# THE IMPACT OF INFLATION AND INCOME GROWTH ON NON-PERFORMING AND RESTRUCTURED LOANS: THE CASE OF BULGARIA

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**Abstract**

This paper examines the relationship between non-performing and restructured loans, inflation and income growth in Bulgaria. The linear regression analysis shows that there is significant negative impact of inflation and income growth on NPLs and restructured loans for consumer credits and significant negative impact of inflation on NPLs and restructured loans for housing credits. There is no heteroscedasticity of the errors which proves that the coefficients are precise. Results show lack of multicollinearity, normal distribution of residuals and correct linear functional form of the model. However, there is autocorrelation of residuals and weak explanatory power. For improving the explanatory power of the linear regression model, more explanatory variables should be included - bank-specific, macroeconomic and institutional determinants.

**Abbreviations**

NPLs – non-performing loans

## 1. Introduction.

Non-performing loans are a problem for the banking sector and for the whole economy. NPLs can break confidence in the banking institutions, which may lead to negative cross-border effects and may hamper investment. Restructuring of NPLs is an instrument for reduction of financial fragmentation and facilitation of capital flows.

The post-COVID-19 economic situation in combination with high inflation is expected to have impact on the level of NPLs in banks` portfolios. In comparison, the previous crisis of 2007-2009, leads to a huge amount of non-performing loans in countries all over the world.

Before the crisis 2007-2009 the economic situation seems favourable - globally high growth rates, stable and low inflation rates, low short-term interest rates as a result of the prudent monetary policy pursued by leading industrial countries, simultaneously acceptable long-term interest rates due to the relatively high levels of savings in Asia and oil-exporting countries, increase in productivity and trade. This leads to greater integration of developing countries into the global economy. The economic growth leads to increased production in many countries, and this, in combination with greater integration of developing countries into the global economy and the significant increase in trade, allows prices of most goods and services to remain relatively

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unchanged for several years. This growth combined with the lack of regulation leads eventually to excessive indebtedness of financial institutions, businesses and households in the United States and Europe - debt that can hardly maintain for a long time. Due to low interest rates investors orientate themselves to riskier financial instruments, including equity, real estate and commodities. The world economy faces serious losses. Leading banks write off large items of their assets. Banks in many developed industrial countries have significant difficulties, forced to seek foreign support.

Hardly someone can define clearly the reasons which lead the world economy to helpless situation. One of the most commonly appointed reasons is the excessive loosening of loan requirements, caused by the strong desire of the financial institutions to increase their market presence. It is known that during periods of economic progress financial institutions exchange stability against market share. As a result, the financial standards get easier, candidates for obtaining credit rarely receive denial, and a significant portion of the assets of the banking system pass into the hands of people who cannot serve their loans. Thus the banking system loses its resistance and ability to stand shocks and even the least slowing pace of economic growth can cause a chain reaction followed by collapse.

Researchers notice the increased amounts of non-performing loans in the years after the crisis and their interest is focused on the factors that have negative impact on banks` portfolios. The reason is that maintaining a safe level of bad loans is an important issue for the survival of banks. There are many factors responsible for this ratio. In recent years, the determinants of NPLs have been the subject of particular interest. There is a number of publications discussing the problem of bad loans, the quality of the loan portfolio and the soundness of banks.

## 2. Impact of inflation on NPLs – literature review.

Inflation is one of the most studied macroeconomic indicators concerning economic shocks and severe downturns.

The impact of inflation on non-performing loans is not clearly stated. Opinions are controversial, but some researchers point out that higher inflation has a negative effect on lenders and increases the level of credit risk and hence bad loans. Agarwal and Baron (2023) claim that rising inflation can lead to losses in the whole banking sphere because banks reduce lending, primarily in the housing sector. This in turn leads to a rise in house prices. According to Peshev (2014), inflation can increase loan demand as it leads to redistribution of wealth from creditor to debtor, but it can also negatively affect loan demand as rising prices reduce households' disposable income and firms' net cash flow. Klein (2013) also argues that the impact of inflation on NPLs is ambiguous, as on one hand higher inflation reduces debt real value, making loan servicing easier, but on the other hand rising inflation reduces people`s real income against background of high prices.

Golitsis, Fassas, & Lyutakova (2019) examine the factors affecting credit risk specifically for the Bulgarian banking sector and find among them the importance of the impact of inflation. Kjosevski & Petkovski (2021) find evidence that inflation is among the most important macroeconomic factors influencing NPLs.

Anita, Tasnova, & Nawar (2022) investigate selected macroeconomic determinants of non-performing loans for eight South-Asian Association for Regional Cooperation countries and find that low levels of inflation lead to high levels of NPLs. Erdinc & Abazi (2014) reveal that inflation has very significant negative impact on NPLs in twenty emerging European countries, suggesting that inflation "reduces the real debt obligations of borrowers". Mazreku et al. (2019) test the relationship between macroeconomic factors and the level of NPLs in ten transition countries from Central and Eastern Europe, including Bulgaria, during the period 2006 - 2016 and reveal that inflation has a significant negative relationship with NPLs, "possibly due to the resulting reduction in real debt repayments".

Radivojević et al. (2019) create econometric model in order to demonstrate the impact of crucial macro and microeconomic variables on NPLs for countries in Latin America. The authors define high inflation as one of the main problems in Latin America and the results of their study show that inflation has not statistically significant effect on NPLs.

Peric & Konjusak (2017) argue that inflation can have a positive or a negative influence on NPLs. They explain the negative influence with the reduction of loan's real value as a result of high inflation which makes repayment easier or, based on the Philip curve[2], inflation can decrease unemployment and increase creditworthiness of borrowers. Nevertheless, their study reveals that inflation is not statistically significant determinant of NPLs in the Central and Eastern European countries. Trying to identify the factors affecting the non-performing loans rate of Eurozone's banking systems for the period 2000-2008, Makri, Tsagkanos & Bellas (2014) find that inflation does not have any significant impact.

