

# MACROECONOMIC DETERMINANTS OF NON-PERFORMING LOANS: A QUANTILE REGRESSION APPROACH EVIDENCE FROM VIETNAM'S BANKING SYSTEM

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## ABSTRACT

This study investigates the impact of economic growth, inflation, money supply, and real interest rates on non-performing loans (NPLs) in the Vietnamese banking system. To achieve the research objective, we employ Ordinary Least Squares and Quantile regression methods to estimate models with data collected from the World Bank on the Vietnamese banking system for the period 2000-2020. The Ordinary Least Squares estimation results do not find a significant impact of economic growth on NPLs, but Quantile regression estimation results reveal that economic growth has a negative effect on NPLs for the lower quantile groups, with this effect being insignificant for the quantile groups above 0.3. Furthermore, the study's findings indicate that inflation and real interest rates have a negative impact on NPLs across most quantile groups, while the money supply has a negative impact on NPLs only in the medium quantiles (0.4 and 0.5) and high quantile groups (above 0.7). Additionally, we found a stable equilibrium between NPLs and economic growth, inflation, money supply, and real interest rates, with a positive long-term impact of economic growth, inflation, money supply, and real interest rates on NPLs. The research findings propose several policy implications for controlling NPLs in the Vietnamese banking system.

**Keywords:** non-performing loans; quantile regression; Ordinary Least Squares, macro factors

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## INTRODUCTION

Van Greuning and Bratanovic (2020) argued that bank risks include three main types: financial, operational, and environmental. In particular, environmental risks are related to the banking business environment, including fluctuations in macroeconomic-legal factors,

financial infrastructure, and payment systems. In other words, environmental risks include all types of exogenous risks, and if they were realized, they could damage a bank's operations or undermine a bank's ability to continue as a business.

Many empirical researches have shown that environmental risks, in general, and

macroeconomic risks, in particular, are one of the root causes that causes credit risks for banks, especially affecting the NPLs ratio (Climent-Serrano & Pavia, 2014; Monokroussos et al., 2016; Kashif et al., 2016; Szarowska, 2018; Wang, 2018; Qian & Yang, 2022). According to the standpoints of some researchers, NPLs of the banking system is considered as a component of the "financial pollution" element because it causes a negative impact on economic growth (Barseghyan, 2010; Zeng, 2011). Therefore, it's important to investigate the factors impacting NPLs, especially in emerging economies (Mileris, 2012).

In the context of Vietnam, the current situation under the influence of the Covid-19 pandemic has resulted in a sharp decline in economic growth, an increase in inflation, a decrease in real interest rates, and the State Bank's submission to the Government of a scenario regarding the upward trend of NPLs soon. Accordingly, the estimated balance sheet and optimal NPLs ratio at the end of 2021 will be around 7.1 -7.7%, approximately 8%. This forecasting result, which is based on circulars, namely 01/2021/TT-NHNN, 03/2021/TT-NHNN, and 14/2021/TT-NHNN, allows the banks to restructure, expand and defer debts. Thus, from theory to practice, it's shown that there is an impact of economic factors on NPLs of the banking system from a general perspective. Within the scope of this article, we employ quantile regression to assess the impact of economic variables, including economic growth, inflation, money supply, and real interest rates, on the non-performing loans of the banking system in Vietnam at different quantiles. The study also uncovered the long-term relationship between non-performing loans and these economic factors. Our findings shed light on the dynamic interplay between economic variables and non-performing loans in the Vietnamese banking system and provide valuable insights for policymakers and practitioners in managing credit risk.

## LITERATURE REVIEWS

The macroeconomic determinants of non-performing loans are considered by many factors such as economic growth, inflation, unemployment rate, money supply, stock price index, government spending, exchange rate, and interest rate. However, the macroeconomic determinants will be chosen to suit the research

purpose due to the limitation of data and conditions of research models.

