. It represents the state of the economy and the income of the country's population. This variable is perceived as an Economic Shock because it reflects a sharp decline in GDP, worsening the financial position of banks' clients and increasing debt. The second independent variable is Financial Stress, measured by the quarterly average value of the Financial Stress Index. It reflects the current level of stress in Ukraine's financial sector, complicating debt management amid inflation and/or exchange rate fluctuations.

Control Variable

In the modelling of Ukrainian financial indicators, it is important to include the possibility of structural breaks. Financial crises, war escalation, and regulatory regime changes that lead to the closure of dozens of banks can negatively influence econometric results. Taking the previously mentioned factors into account, current research uses two dummy variables to account for structural shifts. These variables represent the banking system cleanup reform of 2017, which led to the nationalisation of Privatbank, and the exogenous shock of the start of a full-scale invasion in 2022.

d_2017 is a binary variable representing the structural shift following the nationalisation of PrivatBank and changes in NPL accounting methodology. d_war is a binary variable representing the impact of the 2022 full-scale invasion.

MODELS

To precisely describe the heterogeneous Ukrainian banking system and test whether different types of banks perform differently, five models for each banking group were developed. Such an approach was chosen based on the banking group division used in the research by Hlazunov, Dadashova, and Lukianenko, which demonstrated that Ukrainian banks encounter asymmetric responses to macroeconomic impulses depending on the form of capital ownership. There is a model for each banking group in the research (11).

Model 1 – Total Market

Model 2 – State banks without PrivatBank

Model 3 – PrivatBank

Model 4 – Private banks

Model 5 – Foreign banks

PrivatBank is separated from state-owned banks under its own model due to its financial history and scale, as the results for the state banks model would have been twisted. Privatbank is the biggest bank in Ukraine, and given its large volume of NPLs, the model of a state bank would have been obscured. Analysing PrivatBank as a separate model saves the econometric clarity of the analysis for the rest of the state institutions.

For each of the aforementioned banking groups' models, there is a long-run equilibrium equation:

$$NPL_i = \beta_0 + \beta_1 \cdot GDP + \beta_2 \cdot FSI + \gamma_1 \cdot d_{2017} + \gamma_2 \cdot d_{war} + \epsilon_i$$

- β_1, β_2 - long-run sensitivity coefficients for the macroeconomic and financial triggers, respectively;
- γ_1, γ_2 - long-run intercept adjustment coefficients for the structural changes and exogenous shocks;
- ϵ_i — white noise.

Chapter 4. Empirical Analysis and Results

In credit risk modelling, there are significant time lags due to banks' inability to recognise and write off a bad loan in the same period when GDP has fallen, or FSI has risen. To better understand how macroeconomic and financial shocks behave over time, this research implements impulse response functions.

Before estimating the econometric model, the dynamics of the NPL ratio with respect to real GDP and FSI are visually analysed using Figures 1 and 2. The analyses provide preliminary information on the relationships among the state of the real sector of the economy, financial stability, and the quality of banks' credit portfolios. Aforementioned analyses across different banking groups are provided below.

COMPARISON BETWEEN NPL RATIO AND REAL GDP

The dynamics between the NPL ratio and real GDP provide several observations that warrant further exploration. In 2017, there was an evident increase in the NPL ratio within state banks, as that year saw the nationalisation of Privatbank and a change in the NBU's asset valuation methodology (the implementation of Resolution No. 351). This regulatory transition led to NPL ratios reaching almost 90% for state-owned banks (see Fig. 1). At the same time, other banking groups also saw a rise in their NPL ratios throughout 2017. However, they never reached the levels of the state banks. The main difference is that state banks were loaded with large amounts of bad loans, while private and foreign banks were actively writing them off. On top of that, private banks were much more flexible in debt restructuring, helping them prevent loan defaults.

When the full-scale invasion began in 2022, GDP declined rapidly, simultaneously triggering a visible spike in the NPL ratio. Yet, compared with the 2017 banking crisis, the 2022 rise in NPLs was relatively contained for several reasons. The main difference lies in the nature of the shocks: the 2017 crisis was driven by the exposure to bad loans, while the 2022 shock was exogenous, with the system already clean of bad loans. The overall increase in NPL volume was driven by asset destruction, the occupation of Ukrainian territories, and business closures. However, the impact was mitigated by regulatory exemptions issued by the National Bank of Ukraine. If the delays were war-caused, they were not recognised as defaults, while also allowing banks to restructure without lowering the borrower's credit score.

Another important aspect of Ukrainian banking is being ready for a full-scale invasion: regular stress testing of banks. Years prior to the full-scale invasion, NBU had incorporated geopolitical risks and potential military escalation into its stress-testing structure. So when the shock happened, the system was both clean after the 2017 reform and ready to work under pressure, maintaining banking operations.