## 3. Inflation, income, interest rates and NPLs.

In response to rising inflation policymakers increase nominal interest rates. Thus the cost of the borrowed money is higher, so consumers and investors may prefer to save because of a higher interest income. For example - high interest rates can force consumers to refuse to buy home or car because the cost of repaying the loan is too high; businesses would also prefer to put their money in bank deposits because of the high return, or spend the money for new projects, rather than using expensive crediting.

Credit demand is inversely related to interest rate - at high interest rates aggregate demand for credit declines and vice versa. In addition, during times of high inflation and high rates not only credit demand decreases, but creditors are also less willing to give credits because of the asymmetric information and moral hazard - at higher interest rates, the adverse selection problem appears more often; at lower interest rates there are more potential borrowers, and fewer of them have a high credit risk profile. Moreover, higher risk reduces the attractiveness of investments.

[2] The Philip curve is an economic concept developed by A.W.Philips, which states that inflation and unemployment have a stable and inverse relationship.

The theoretical prediction is that higher inflation associated with higher nominal interest rates depresses investments of entrepreneurs and consumers[3], which results in fewer granted loans and hence, fewer non-performing loans.

Besides, the impact of higher interest rates on existing loans may vary depending on whether the loan is with fixed or variable interest rate. If the nominal interest rate is fixed, as a result of a high inflation the real value of the liabilities decreases, i.e. real borrowing costs fall and debt burden also falls. Consequently, the probability that the loan will not be repaid decreases. For this reason, loosening monetary policy by raising inflation, higher income and raising the price level leads to a fall in real interest rates, lowers borrowing costs and increases the real net wealth of firms and households. This makes servicing the loans with fixed nominal interest rates easier and reduces the likelihood of non-performing loans.

Simultaneously, high inflation and rising nominal interest rates make loans with variable rates more expensive, because borrowers with a variable rate will pay more than the initially agreed loan instalment. This may increase the possibility for not servicing the loan. Variable interest rate has two components: 1) the cost of financing for lenders, linked to a benchmark interest rate which indicates the borrowing costs for banks for the funds they take from the marketplace; 2) margin that covers the costs and the profit of the lender. The rate of the outstanding balance of the loan depends on the market interest rate. It increases when the market interest rate rises, but it decreases as well, when market interest rate declines. As fixed rates are less flexible, they should predict all possible scenarios and generate bank profit in all circumstances. For this reason, fixed rates are usually higher and used mostly for short-term loans. The most popular mortgage loan has fixed rate for the first five years and after this period the rate is adjusting, depending on the market interest rate. Therefore, the mortgage instalment may rise, but it may also fall, in a period of declining interest rates.

Nobody can predict long-term economic conditions, and it is better for both borrowers and lenders to have opportunity for reaction and further negotiations. This includes not only changes in interest rates and loan repayments, but also the opportunity for debt restructuring, for the common goal - avoiding the possibility of default and fairly satisfying the interests of lenders and borrowers. Credit institutions have variable instruments for management of non-performing exposures, including restructuring, improving the collection process, use of collaterals and sell. Making a loan price requires not only calculation of the interest rate but also consideration of all macro- and microeconomic conditions at national and world level, as well as their predictive values. In this context, evidence exists about low interest rates that induce higher amounts of NPLs. Maivald & Teplý (2020) analyze a sample of 823 banks from the Eurozone, Denmark, Japan, Sweden, and Switzerland for a period of zero and negative rates and conclude that "after 1 year of low interest rates, the NPL ratio increases". It can be assumed that low rates suppress the attention of borrowers and lenders for possible losses amid changes in the economic environment, while rising inflation associated with expectations for higher rates is a signal for considering reasonable reactions.

[3] According to the traditional interest rates channel a monetary contraction through increase in the short-term interest rate leads to pushing up longer-term rates, which leads to decrease in investments.

Moreover, the level of the interest rates would not be embarrassing if borrowers have sufficient income to pay their debts. The income effect states that income growth influences peoples` ability to buy goods and services. The increase in consumer`s purchasing power supposes increased demand and increased willingness to take credits. As a result of expansionary monetary policy, which includes growing income, higher prices and increasing inflation, the interest rates would rise. The question is: are people rich enough to pay for this?

## 4. Methodology and data used.

This paper studies the impact of inflation and income growth on non-performing and restructured loans in Bulgaria for the period 2010-2023 through linear regression model, performed with E-views 12.

It examines the influence of inflation and income growth on two dependent variables:
- NPLs_restructured loans of housing households` loans;
- NPLs_restructured loans of consumer loans.