The economic factor selected in the latest studies is economic growth, denoted by GDP. For economic growth, most of the papers stated that the impact of economic growth on non-performing debt was negative (Gunsel, 2012; Louzis et al., 2012; Thiagarajan et al., 2011; Castro, 2013; Kashif et al., 2016; Messai & Gallali, 2019). It was explained that when the macroeconomic environment was good, the borrowers had favorable conditions to run their businesses and expand their investments, as a result of owning stable and prosperous sources of income, their financial ability to repay loans on time and limit the non-performing debt arising (Kashif et al., 2016; Szarowska, 2018; Messai & Gallali, 2019). However, the negative relationship from GDP to non-performing loans reveals that when the economy goes down, the non-performing loans will go up. When non-performing loans of the banking system increase, it, in turn, reduces GDP. The negative relationship between GDP and NPLs is found in studies in many markets, such as Ariff & Marisetty (2001) for OECD and Asian countries; Kashif et al. (2016) for the Pakistani market; Messai & Gallali (2019) for the European market.

In another aspect, Gremi (2013) said that the credit growth of the banking system is a positive sign for the economy, it performed the health of the banking industry and the stability of the macro environment. However, excessive credit growth will reduce the quality of loans, especially increasing non-performing loans. It implies a positive link between high economic growth and non-performing loans.

The results of the impact of inflation on non-performing loans are not consistent, with both positive and negative effects (Castro, 2013; Monokroussos et al., 2016). However, there are more conclusions about the negative impact of inflation on non-performing loans than positive ones. Aver (2008), Bofondi & Ropele (2011), Castro (2013), Gremi (2013), Bucur & Dragomirescu (2014), Waemustafa & Sukri (2015) found the negative impact of inflation on NPLs.

The research concluding the negative impact of inflation on NPLs explained that the real value of liabilities to a bank would begin to decline in periods of high inflation. It helps borrowers unable to repay the loans more easily, thus

limiting NPLs. Besides, the positive correlation between inflation and credit risk was found in the papers of Gonsel (2012) and Nkusu (2011). Gonsel (2012) argued that when the high inflation seemed to make it difficult for banks in the north of Cyprus to assess their customers' credit risk and lead to poor loan quality. In addition, high inflation causes borrowers' real incomes to decrease, reducing their debt repayment capacity and increasing NPLs (Nkusu, 2011).

Another macro variable that affects NPLs in the banking system is the interest rate. Louzis et al. (2012) and Nkusu (2011) found a positive relationship between interest and NPLs, especially when the loan interest rate was floating. When the interest rate increases, the interest burden will increase accordingly, which leads to a higher probability of NPLs ratio. Similarly, Bofondi & Ropele (2011) also concluded that the high interest would increase NPLs ratio in Italy. This result was found in Greece, Ireland, Finland, Spain, and Italy (Castro, 2013).

Increasing the money supply is often used by State banks in expansionary monetary policy to reduce the interest rate and create momentum for economic growth. Because when the interest rate decreases, it will create many opportunities for firms, and they will receive cheap capital sources for production and business, increasing output for the economy and generating profits for themselves. In such conditions, corporate and individual customers increase their financial capacity and liability for debts, thereby limiting bad debts arising (Ahmad & Ariff, 2007; Louzis et al., 2012). The results that an increase in money supply will lead to a decrease in NPLs of the banking system are found in many studies in many different countries, such as Kalirai & Scheicher (2002) for the Australian market and Vogiazas & Nikolaidou (2011) for the Romanian market.

In addition, other factors used in the previous papers about macroeconomic determinants of NPL are the unemployment rate (Nkusu, 2011; Louzis et al., 2012; Castro, 2013), stock price index growth (Castro, 2013), credit growth (Kattai, 2010; Castro, 2013) and real exchange rate (Nkusu, 2011, Castro, 2013).