The GDP recovery spike seen in Figure 1 in 2023 is driven by international financial support and the Ukrainian private sector's strong adaptation to wartime conditions, rather than by classical industrial development. However, the NPL ratio did not decline as it usually does, suggesting that there is a significant delay (time lag) before bank loans' quality actually starts to improve.

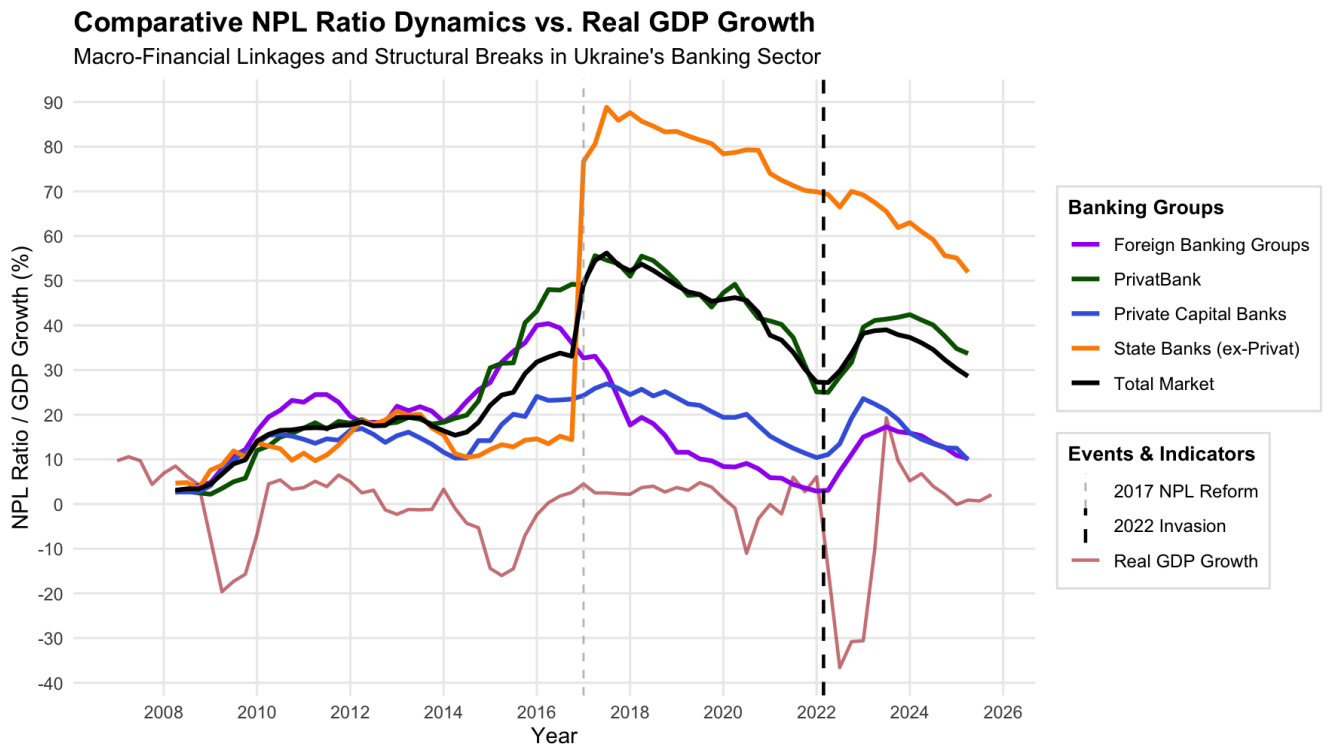


Fig. 1. Comparative dynamics of NPL ratios across banking groups and real GDP growth in Ukraine (2008–2025); Author's calculations based on the NBU data in R

COMPARISON BETWEEN NPL RATIO AND FSI

The visualisation of the dynamics of the NPL ratio and the Financial Stress Index reveals another side of the reactions to the same shocks discussed previously. The FSI serves as an indicator of market volatility. Notably, FSI spikes typically precede increases in the NPL ratio (see Fig. 2). The largest peaks of financial stress occurred in 2014 and 2015, driven by political instability triggered by several factors. In January 2014, the escalation of the Maidan triggered a shock in the form of a massive withdrawal of funds from bank deposits and, subsequently, from currency. The absolute peak in FSI occurred in 2015, driven by the escalation of Russian aggression against Ukraine, uncontrolled

devaluation, and the official announcement of sovereign debt restructuring. As mentioned previously, the effect of these shocks on the NPL ratio did not occur at the same time, instead it began to rise gradually. Due to economic inertia and the rule that a loan is considered defaulted after 90 days of being overdue, the banking system had been accumulating problems for about 2 years. This confirms that a financial crisis can have a delayed effect on the credit crisis with a delay of 1-2 years (4-8 quarters).

The previously mentioned observation about the delayed effects of FSI shock explains what appears to be a visual anomaly. FSI remains stable, while the 2017 NPL ratio has increased dramatically – it was not a new market crisis, but rather a regulatory cleanup. The financial stress of 2015 created the problem, and the 2017 reform finally made it appear in the reports.