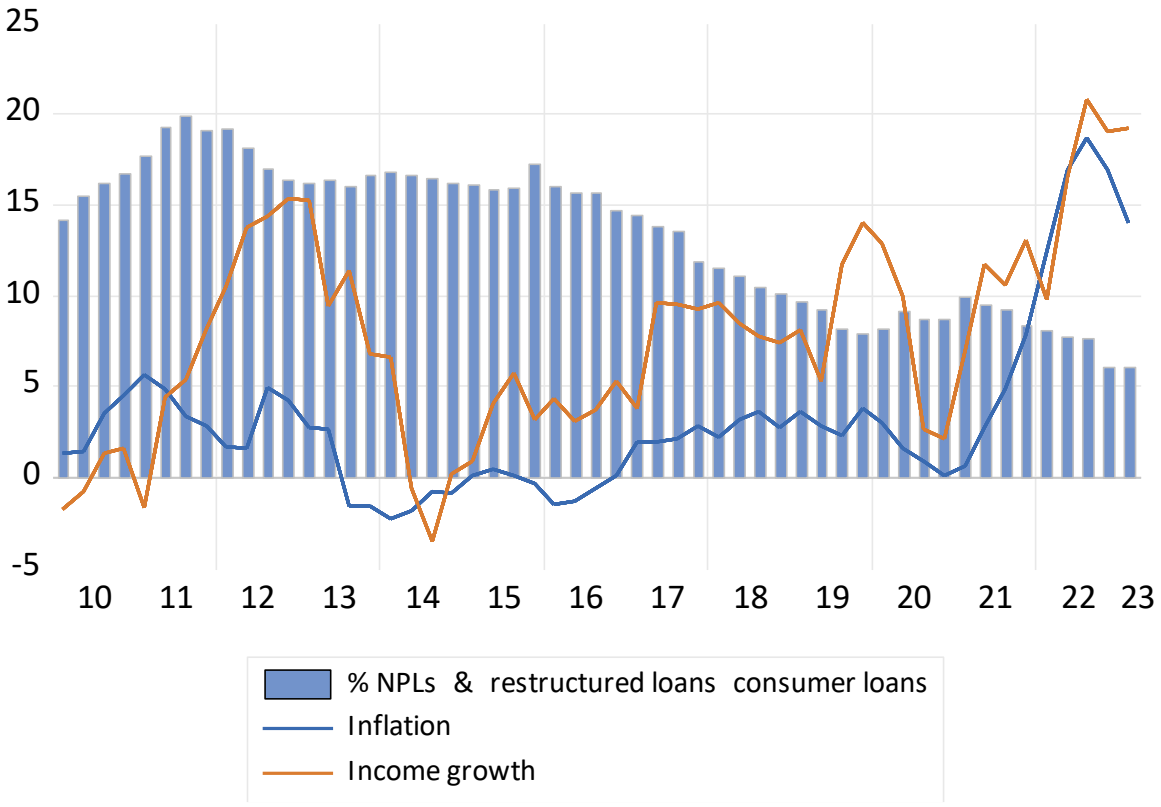
The equation used for the linear model is:
$Y_n = \beta_0 + \beta_1 X_{1n} + \beta_2 X_{2n} + U_n$, where:

$Y_n$ is the dependent variable NPLS_RESTRUCTURED_LOANS;
$X_{1n}$ is the explanatory variable INFLATION;
$X_{2n}$ is the explanatory variable INCOME_GROWTH;
$\beta_1$ and $\beta_2$ are the coefficients that show the effect of the explanatory variables on the dependent variable Y;
$U_n$ is the error term;
n =1,2,3 … is the number of observations.

The number of observations for each variable is 53, quarterly time series data for the period March 2010-March 2023. The data is derived from Bulgarian National Bank statistics and National Statistical Institute of Bulgaria. The inflation values are calculated on an annual basis compared to the same quarter of the previous year. The income growth is the percentage change in the average income per capita compared to the corresponding quarter of the previous year.

Graphics of the dynamics of the dependent variables and the explanatory variables are shown in Figure 1 and Figure 2.

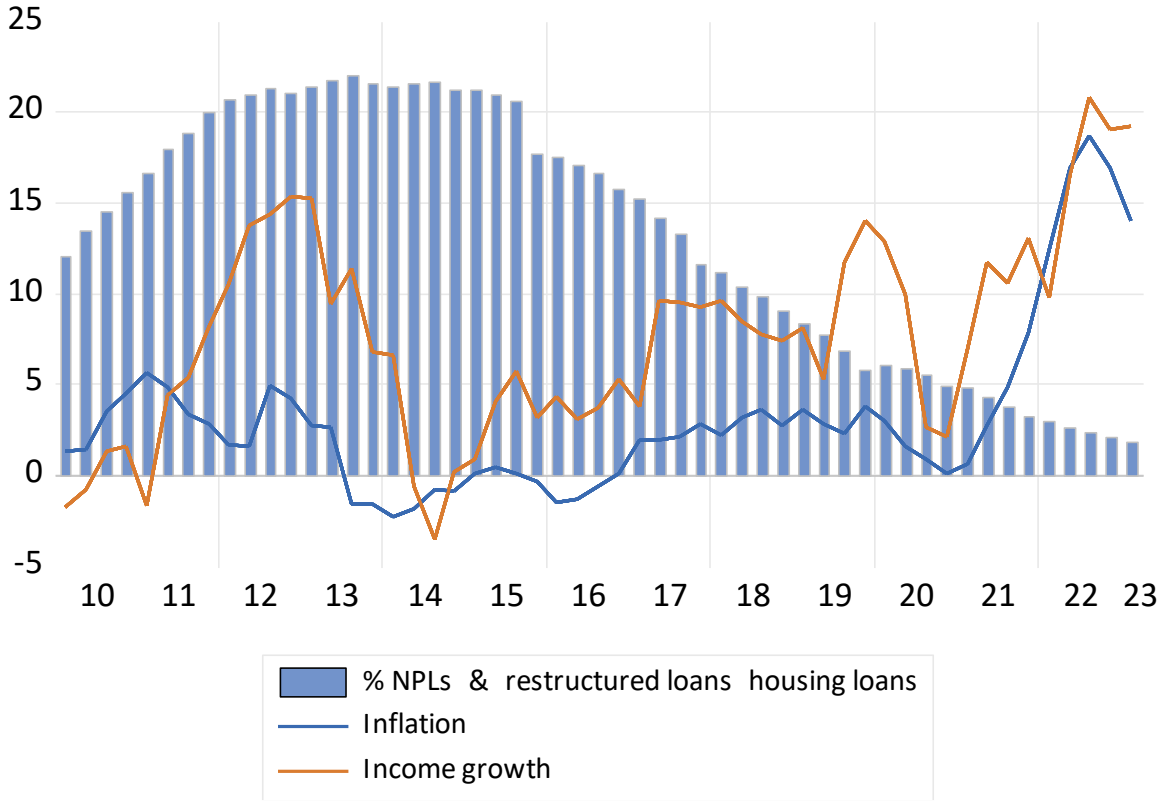
*Figure 1: Relationship between NPLs_restructured consumer loans, inflation and income growth in Bulgaria*