Recently, many studies have continued the relationship between macro factors and non-performing loans. For example, the study of

Arham et al. (2020) examines the impact of macroeconomic cyclical indicators and country governance on bank non-performing loans in Emerging Asia. Research by Lubis & Mulyana (2021) has an objective to study and analyze the effect of macroeconomic proxied by GDP, inflation, exchange rate, unemployment rate, the policy of interest rate, and loan growth on NPLs and its implications for Allowance for Impairment Losses. The research of Foglia (2022) investigates the influence of macroeconomic determinants on non-performing loans in the Italian banking system. However, most of the studies have used estimates for the mean results of the impact of macro factors on NPLs. Studying the impact of macro factors on each quantile of the NPLs does not have any access to studies. Our study fills this gap in the direction of the quantile regression approach. At the same time, the Ordinary Least Squares estimator, which gives the mean regression function, is also used in our study. Quantile regression compared with Ordinary Least Squares regression results show exciting findings about the impact of macro factors on each percentile of NPLs.

## METHODOLOGY

In this study, we use the quantile regression method instead of the Ordinary Least Squares method because of its advantages over the Ordinary Least Squares method. Koenker & Bassett (1982) are the first authors to use the quantile regression method instead of estimating the parameters of the mean regression by the Ordinary Least Squares method. They proposed to estimate the regression parameter on each quantile of the dependent variable so that the total absolute difference of the regression function at the quantile  $\eta$  of the dependent variable is minimal. In other words, instead of determining the effect of the independent variable on the mean of the dependent variable, quantile regression will help assess the impact of the independent variable on the dependent variable on each quantile of the dependent variable.

Regression by the Ordinary Least Squares method only obtains a single regression line representing the conditional mean of the dependent variable  $Y$  according to the values of the independent variable  $X$ . Meanwhile, the quantile regression shows multiple regression functions for each quantile of the dependent

variable. Figure 1 illustrates the case where quantile regression is performed under quantiles 0.1, 0.25, 0.5, 0.75, and 0.9, compared to Ordinary Least Squares regression.

Compared with the Ordinary Least Squares method, the quantile regression has some outstanding advantages (Anh, 2015) such as:

1. The quantile regression allows expressing the relationship in detail between the dependent variable and independent variables on each quantile of a dependent variable, not just showing this relationship by mean value like Ordinary Least Squares method;
2. In Ordinary Least Squares regression, the outliers are often removed so that the Ordinary Least Squares estimators are unbiased. In contrast, the robustness of the quantile is not affected by such outliers.
3. The parametric tests of quantile regression do not rely on any assumptions about the distribution form of the regression errors, while the Ordinary Least Squares regression requires the residuals of estimators to follow a normal distribution.
4. The quantile regression is typically suitable to analyze the regression model with the presence of variable variance or the distribution function of the dependent variable in the sample is asymmetric around the mean;
5. The quantile regression estimators approximate the General Method of Moment.

With five outstanding advantages, the conditions such as the residual following normal distribution, constant variance, and no autocorrelation in the Ordinary Least Squares regression are no longer required in the quantile regression. In addition, with the bootstrap technique for parametric tests of quantile

regression, this method is very suitable for a small sample.

Given  $Y$  is a random quantity with the distribution function  $F_y$ . For  $\tau \in (0,1)$ , the quantile  $\tau$  of  $Y$  is  $Q_\tau$  with:

$$Q_\tau = \inf\{y: F_\tau(y \geq \tau)\} \tag{1}$$

The conditional quantile at quantile  $\tau$  of  $Y$  at  $X=x$  is determined as follows:

$$Q_\tau(Y|X = x) = \inf\{y: F_{Y|X}(y|x) \geq \tau\} \tag{2}$$

Expanding quantile regression was proposed by Koenker & Bassett (1978): in case, the dependent variable  $Y$  has the form  $Y = h(X_i, \beta_\tau) + u_{\tau i}$  where  $u_{\tau i}$  is an error of the  $i$  observation at quantile  $\tau$  satisfying  $Q_\tau(u_{\tau i} | X_i) = 0$ .