In contrast to 2017, during 2022's full-scale invasion, FSI increased rapidly, while the NPL reaction was relatively low. This kind of reaction occurred due to NBU Resolution No. 18 (February 24, 2022), which introduced regulatory forbearance. Such institutional readiness was a key to ensuring the system's resilience and preventing a repeat of the 2017 crisis.

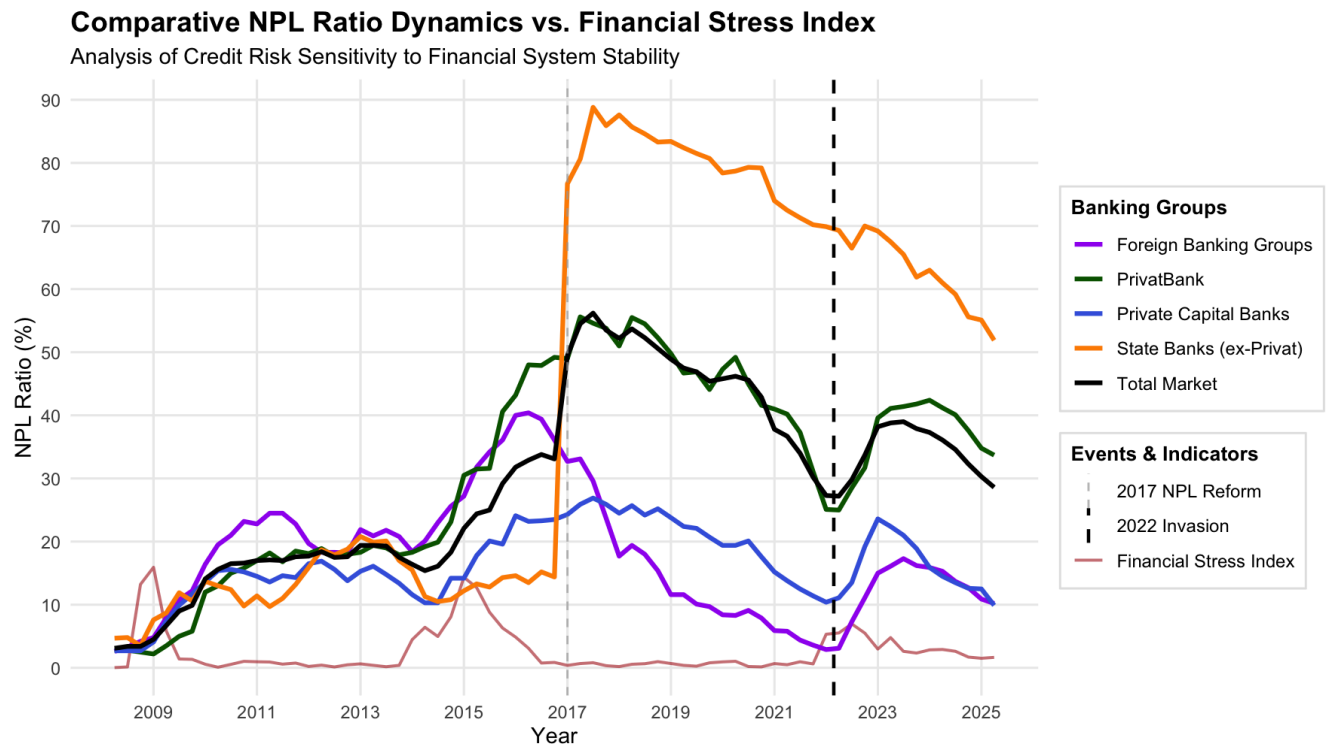


Fig. 2. Comparative dynamics of NPL ratios across banking groups and fluctuations in the Financial Stress Index in Ukraine (2008–2025); Author’s calculations based on the NBU data in R

After analysing the dynamics of the NPL ratio with GDP and FSI, the conclusion is that the relationship is non-linear and more complex. Simple correlation metrics fail to capture all the structural dynamics of the Ukrainian banking sector, including time lags, the 2017 institutional changes, and the portfolio resilience in 2022. To thoroughly quantify these interactions, the Autoregressive Distributed Lag (ARDL) framework is used for further empirical estimation.

For each model, the following tests and estimations were performed:

- Stationarity Testing: ADF tests are conducted at both levels and in first differences to determine the integration order of the variables.
- Model Selection: Automated lag selection was performed with the Akaike Information Criterion (AIC) to find the optimal lag structure for each banking group.

- Cointegration Testing: The ARDL Bounds F-test was used to test for the existence of long-run relationships between NPLs, GDP, and FSI.
- Error Correction: The Restricted Error Correction Model (RECM) was used to estimate the speed at which NPL ratios return to equilibrium after a shock (Speed of Adjustment).
- Impulse Response Functions: The IRF estimate was conducted to visualise the dynamic impact of macroeconomic shocks on credit risk over time.