*Source: Bulgarian National Bank, National Statistical Institute*

The graphics show that in Bulgaria to high values of NPLs and restructured loans correspond high income growth rates and low or negative inflation rates. The influence of the crises from 2007-2009 on bad consumer loans leads to their highest value of 19% in 2011, slightly decreasing in the next years. The crisis leads to boost in bad housing loans and they stay at incredibly high values of about 20% in the period 2011-2015. In the years after the crises the inflation is low and the rate of income growth is high. This leads to reduction of non-performing and restructured loans, which is more significant after 2015-2016 and has more considerable effect on housing credits.

*Figure 2: Relationship between NPLs_restructured housing loans, inflation and income growth in Bulgaria*




*Source: Bulgarian National Bank, National Statistical Institute*

A linear regression is performed for the two dependent variables separately. After the regression the following tests are performed:

- test for heteroscedasticity;
- test for autocorrelation;
- test for multicollinearity;
- test for normal distribution of residuals;
- test whether the linear functional form is correct.

It is assumed that the impact of inflation and income growth on NPLs&restructured loans occurs with a certain time lag. For this reason, the linear regressions are run with 2-lag values of the explanatory variables “inflation” and “income growth”.

The results of the regressions and the tests are summarized in Table 1:

*Table1: Results of the linear regression models*

| | **NPLs and restructured loans of consumer loans** | **NPLs and restructured loans of housing loans** |
|---|---|---|
| **See** | Appendix 1 | Appendix 2 |
| **Representation of the model** | NPLS_RESTRUCT_LOANS_CONSUMER_LOANS = 15.89-0.27*LINFLATION - 0.26*LINCOME_GROWTH | NPLS_RESTRUCT_LOANS_HOUSING_LOANS = 16.43-0.75*LINFLATION - 0.15*LINCOME_GROWTH |
| **p-value of predictive variable *inflation*** | 0,07 | 0.00 |
| **p-value of predictive variable *income growth*** | 0.02 | 0,47 |
| **R2** | 0,29 | 0,25 |
| **Testing for heteroscedasticity** | no heteroscedasticity | no heteroscedasticity |
| **Testing for autocorrelation of residuals** | serial correlation of residuals | serial correlation of residuals |
| **Testing for multicollinearity** | no multicollinearity | no multicollinearity |
| **Testing for normal distribution of residuals** | normal distribution of residuals | normal distribution of residuals |
| **Testing whether the linear functional form is correct** | the model is free from specification errors | the model is free from specification errors |

## 5. Discussion of results

The results of the linear regressions show negative impact of inflation and income growth on NPLs and restructured loans in Bulgaria on the two dependent variables: consumer loans and housing households` loans. Though, the effect of income growth on non-performing housing loans is insignificant.

It can be concluded that in Bulgaria:

- inflation has negative impact on NPLs and restructured consumer loans;
- inflation has negative impact on NPLs and restructured housing households` loans;
- income growth has negative impact on NPLs and restructured consumer loans.

The $R^2$ values show weak explanatory power of the regression models - only about 30% of the variability of NPLs and restructured loans can be explained with these models. This leads to the assumption that more advanced econometric techniques and more determinants are required for analyzing the factors which deteriorate banks` portfolios.

The lack of heteroscedasticity predicts that the variance of the errors of the two simple linear regressions is constant. This means that the standard deviations of the predicted variable "NPLs and restructured loans" for a specific time are constant, monitored over the different values of the independent variable "inflation". The homoscedasticity of the errors states that the coefficients are precise.

The presence of autocorrelation of the residuals states that the errors in the regressions are not independent of each other. Nevertheless, the residuals are normally distributed. The lack of specification errors in the two linear regressions leads to the assumption that the linear model is specified correctly.

## 6. Conclusion

In Bulgaria the reduction of the level of non-performing and restructured loans for consumer and housing credits happens at low inflation rates and high income growth rates. Both rising inflation and income growth influence negatively the amount of NPLs. Expectations for rising inflation in combination with higher income may increase interest rates. In such period, management of financial institutions should give specific attention to mitigate potential credit risk and losses.

The findings of the study show negative relationship between NPLs&restructured loans and inflation and NPLs&restructured loans and income growth in Bulgaria for housing and consumer loans, as the effect of income growth on housing non-performing loans is insignificant. The inference supports the prediction that higher income and higher inflation associated with higher nominal interest rates depresses investments and lending, simultaneously lowers borrowing costs for loans with fixed rates, which results in fewer non-performing loans. The lagged negative influence of inflation and income growth on NPLs suggests that expectations for higher interest rates warns borrowers and lenders to take actions to avoid non-performance, which will be a loss for both of them.