Then, the conditional quantile function is  $Q_\tau(Y_i | X_i) = h(X_i, \beta_\tau)$ . Where  $Q_\tau(Y_i | X_i)$  is the regression of the  $\tau$ -th quantile with  $\tau \in (0,1)$  for the dependent variable  $Y_i$ ,  $\beta_\tau$  is the estimated parameter vector.

If considering a particular sample, the obtained estimators  $\beta_\tau$ , symbol  $\hat{\beta}_\tau$ , and the linear quantile regression function have forms:

$$Q_\tau(Y_i | X'_i) = h(X'_i, \hat{\beta}_\tau) \text{ hay } Y_i = X'_i \hat{\beta}_\tau + u_{\tau i} \quad (u_{\tau i} \text{ is error}) \tag{3}$$

Parameter  $\beta$  at quantile  $\tau$ :

$$\hat{\beta}_\tau = \frac{1}{n} \left[ \sum_{\{i|Y_i \geq X'_i \beta_\tau\}} \tau \cdot (Y_i - X'_i \beta_\tau) + \sum_{\{i|Y_i < X'_i \beta_\tau\}} (1 - \tau) \cdot (Y_i - X'_i \beta_\tau) \right] \tag{4}$$

The coefficient  $\hat{\beta}_\tau$  represents that each observation in the sample is put a weight accordingly: the observations above the  $\tau$  quantile regression line is put a weight of  $\tau$  and the observations below the line are put a weight of  $(1-\tau)$ .

If  $\tau = 0.5$ , then function (4) becomes:

$$\hat{\beta}_\tau = \frac{1}{n} \left[ \sum_{\{i|Y_i \geq X'_i \beta_\tau\}} (Y_i - X'_i \beta_\tau) \right] \tag{5}$$

$\hat{\beta}_\tau$  in function (5) is the parameter of Ordinary Least Squares regression, thus this method is a special case of quantile regression when  $\tau=0.5$ .