The following sections describe the test results in detail, with Tables 1 and 2 containing the calculation results.

IN LEVELS REGRESSION ANALYSIS

Table 1. ARDL model estimation results for variables in levels

Banking Group	Total Market	State Banks	Privatbank	Private Banks	Foreign Banks
Speed of Adj.	0.0107**	-0.1026**	0.0502***	-0.0011***	-0.0639***
s.e. (ECT)	(0.0016)	(0.0307)	(0.0073)	(0.0001)	(0.0071)
Long-run GDP	N/A	0.30	N/A	N/A	-0.33***
s.e. (L-R GDP)	N/A	(0.44)	N/A	N/A	(0.08)
Long-run FSI	N/A	0.03	N/A	N/A	0.41
s.e. (L-R FSI)	N/A	(0.17)	N/A	N/A	(0.27)
Bounds F-stat	8.18	2.04	8.75	9.56	14.82
ADF p-value	0.8242	0.7297	0.7324	0.7603	0.2377

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. N/A indicates that the coefficient was not estimated due to the lack of long-run cointegration; Author's calculations based on the NBU data in R

Speed of Adjustment is the primary indicator of whether the system is working correctly. It explains how quickly NPL returns to its pre-shock level (in quarters). Figure 3 displays a visual comparison of ECT results.

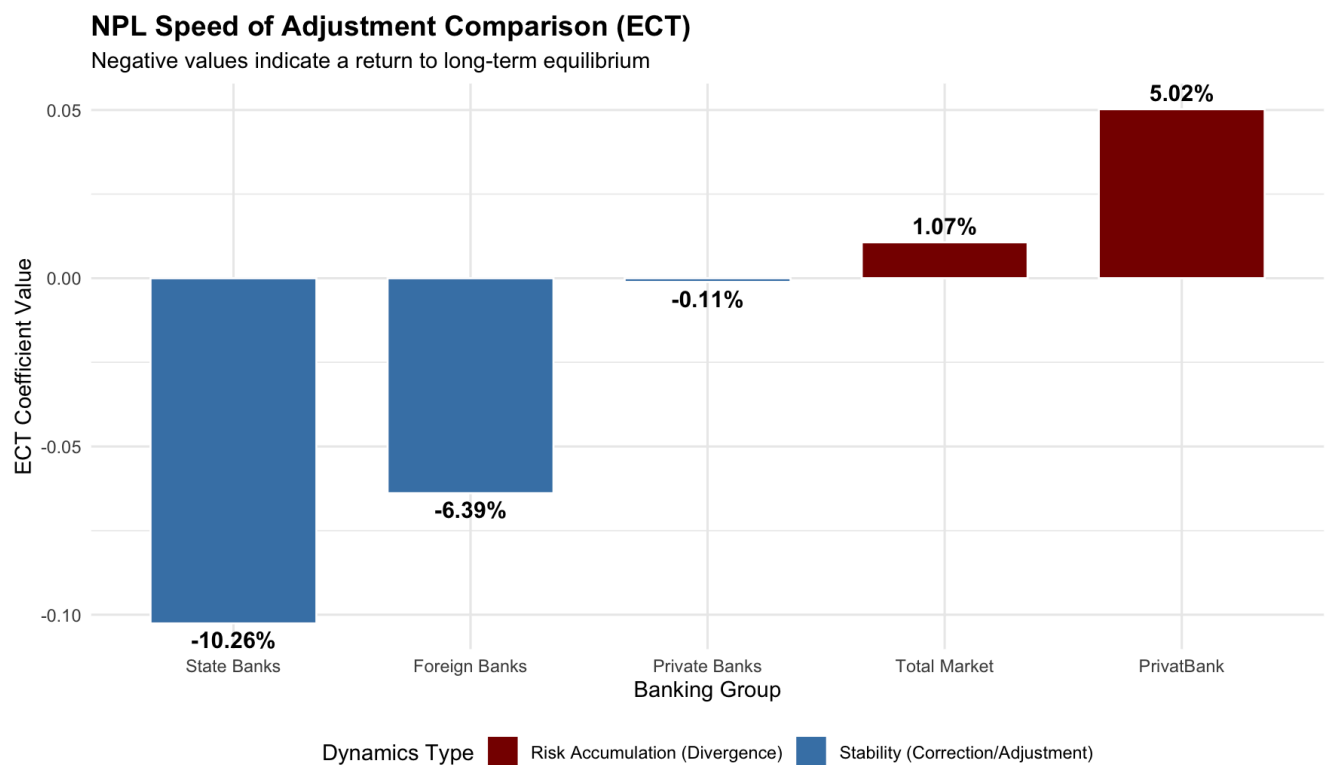


Fig. 3. Speed of adjustment to long-term equilibrium (ECT coefficient) comparison across banking groups; Author's calculations based on ARDL model estimation

For both Total Market and Privatbank, the values are positive numbers, 0.0107 and 0.0502, respectively, which is a sign of divergence. It means that instead of returning to the normal state after the shock, NPL proceeds to stay or even grow further. The market insists there was no mechanism for self-cleaning. As for Privatbank, positive ECT is the result of nationalisation and balance cleaning in

2017. The shock of the excessive rise in NPLs was so great that the system was not able to return to previous levels.

For state banks, the speed of adjustment is -0.1026, indicating that, on average, around 10.3% of the NPL shock is corrected each quarter. This shows a slow but steady recovery process.