## References


1. Agarwal, Isha & Naron, Matthew, 2023. Exploring the link between rising inflation and economic growth: The role of the banking sector, World Bank, on-line, Available at: https://blogs.worldbank.org/allaboutfinance/exploring-link-between-rising-inflation-and-economic-growth-role-banking-sector#

2. Anita, S., Tasnova, N. & Nawar, N., 2022. Are non-performing loans sensitive to macroeconomic determinants? An empirical evidence from banking sector of SAARC countries. Future Business Journal, 8, 7 (2022)

3. Brooks, Chris, 2008. Introductory Econometrics for Finance. 2nd. ed. New York: Cambridge University Press

4. Erdinc, Didar & Abazi, Eda, 2014. The Determinants of NPLs in Emerging Europe, 2000-2011, Journal of Economics and Political Economy, KSP Journals, vol. 1(2), pages 112-125,

5. Golitsis, Petros; Fassas, Athanasios P. and Lyutakova, Anna, 2019. Credit Risk Determinants: Evidence from the Bulgarian Banking System, Risk Market Journals Bulletin of Applied Economics, 2019, 6(1), 41-64

6. Kjosevski, J & Petkovski, M 2021, 'Macroeconomic and Bank-Specific Determinants of Non-performing Loans: The Case of Baltic States', Empirica, vol. 48, no. 4, pp. 1009–1028,

7. Klein, N. 2013. Non-Performing Loans in CESEE; Determinants and Impact on Macroeconomic Performance. IMF Working Papers 13/72

8. Maivald, Matěj & Teplý, Petr, 2020. The impact of low interest rates on banks' non-performing loans, FFA Working Papers 2.002, Prague University of Economics and Business, revised 25 Feb 2020.

9. Makri, Vasiliki & Tsagkanos, Athanasios & Bellas, Athanasios, 2014. Determinants of Non-Performing Loans: The Case of Eurozone, Panoeconomicus, Savez ekonomista Vojvodine, Novi Sad, Serbia, vol. 61(2), pages 193-206,

10. Mazreku, Ibish & Morina, Fisnik & Misiri, Valdrin & Spiteri, Jonathan & Grima, Simon, 2018. Determinants of the Level of Non-Performing Loans in Commercial Banks of Transition Countries. European Research Studies Journal. XXI. 10.35808/ersj/1040.

11. Peric, B. and Konjusak, N., 2017. How did rapid credit growth cause non-performing loans in the CEE countries? South East European Journal of Economics and Business, Volume 12 (2) 2017, 73-84

12. Peshev, Petar, 2014. Credit dynamics factors outside the euro area, Discussion Papers, Bulgarian National Bank, Issue 95, p1-92.

13. Radivojević, Nikola & Cvijanović, Drago & Sekulic, Dejan & Pavlovic, Dejana & Jovic, Srdjan & Maksimović, Goran, 2019. Econometric model of non-performing loans determinants, Physica A: Statistical Mechanics and its Applications, Elsevier, vol. 520(C), pages 481-488

## Linear regression with 2 lags

Dependent Variable: __NPLS RESTRUCTURED LOANS CONSUMER LOANS
Method: Least Squares
Date: 12/04/23 Time: 15:58
Sample (adjusted): 2010Q3 2023Q1
Included observations: 51 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LINFLATION | -0.269474 | 0.147549 | -1.826334 | 0.0740 |
| LINCOME_GROWTH | -0.260199 | 0.111451 | -2.334661 | 0.0238 |
| C | 15.88861 | 0.831201 | 19.11524 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.289760 | Mean dependent var | 13.29952 |
| Adjusted R-squared | 0.260166 | S.D. dependent var | 4.085194 |
| S.E. of regression | 3.513822 | Akaike info criterion | 5.408308 |
| Sum squared resid | 592.6535 | Schwarz criterion | 5.521945 |
| Log likelihood | -134.9119 | Hannan-Quinn criter. | 5.451732 |
| F-statistic | 9.791371 | Durbin-Watson stat | 0.085624 |
| Prob(F-statistic) | 0.000271 | | |

Estimation Command:
==========
LS __NPLS___RESTRUCTURED_LOANS_CONSUMER_LOANS LINFLATION LINCOME_GROWTH C

Estimation Equation:
==========
__NPLS___RESTRUCTURED_LOANS_CONSUMER_LOANS = C(1)*LINFLATION + C(2)*LINCOME_GROWTH + C(3)

Substituted Coefficients:
==========
__NPLS___RESTRUCTURED_LOANS_CONSUMER_LOANS = -0.269474334636*LINFLATION - 0.260199332049*LINCOME_GROWTH + 15.8886131606

## Testing for Heteroscedasticity:

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

| | | | |
|---|---|---|---|
| F-statistic | 0.455523 | Prob. F(2,48) | 0.6368 |
| Obs*R-squared | 0.949957 | Prob. Chi-Square(2) | 0.6219 |
| Scaled explained SS | 0.387042 | Prob. Chi-Square(2) | 0.8241 |

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 12/04/23 Time: 16:14
Sample: 2010Q3 2023Q1
Included observations: 51

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 9.555892 | 2.692217 | 3.549451 | 0.0009 |
| LINFLATION | -0.002344 | 0.477904 | -0.004904 | 0.9961 |
| LINCOME GROWTH | 0.287356 | 0.360982 | 0.796039 | 0.4299 |

| | | | |
|---|---|---|---|
| R-squared | 0.018627 | Mean dependent var | 11.62066 |
| Adjusted R-squared | -0.022264 | S.D. dependent var | 11.25646 |
| S.E. of regression | 11.38108 | Akaike info criterion | 7.758804 |
| Sum squared resid | 6217.393 | Schwarz criterion | 7.872441 |
| Log likelihood | -194.8495 | Hannan-Quinn criter. | 7.802228 |
| F-statistic | 0.455523 | Durbin-Watson stat | 0.349527 |
| Prob(F-statistic) | 0.636829 | | |

$H_0$: Homoscedasticity/No heteroscedasticity
$H_1$: There is heteroscedasticity

p=0.6368>0.05 – so the null hypothesis of homoscedasticity could be accepted

**Testing for autocorrelation of residuals:**

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

| | | | |
|---|---|---|---|
| F-statistic | 333.1458 | Prob. F(2,46) | 0.0000 |
| Obs*R-squared | 47.70640 | Prob. Chi-Square(2) | 0.0000 |

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 12/04/23 Time: 16:15
Sample: 2010Q3 2023Q1
Included observations: 51
Presample missing value lagged residuals set to zero.