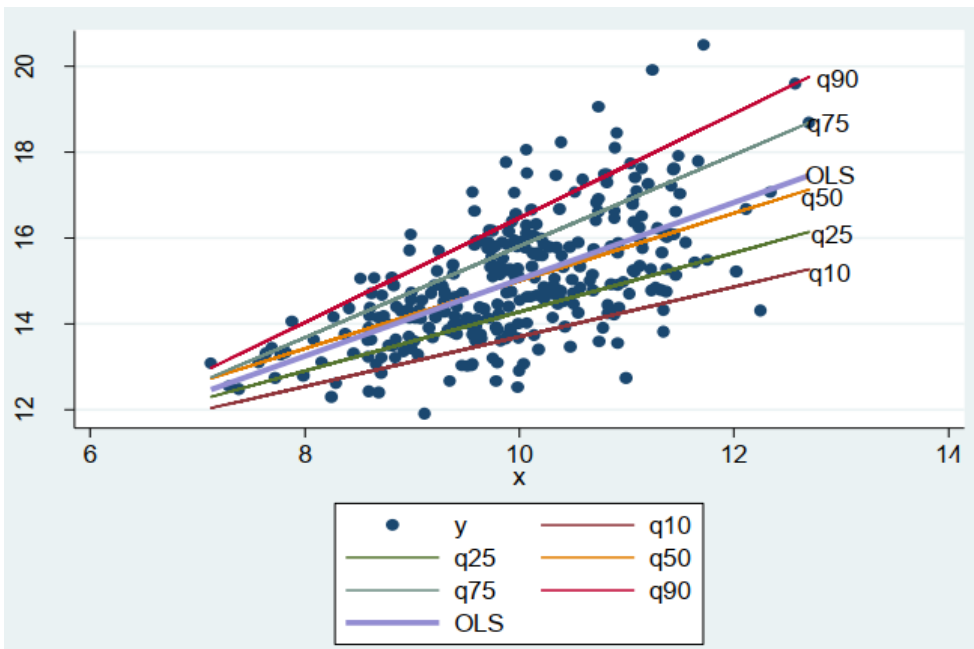


Figure 1: The results of quantile regression of Y over X

**RESEARCH MODEL**

Among the quantitative studies on the relationship between credit risk and macro factors, credit risk is often represented by non-performing loans or credit risk provision. The macro factors, such as economic growth, inflation, unemployment, interest rate, stock prices, money supply, and government spending, are usually selected. The researchers choose representative variables that can be accessible and sufficient to ensure the regression results are reliable. This paper is based on previous empirical research to develop a model exploring the impacts of macro factors on NPL of Vietnam's banking system. With the selected macro variables such as economic growth (GDP), inflation (INF), money supply (M2) and real interest rate (RINT) for Vietnam in the period from 2000 to 2020, the research model has the form:

$$NPL_t = \beta_0 + \beta_1 GDP_t + \beta_2 INF_t + \beta_3 M2_t + \beta_4 RINT_t + \mu_t \tag{6}$$

Where, NPL: The non-performing loan ratio of Vietnam's banking system, selected from World Bank data; GDP: GDP growth, source from World Bank data; INF: inflation ratio, source from World Bank data; M2: the ratio of money supply M2 on GDP, source from World Bank data; RINT: Real interest rate, source from World Bank data.

**RESULTS AND DISCUSSION**

**The Non-performing Loans of the Vietnam Banking System**

Figure 2 illustrates the ratio of non-performing loans to total outstanding loans in the Vietnamese commercial banking system during the period 2000-2020. The fluctuations in non-performing loans of the Vietnamese commercial banking system depicted in Figure 2 can be divided into four distinct phases: (i) Phase 1 from 2000 to 2005; (ii) Phase 2 from 2006 to 2010; (iii) Phase 3 from 2011 to 2015; (iv) Phase 4 from 2016 to 2020.

From 2000 to 2005, the average Non-Performing Loans ratio of the Vietnamese banking system was 5.52%. This is the period when bad debt is quite high, above 5%, exceeding the allowable limit according to international practices. A high rate of bad debt will cause instability in the macro economy, bad debt is one of the causes of high inflation and, subsequently, higher interest rates. Therefore, the State Bank must implement a tight monetary policy to control inflation. During this period, the State Bank of Vietnam issued guidelines and accompanied credit institutions to deal with bad debts. A decisive document for bad debt reduction is Decision 493/2005/QD-NHNN, stipulating debt classification, setting up, and using provisions to deal with credit risks. Accordingly, outstanding loans of commercial

banks and credit institutions to customers are classified into 5 groups; in which group 1 is good debt, group 2 is doubtful debt, from Group 3 to Group 5 is classified as bad debt. Due to such a classification of debts, the number of bad debts of commercial banks and credit institutions in 2005 increased slightly compared to 2004, but it will help the Vietnamese commercial banking system to correctly determine the bad debt ratio according to international standards from which there are more appropriate and effective solutions.