Private banks show an ETC of -0.0011, although it is statistically significant, the value is almost zero. Such numbers indicate that private banks cannot reduce their NPL levels once the shock occurs.

Foreign banks demonstrate an ECT level of -0.0638, being the most stable ones among the other groups. Banks with foreign capital proceed to correct about 6.4% of their NPL level quarterly, which may imply adherence to foreign standards.

The long-run effects of NPL on both GDP and FSI are similar. For Total Market, Privatbank, and private banks, the model could not produce a long-run estimate. This means that, for these models, GDP and FSI do not influence in the long-run period.

State banks have insignificant results for both GDP and FSI, suggesting that neither economic growth nor financial stress is a main driver of NPL decrease. The standard error of 0.44 confirms that the results are not significant.

The only banking group with significant results is foreign banks, showing that the GDP growth is one of the main reasons for the NPL decrease. The results demonstrate that for every 1-unit increase in GDP growth, the NPL ratio in foreign banks drops by 0.33 units in the long run. For the FSI, the result turned out to be insignificant, suggesting that short-run stress is less likely to influence NPL, in contrast to GDP.

The bound F-test indicates a connection among all bank groups (as indicated by high test statistics), except state banks. However, for ADF, the p-values are too high, so the obtained results are incomplete and not final.

The results of the aforementioned tests have led to the conclusion that additional tests are needed for several reasons. Positive values of ECT imply that the economic system of Ukraine is

unable to recover at all, which is an economic paradox. Another reason is high ADF values, showing that the residuals of linear models are not stationary. In Ukraine, it is common for NPLs to change not by 1-2% per month but in large clusters, 2017 and 2022 being good examples. Linear models used in previous tests cannot handle these large clusters effectively enough. Considering all these factors, it was decided to log-transform the values to reach the results that are more economically realistic.

LOG AND FIRST DIFFERENCES REGRESSION ANALYSIS

Table 2. ARDL model estimation results for log-transformations and first differences

Banking Group	Total Market	State Banks	Privatbank	Private Banks	Foreign Banks
Speed of Adj.	-0.0731*	-0.1379*	-0.2069*	-0.0861*	-0.0448*
s.e. (ECT)	(0.0093)	(0.0201)	(0.0583)	(0.0090)	(0.0081)
Long-run GDP	-2.52	-2.79	0.47	-6.75**	-21.26
s.e. (L-R GDP)	(1.53)	(2.51)	(1.22)	(2.88)	(14.91)
Long-run FSI	1.77	2.76**	0.01	2.46	-1.49
s.e. (L-R FSI)	(0.98)	(1.04)	(0.49)	(1.46)	(2.79)
Bounds F-stat	11.49	8.63	2.32	17.14	5.55
ADF p-value	0.0450	0.0179	0.0424	0.0210	0.0875

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. N/A indicates that the coefficient was not estimated due to the lack of long-run cointegration; Author's calculations based on the NBU data in R

The results after applying the log transformation to the data are stabilised versions of time-series values. Compared with the values in Table 1, the new results demonstrate economically significant elasticity values.

The test's key findings are negative, statistically significant ECT values across all banking sectors, unlike the previous model. This confirms the existence of a self-recovery mechanism in Ukraine's economic system. Privatbank shows the highest after-shock recovery dynamics, with an ECT of -0.2069, indicating that the system can correct more than 20% of the imbalance per quarter. State and private banks have pretty stable adjustment speeds of 13.8% and 8.6%, respectively. Foreign Banks turned out to be the least adaptive, with a 4.4% recovery rate. The lowest rate is due to foreign Banks following not only NBU rules but also the strict standards of their main offices in other countries, prioritising these standards over the current economic situation in Ukraine.

In the long-run effects, the biggest impact of real GDP on NPLs is observed in Banks with private capital. The long-run coefficient of -6.75 indicates the high sensitivity of the private banking sector to macroeconomic volatility. More specifically, it means that for every 1% decrease in real GDP, the NPL rate increases by 6.75% over the long term. For all other banking groups, the GDP coefficients are either mediocre or statistically insignificant, demonstrating the structural diversity within the Ukrainian banking sector.

Regarding the FSI, the long-run effects indicate that state banks are the most vulnerable to systemic financial shocks. A 1-unit increase in FSI results in a 2.76% increase in NPLs in this sector. This is explained by state-sector lending to strategic enterprises (energy complexes, infrastructure, military-industrial complexes, etc.), which are typically the first to show signs of distress during the devaluation of the hryvnia. For private and foreign Banks, the influence of financial stress is less pronounced in the long run. As for banks with private capital, the explanation is that they have a better

ability to adapt to currency shocks. Foreign banks in Ukraine can withstand financial stress with support from their parent companies and access to external capital.