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LINFLATION | 0.084641 | 0.043060 | 1.965657 | 0.0554 |
| LINCOME_GROWTH | -0.014319 | 0.029070 | -0.492563 | 0.6247 |
| C | -0.104873 | 0.218466 | -0.480043 | 0.6335 |
| RESID(-1) | 1.216731 | 0.146751 | 8.291140 | 0.0000 |
| RESID(-2) | -0.258672 | 0.150684 | -1.716649 | 0.0928 |

| | | | |
|---|---|---|---|
| R-squared | 0.935420 | Mean dependent var | -2.19E-15 |
| Adjusted R-squared | 0.929804 | S.D. dependent var | 3.442829 |
| S.E. of regression | 0.912161 | Akaike info criterion | 2.746894 |
| Sum squared resid | 38.27373 | Schwarz criterion | 2.936288 |
| Log likelihood | -65.04579 | Hannan-Quinn criter. | 2.819267 |
| F-statistic | 166.5729 | Durbin-Watson stat | 1.947669 |
| Prob(F-statistic) | 0.000000 | | |

$H_0$: No serial correlation
$H_1$: There is serial correlation

p=0.000, so the null hypothesis is rejected and there is serial correlation

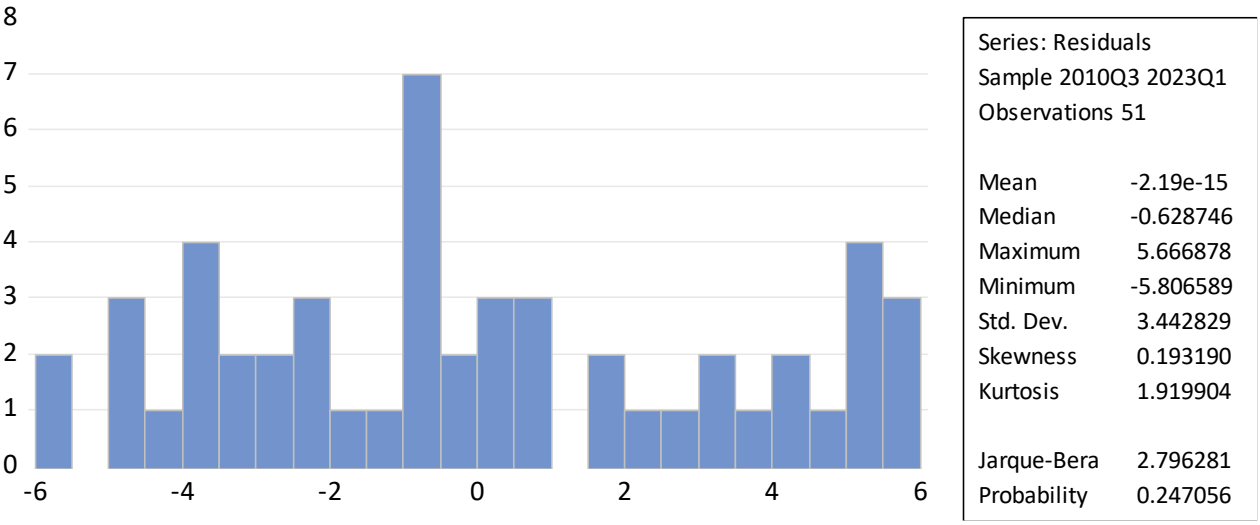
### Testing for multcollinearity

Variance Inflation Factors
Date: 12/06/23 Time: 18:30
Sample: 2010Q1 2023Q1
Included observations: 51

| Variable | Coefficient Variance | Uncentered VIF | Centered VIF |
|---|---|---|---|
| LINFLATION | 0.021771 | 2.078613 | 1.447575 |
| LINCOME_GROWTH | 0.012421 | 4.112487 | 1.447575 |
| C | 0.690896 | 2.853797 | NA |

Centered VIF<10, there is no multicollinearity in the model.

**Testing for normality** – the Bera-Jarque normality, if the residuals are normally distributed, the Bera-Jarque statistic would not be significant.




$H_0$: the residuals are normally distributed;
$H_1$: the residuals are not normally distributed.

The p-value of Jarque-Bera statistic=0.247056>0.05, which means that Jarque-Bera statistic is not significant and we accept $H_0$: the residuals are normally distributed

**Testing whether the linear functional form is correct:**

In order to test whether the linear functional form is correct, the Ramsey`s RESET Test is applied.

Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values
Specification: NPLS RESTRUCTURED LOANS_CONSUMER L OANS LINFLATION LINCOME GROWTH C

| | Value | df | Probability |
|---|---|---|---|
| t-statistic | 0.003731 | 47 | 0.9970 |
| F-statistic | 1.39E-05 | (1, 47) | 0.9970 |
| Likelihood ratio | 1.51E-05 | 1 | 0.9969 |

F-test summary:

| | Sum of Sq. | df | Mean Squares |
|---|---|---|---|
| Test SSR | 0.000176 | 1 | 0.000176 |
| Restricted SSR | 592.6535 | 48 | 12.34695 |
| Unrestricted SSR | 592.6533 | 47 | 12.60964 |

LR test summary:

| | Value |
|---|---|
| Restricted LogL | -134.9119 |
| Unrestricted LogL | -134.9119 |

Unrestricted Test Equation:
Dependent Variable: NPLS RESTRUCTURED LOANS CONSU MER LOANS
Method: Least Squares
Date: 12/04/23 Time: 16:19
Sample: 2010Q3 2023Q1
Included observations: 51