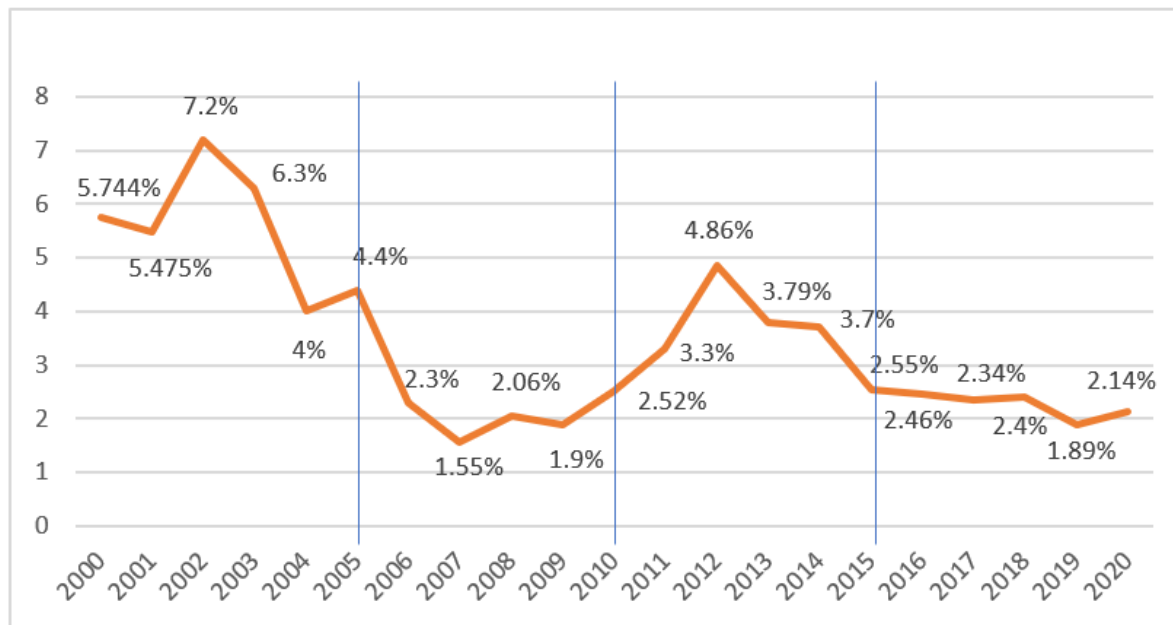
From 2006 to 2010, the average Non-Performing Loans rate was 2.07%. 2006 is the second-year commercial banks and other credit institutions in Vietnam implemented debt classification according to the document Decision No. 493 of the State Bank, in line with international practices. From 2005 to 2007, the rate of Non-Performing Loans decreased significantly, from 4.4 %/year to 1.55 %/year. But by 2008, the Non-Performing Loans rate had increased again (2.06 %/year), mainly in the real estate sector. Real estate credit rose sharply in 2007 and when the real estate bubble burst, the real estate market fell, and borrowers could not pay their debts, giving rise to bad debts. The real estate market's collapse made Non-Performing Loans of Vietnam gradually increase from 2007 to 2010 at 2.52%.

From 2011 to 2015, the average Non-Performing Loans rate was 3.64%. Bad debt from real estate credit has not been resolved, pushing the whole system's bad debt to continue to increase until 2012 at 4.86%. Although banks have reduced lending rates and inflation has been controlled, businesses still face difficulties and do not have a source of revenue to repay bank loans. The economic situation has led many economists to believe that the bad debt figure of 4.86% in 2012 does not reflect the difficult situation of Vietnamese enterprises or the credit quality of Vietnamese commercial banks. Some independent rating agencies also believe that the level of undisclosed bad debt is much higher. For example, according to Fitch Ratings, Vietnam's bad debt ratio in 2012 was 13% of the total outstanding loans, much higher than the announced 4.86%. Faced with the increasing bad debt situation, on March 1, 2012, the Prime Minister issued Decision No. 254/QD-TTg approving the project "Restructuring the credit institution system for the period 2011-2015".

Based on Decision No. 254, the State Bank issued Decision No. 734/QD-NHNN dated April 18, 2012, on action plans to contribute to the successful implementation of the objectives of the project on restructuring the credit institution system. Next, the Government of Vietnam further issued Decision 843/2013/QD-TTg dated May 31, 2013, approving the Project "Handling bad debts of the system of credit institutions" and issued Decree No. 53/ 2013/ND-CP on the establishment of organization and operation of Vietnam Asset Management Company on May 18, 2013. The Government's consecutive bad debt handling plans have shown the Government's determination in reducing the bad debt of the Vietnamese commercial banking system.