The Bounds F-statistic cointegration test for state and private banks proved a fundamental link between the economic cycle and credit portfolio quality. Foreign banks have a slightly lower value, indicating that these types of banks are less dependent on the Ukrainian market and rely more on the standards of their parent groups. The Privatbank value underscores that there is no stable connection between NPL and FSI, due to legal factors and nationalisation. The stationarity test of the residuals confirms the validity of the findings, except for foreign banks, possibly due to the aforementioned dependence on parent companies' global strategies.

IMPULSE RESPONSE FUNCTION ANALYSIS

The coefficients obtained from the ARDL models provide this research with a quantitative assessment of long-run and short-run relationships. They show a static view of how macroeconomic shocks affect NPL, but to better understand the magnitude of these effects, it is important to know how these risks accumulate over time.

That is why the study moves further away from static coefficients toward Impulse Response Functions (IRFs). This analysis simulates a shock to GDP or FSI and shows its impact on the graph over 12 quarters (see Fig. 4). The previous tables' analysis shows whether the connection exists at all, where IRF functions demonstrate how long it takes for the banking sector to recover after shocks.

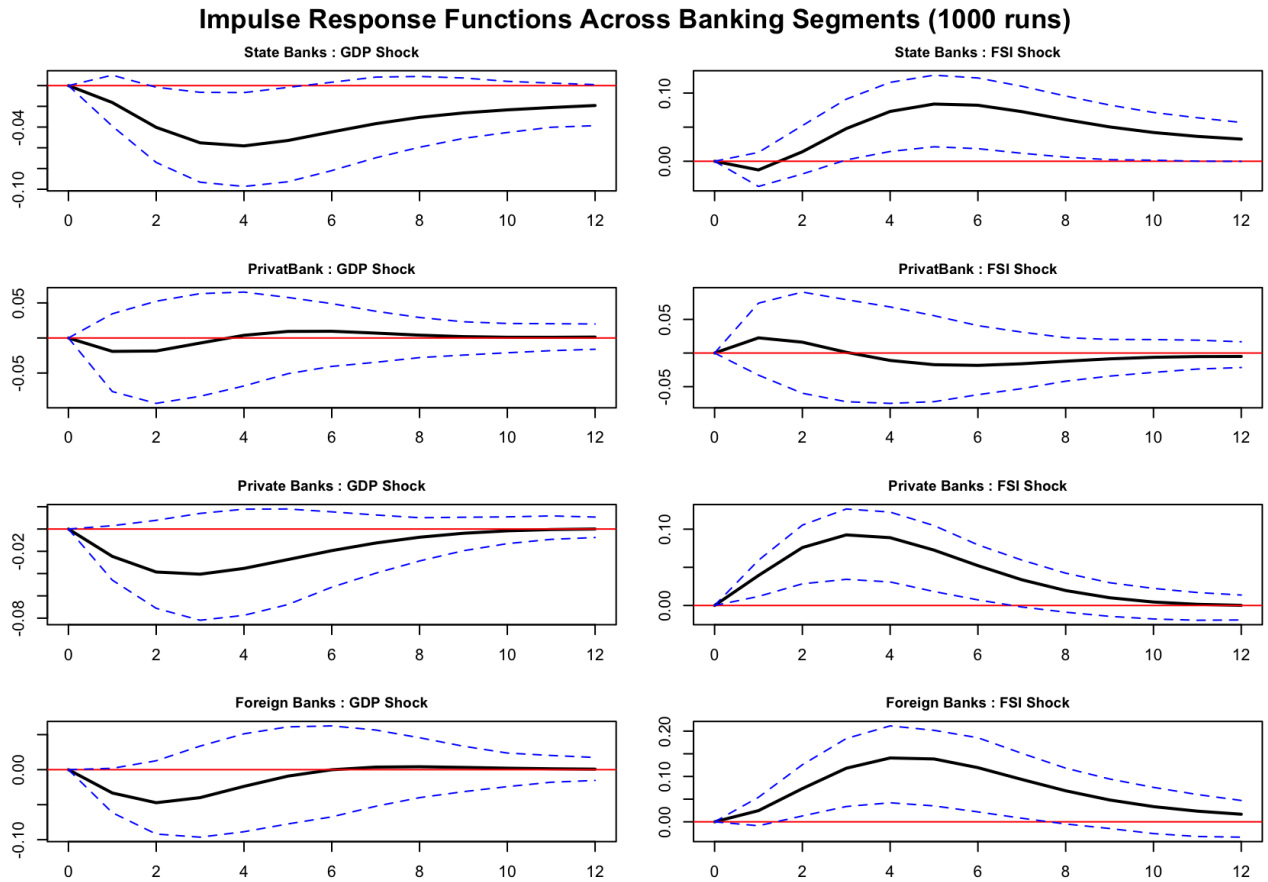


Fig. 4. Impulse Response Analysis for Ukrainian Banking Segments (2008–2025); Author's calculations based on the estimated ARDL model parameters.