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LINFLATION | -0.268070 | 0.404954 | -0.661976 | 0.5112 |
| LINCOME_GROWTH | -0.258291 | 0.523856 | -0.493056 | 0.6243 |
| C | 15.82226 | 17.80365 | 0.888709 | 0.3787 |
| FITTED^2 | 0.000269 | 0.072126 | 0.003731 | 0.9970 |

| | | | |
|---|---|---|---|
| R-squared | 0.289760 | Mean dependent var | 13.29952 |
| Adjusted R-squared | 0.244425 | S.D. dependent var | 4.085194 |
| S.E. of regression | 3.551006 | Akaike info criterion | 5.447524 |
| Sum squared resid | 592.6533 | Schwarz criterion | 5.599039 |
| Log likelihood | -134.9119 | Hannan-Quinn criter. | 5.505422 |
| F-statistic | 6.391596 | Durbin-Watson stat | 0.085628 |
| Prob(F-statistic) | 0.001010 | | |

The p-values of the t-statistic, F-statistic and Likelihood ratio are greater than 0,05, so it can be inferred that the model is free from specification errors.

## Linear regression with 2 lags

Dependent Variable: NPLS RESTRUCTURED LOANS HOUSING LOANS
Method: Least Squares
Date: 12/06/23 Time: 18:37
Sample (adjusted): 2010Q3 2023Q1
Included observations: 51 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LINFLATION | -0.754822 | 0.264515 | -2.853604 | 0.0064 |
| LINCOME GROWTH | -0.145535 | 0.199800 | -0.728403 | 0.4699 |
| C | 16.43024 | 1.490115 | 11.02615 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.248849 | Mean dependent var | 13.38183 |
| Adjusted R-squared | 0.217551 | S.D. dependent var | 7.121398 |
| S.E. of regression | 6.299316 | Akaike info criterion | 6.575782 |
| Sum squared resid | 1904.706 | Schwarz criterion | 6.689418 |
| Log likelihood | -164.6824 | Hannan-Quinn criter. | 6.619206 |
| F-statistic | 7.950950 | Durbin-Watson stat | 0.056430 |
| Prob(F-statistic) | 0.001041 | | |

Estimation Command:
==========
LS __NPLS___RESTRUCTURED_LOANS_HOUSING_LOANS LINFLATION LINCOME_GROWTH C

Estimation Equation:
==========
__NPLS___RESTRUCTURED_LOANS_HOUSING_LOANS = C(1)*LINFLATION + C(2)*LINCOME_GROWTH + C(3)

Substituted Coefficients:
==========
__NPLS___RESTRUCTURED_LOANS_HOUSING_LOANS = -0.754822206823*LINFLATION - 0.145535014745*LINCOME_GROWTH + 16.4302406129

## Testing for Heteroscedasticity:

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

| | | | |
|---|---|---|---|
| F-statistic | 3.001618 | Prob. F(2,48) | 0.0591 |
| Obs*R-squared | 5.669383 | Prob. Chi-Square(2) | 0.0587 |
| Scaled explained SS | 2.573951 | Prob. Chi-Square(2) | 0.2761 |

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 12/06/23 Time: 18:39
Sample: 2010Q3 2023Q1
Included observations: 51

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 22.75153 | 8.692319 | 2.617429 | 0.0118 |
| LINFLATION | -2.250383 | 1.543003 | -1.458444 | 0.1512 |
| LINCOME_GROWTH | 2.852364 | 1.165499 | 2.447334 | 0.0181 |

| | | | |
|---|---|---|---|
| R-squared | 0.111164 | Mean dependent var | 37.34718 |
| Adjusted R-squared | 0.074130 | S.D. dependent var | 38.18863 |
| S.E. of regression | 36.74593 | Akaike info criterion | 10.10295 |
| Sum squared resid | 64812.63 | Schwarz criterion | 10.21659 |
| Log likelihood | -254.6253 | Hannan-Quinn criter. | 10.14638 |
| F-statistic | 3.001618 | Durbin-Watson stat | 0.345985 |
| Prob(F-statistic) | 0.059117 | | |

$H_0$: Homoscedasticity/No heteroscedasticity
$H_1$: There is heteroscedasticity

p=0.06>0.05 – so the null hypothesis of homoscedasticity could be accepted

## Testing for autocorrelation of residuals:

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

| | | | |
|---|---|---|---|
| F-statistic | 717.3311 | Prob. F(2,46) | 0.0000 |
| Obs*R-squared | 49.41557 | Prob. Chi-Square(2) | 0.0000 |

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 12/06/23 Time: 18:40
Sample: 2010Q3 2023Q1
Included observations: 51
Presample missing value lagged residuals set to zero.

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LINFLATION | 0.233900 | 0.071292 | 3.280866 | 0.0020 |
| LINCOME GROWTH | -0.056061 | 0.036649 | -1.529662 | 0.1329 |
| C | -0.168335 | 0.282042 | -0.596845 | 0.5535 |
| RESID(-1) | 1.137845 | 0.165698 | 6.866962 | 0.0000 |
| RESID(-2) | -0.147586 | 0.173476 | -0.850754 | 0.3993 |

| | | | |
|---|---|---|---|
| R-squared | 0.968933 | Mean dependent var | -5.31E-16 |
| Adjusted R-squared | 0.966231 | S.D. dependent var | 6.172044 |
| S.E. of regression | 1.134190 | Akaike info criterion | 3.182610 |
| Sum squared resid | 59.17385 | Schwarz criterion | 3.372004 |
| Log likelihood | -76.15655 | Hannan-Quinn criter. | 3.254983 |
| F-statistic | 358.6655 | Durbin-Watson stat | 1.666347 |
| Prob(F-statistic) | 0.000000 | | |