The results of the GDP shock vary across the four analysed bank categories: while a positive GDP shock reduces the amount of NPL, confirming the inverse relationship between credit risk and economic growth, the duration of the effects differs across categories.

For state banks and private banks, the results are pretty similar – segments show statistically significant results. As shown, the NPL ratio begins to decline almost immediately after the shock, with the greatest improvement in the third and fourth quarters. State banks' after-shock recovery lasts longer than private banks' – the return to the baseline accelerates after the sixth quarter. It can be argued that economic growth benefits domestic banks.

Privatbank experiences a more stable response, not as intense as state banks, even with a negative trend. According to the results, Privatbank is rather driven by historically bad portfolios than by quarterly GDP.

Foreign Banks, unlike the other categories, show a much quicker and more momentary reaction to shocks. The peak of improvement is in the second quarter, reflecting their rapid credit restructuring and successful risk management.

Redirecting attention from the real economy to the financial situation, this paper now examines how FSI affects NPL ratios. Though similar in some respects, unlike the positive effect of GDP growth, financial stress acts as a direct catalyst for risk acceleration.

State banks demonstrate a delayed but significant increase in NPLs after the second quarter, reaching a peak between the fifth and sixth quarters. Such a delay confirms the previous statement – state banks act as a buffer against financial stress, taking the main hit on their balance sheets, but in 1-2 years, financial shock surfaces in the form of defaults.

Privatbank, similar to the reaction to the GDP shock, has the most unique reaction to the shock. The reaction to FSI is relatively low and statistically insignificant in the long run, indicating that Privatbank's NPL coefficient is not related to market financial stress due to the consequences of nationalisation.

Private banks have the highest and most immediate reaction to financial stress, as shown by a rapid NPL spike in the first quarter that peaks in the third quarter. Such a reaction proves that private capital is particularly vulnerable to market panic.

Lastly, foreign banks exhibit a gradual, relatively steady buildup and return to equilibrium, peaking in the fourth quarter. The impact of financial stress is clear, but the reaction is smoother

compared to private banks. Such a reaction implies support from parent banking groups, which helps moderate the shock's intensity.

Chapter 5. Hypotheses Results

Based on the ARDL models and Impulse Response Function analysis, four hypotheses were tested to estimate the dynamics of credit risk in the Ukrainian Banking sector.

Hypothesis 1 statement: Changes in real GDP and the Financial Stress Index are the main triggers determining the dynamics of non-performing loans in Ukraine → is confirmed. According to the cointegration Bounds F-test results, the existence of a long-run relationship was confirmed for all banking groups except Privatbank. Long-run coefficients of both GDP and IFS are statistically significant with a p-value < 0.05 , confirming that these indicators are triggers for a credit risk. Where GDP serves as an element for the improvement of portfolio quality, financial stress serves as the catalyst for defaults.

Hypothesis 2 statement: The impact of macroeconomic and financial shocks on credit risk is different and depends on the type of bank → is confirmed. Empirical evidence indicates significant heterogeneity in the banking sector: ARDL models for different banking groups exhibit diverse time lags, and IRF graphs show different reaction patterns, ranging from an immediate increase in credit risk in private banks to a 1-2-year response in state banks.

Hypothesis 3 statement: Private banks have a higher rate of return in the normal state after shocks compared to foreign and state-owned banks → is rejected. The assumption that banks with private capital are more flexible than other types of banks has not been mathematically confirmed. The highest rate of adjustment was recorded among state-owned banks, likely due to systematic recapitalisation programs. In the IRF analysis, foreign-owned banks show the best results on the GDP graph, but in the FSI reaction, private banks show a better response. Because the hypothesis is only partially correct, it is rejected.

Hypothesis 4 statement: The credit risk of PrivatBank is detached from the market cycle and is driven by historical decisions and legal changes → is confirmed. The evidence lies in the IRF test

results, where PrivatBank's curve shows statistically insignificant effects for both GDP and FSI. Unlike the other bank groups, the NPL level in this bank is determined by the write-off of old bad loans issued by the 2017 nationalisation, de facto operating outside of the classical market cycle of credit risk.

Chapter 6. Discussion

The results from Autoregressive Distributed Lag models and Impulse Response Functions provide an in-depth analysis of how credit risk forms in Ukraine's banking system, with results divided by ownership type. Findings demonstrate that analysing the banking system as a single entity can lead to misleading generalisations, as the behaviour of the banking group varies across institutions due to their institutional nature.

The ARDL model is considered a well-established and useful approach for analysing non-performing loans. Research by Nikolaidou and Vogiazas uses this method, specifically for the analysis of NPLs in developing and transition economies (91). According to the authors' results, the ARDL method is highly efficient for analysing complex financial time-series dynamics, including data that contains structural breaks (94). In this research, applying this framework to the Ukrainian banking sector, the Bounds test for cointegration indicates a long-run link between macroeconomic factors and financial stress, as well as between NPL levels across most of Ukraine's banking segments.

Another important step is the separation of Privatbank from the state banks, as it has unique transmission mechanisms stemming from its massive market share and historical background (Hlazonov and Lukianenko 12). The results of the Privatbank and state bank models demonstrate that combining them can be misleading. Moreover, Privatbank's low Bounds F-statistic (2.32) and the lack of statistically significant long-run macroeconomic variables suggest that its credit portfolio is more likely driven by administrative and legal factors rather than standard market cycles.

The long-run coefficients provide a picture of how different types of banks respond to both real-sector and financial-sector shocks. GDP shock experiences have the biggest impact on private banks, demonstrating a long-run coefficient of -6.75. This result confirms Nkusu's finding: a decline in production and corporate revenues leads to rapid increases in defaults among commercial banks (13). FSI shock, in its turn, demonstrates its long-run significance for classic state-owned banks with a coefficient of 2.76. This behaviour aligns well with the theoretical approaches of Zheng et al., who

noted that financial instability and currency volatility affect large institutional structures most, due to their high concentration of systemic risks (3-4).

The estimated Speed of Adjustment coefficients reveal some divergence in the balance sheet recovery rate, presenting which can be perceived as a paradox. According to the empirical test results, PrivatBank and state-owned banks (-0.2069 and -0.1379, respectively) return to their long-run equilibrium faster than private banks (-0.086) and foreign bank groups (-0.0448). A surface-level reading of these figures might suggest that state-owned banks handle non-performing loans more effectively.

However, this anomaly is clarified when Kollmann's research is taken into account, which shows that high recovery speed is associated with direct fiscal interventions and government recapitalisation programs (80-81). Looking at the results of private and foreign banks, the first one returns to equilibrium almost twice as fast as the second ones, -0.0861 and -0.0448, respectively. The stabilisation seen in the state-owned banks is driven by cash lending from the state budget rather than internal operational efficiency or market flexibility.

The results align with Zainol et al.'s findings, which showed that strict European regulatory requirements require foreign branches to coordinate restructuring procedures with parent offices for extended periods, thereby slowing their adaptation to local crises (704-705). In contrast to foreign capital banks, private banks operate with much greater flexibility, optimising portfolios more quickly.

The 12-quarter Impulse Response Functions yielded unique findings, drawing on the research of Hlazonov et al. (12). In the case of a GDP shock, foreign banks have demonstrated the best resilience within the system. They demonstrate the smallest amplitude of NPL growth, additionally, their recovery began in the third quarter. Such results support the theories of Nkusu (13) and Pesola (16): a decrease in production and GDP declines leads to a rapid increase in commercial bank defaults. However, the findings of this study add a new dimension to this theory: because of stricter credit

standards and borrower selection, foreign financial institutions successfully separate their portfolios from the full impact of macroeconomic shocks.

However, foreign banks' performance under the conditions of the FSI Shock varies. According to the results, the response curve for foreign banks is the highest and shows the greatest inertia, failing to return to equilibrium even after 3 years. Such actions are explained by the blocking of foreign capital through internal institutional procedures, driven by bureaucracy (Zaynol 704-705). At the same time, private banks handle the peak of financial stress relatively faster, recovering within 8 to 10 quarters.

Chapter 7. Conclusions

This research evaluates the determinants and dynamics of non-performing loans in the Ukrainian banking system, successfully using ARDL models to examine financial stability in transition economies. The tests showed a long-run correlation between macroeconomic shocks and loan quality across the market. During the research, it was necessary to divide PrivatBank from other state banks due to its credit portfolio dependence on legal and administrative issues. Additionally, by complementing ARDL models with Impulse Response Function simulations, it was possible to determine how these shocks affect different groups of banks over 12 quarters.

The main finding of this research is that different bank groups indeed have diverse reactions to both macroeconomic and financial shocks. State-owned banks are the first to be influenced by financial stress and liquidity crises, at the same time being the ones to recover after a shock, but artificially, as it was discovered. State banks return to equilibrium with government support and recapitalisation. Private banks proved the most vulnerable to economic downturns and declines in GDP. Foreign banks demonstrated strong resilience against GDP shocks, aided by advanced European risk analysis that enabled them to carefully screen their borrowers. In contrast to private banks, foreign banks have shown much slower adaptation during financial crises. They are slowed down by waiting for approval from their European parent companies to write off NPLs, whereas private banks can quickly adapt to crises.

The findings of this research can serve as evidence for the National Bank of Ukraine to implement separate stress-testing regulations for different types of banking groups. Overall, the econometric models and conclusions provide a reliable framework for maintaining the Ukrainian banking system's financial stability during the post-war economic recovery.

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