$H_0$: No serial correlation
$H_1$: There is serial correlation

p=0.000<0,05, so the null hypothesis is rejected and there is serial correlation

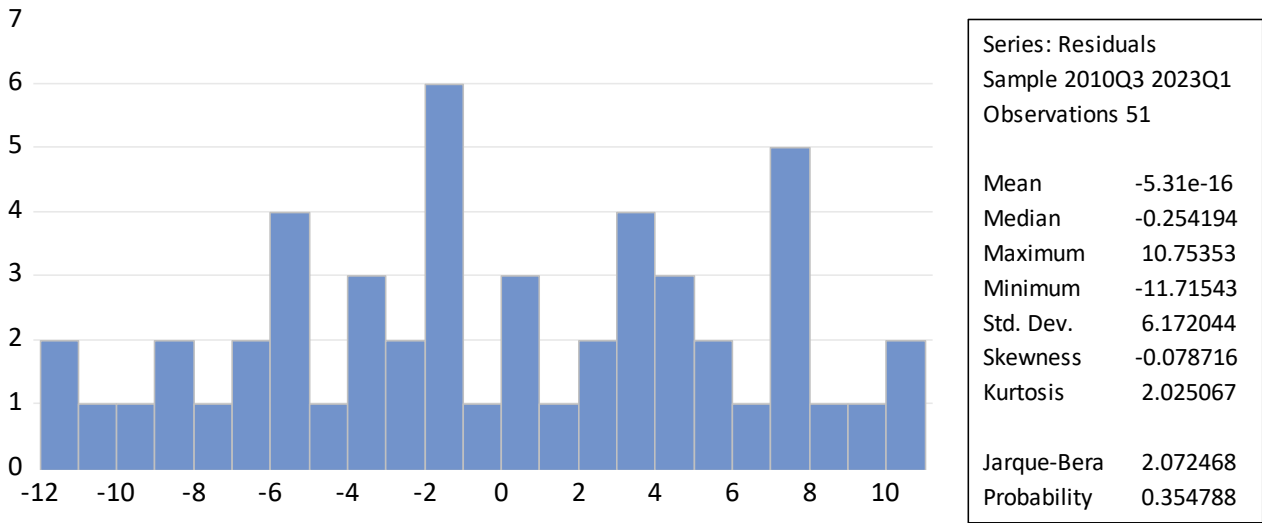
### Testing for multcollinearity

Variance Inflation Factors
Date: 12/06/23 Time: 18:42
Sample: 2010Q1 2023Q1
Included observations: 51

| Variable | Coefficient Variance | Uncentered VIF | Centered VIF |
|---|---|---|---|
| LINFLATION | 0.069968 | 2.078613 | 1.447575 |
| LINCOME_GROWTH | 0.039920 | 4.112487 | 1.447575 |
| C | 2.220443 | 2.853797 | NA |

Centered VIF<10, there is no multicollinearity in the model.

**Testing for normality** – the Bera-Jarque normality, if the residuals are normally distributed, the Bera-Jarque statistic would not be significant.




$H_0$: the residuals are normally distributed;
$H_1$: the residuals are not normally distributed.

The p-value of Jarque-Bera statistic=0.354788>0.05, which means that Jarque-Bera statistic is not significant and we accept $H_0$: the residuals are normally distributed

**Testing whether the linear functional form is correct:**

In order to test whether the linear functional form is correct, the Ramsey`s RESET Test is applied.

Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values
Specification: NPLS RESTRUCTURED LOANS HOUSING LOANS LINFLATION LINCOME GROWTH C

| | Value | df | Probability |
|---|---|---|---|
| t-statistic | 0.622659 | 47 | 0.5365 |
| F-statistic | 0.387704 | (1, 47) | 0.5365 |
| Likelihood ratio | 0.418975 | 1 | 0.5174 |

F-test summary:

| | Sum of Sq. | df | Mean Squares |
|---|---|---|---|
| Test SSR | 15.58343 | 1 | 15.58343 |
| Restricted SSR | 1904.706 | 48 | 39.68138 |
| Unrestricted SSR | 1889.123 | 47 | 40.19410 |

LR test summary:

| | Value |
|---|---|
| Restricted LogL | -164.6824 |
| Unrestricted LogL | -164.4729 |

Unrestricted Test Equation:
Dependent Variable: NPLS RESTRUCTURED LOANS HOUSING LOANS
Method: Least Squares
Date: 12/06/23 Time: 18:45
Sample: 2010Q3 2023Q1
Included observations: 51

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LINFLATION | -0.411156 | 0.612783 | -0.670966 | 0.5055 |
| LINCOME GROWTH | -0.038261 | 0.264798 | -0.144490 | 0.8857 |
| C | 9.831047 | 10.70399 | 0.918447 | 0.3631 |
| FITTED^2 | 0.025677 | 0.041237 | 0.622659 | 0.5365 |

| | | | |
|---|---|---|---|
| R-squared | 0.254994 | Mean dependent var | 13.38183 |
| Adjusted R-squared | 0.207441 | S.D. dependent var | 7.121398 |
| S.E. of regression | 6.339882 | Akaike info criterion | 6.606782 |
| Sum squared resid | 1889.123 | Schwarz criterion | 6.758298 |
| Log likelihood | -164.4729 | Hannan-Quinn criter. | 6.664681 |
| F-statistic | 5.362252 | Durbin-Watson stat | 0.061094 |
| Prob(F-statistic) | 0.002936 | | |

The p-values of the t-statistic, F-statistic and Likelihood ratio are greater than 0,05, so it can be inferred that the model is free from specification errors.

Appendix 2- Housing loans regression analysis