In the period from 2016 to 2020, the average Non-Performing Loans rate was 2.24%. Provisions for bad debts mainly handled regulations on dealing with bad debts before June 2017, measures to deal with bad debts through handling collaterals and debt repayment customers have not yet been strongly implemented. Therefore, continue to overcome shortcomings and limitations in bad debt handling, create a unified and synchronous legal framework on bad debt handling, remove difficulties and obstacles, support credit institutions in effectively and permanently handling bad debts, on June 21, 2017, the National Assembly issued Resolution No. 42/2017/QH14 "on pilot handling bad debts of credit institutions". With the synchronous implementation of solutions, the bad debt ratio at the credit institution system was maintained below 3%, specifically: at the end of 2016 reached 2.46%; at the end of 2017 reached 2.34%; at the end of 2018 reached 1.4%; at the end of 2019 reached 1.89% and as of December 31, 2020, at 2.14%.

From the end of 2020 until now, according to data published by the State Bank of Vietnam, the bad debt ratio on the balance sheet at commercial banks continues to increase. Production and business activities, financial situation, and debt repayment ability of the business community were seriously affected by the COVID-19 epidemic, causing the bad debt ratio on the balance sheet to tend to increase.



**Figure 2:** Non-performing Loans of Vietnam's commercial banking system 2000 -2020

By the end of the second quarter of 2021, the financial statements published by nearly 30 commercial banks showed that the total bad debt on the balance sheet increased by 4.5% in the first 6 months of 2021. The World Bank (World Bank) also advised Vietnam to be wary of risks to the financial sector that are increasing due to the crisis. At present, the State Bank needs to make efforts to support the economy, allowing banks to extend loans and restructure debts, and at the same time, the Government of Vietnam also needs to quickly complete the Scheme on restructuring the credit institutions in the 2021-2025 period, to continue to support these organizations in effectively handling bad debts that are expected to increase due to the impact of the Covid-19 pandemic.

with a significant level of 1%. However, INF, M2, and RINT series with no trend are stationary at level. Thus, there is an inconsistency in the stationarity of the series here. Nelson and Plosser (1982) argue that most time series is non-stationary at level  $I(0)$ , and the difference is the possible way to make them stationary. Indeed, when the series takes the 1st difference, the NPL, GDP, INF, M2, and RINT series are stationary at the significant level of 1% for both cases with trend and no trend.

**The Stationary Test**

In the Ordinary Least Squares and quantile regression (QR) methods, all required data must be stationary because if the data series is not stationary, it can lead to the regression being spurious. Thus, the regression result is unreliable. The stationary test for data series usually applied is the unit root test. It was first introduced by Augment Dickey-Fuller in 1979. Table 1 represents the model's unit root test result for the data series.

The result in Table 1 shows that the series in level with the trend are non-stationary at all,

Table1: Unit root test for data stationarity

Variable	Level						1 <sup>st</sup> difference					
	No Trend			Trend			No Trend			Trend		
	T-statistic	P-value	Is it stationary? (sig.1%)	T-statistic	P-value	Is it stationary? (sig.1%)	T-statistic	P-value	Is it stationary? (sig.1%)	T-statistic	P-value	Is it stationary? (sig.1%)
NPL	-1.681	0.0550	No	-1.863	0.6734	No	-4.356	0.0002	Yes	-4.255	0.0037	Yes
GDP	-2.423	0.0131	No	-2.314	0.4262	No	-3.715	0.0009	Yes	-3.796	0.0100	Yes
INF	-2.791	0.0060	Yes	-2.812	0.1925	No	-6.297	0.0000	Yes	-6.339	0.0000	Yes
M2	-4.070	0.0004	Yes	-4.600	0.0100	Yes	-6.046	0.0000	Yes	-5.702	0.0000	Yes
RINT	-3.017	0.0037	Yes	-3.311	0.0645	No	-6.146	0.0000	Yes	-6.244	0.0000	Yes



## The Ordinary Least Squares and quantile regression results

**Table 2:** The results of quantile regression and Ordinary Least Squares estimation

Variable	GDP	INF	M2	RINT	Pseudo R2
<b>Quantile regression according to quantile</b>					
Q10	-2.6380***	-0.2603***	-0.0242	-0.1954***	0.5500
Q20	-2.1746***	-0.2057***	-0.0162	-0.1615***	0.4393
Q30	-1.6330**	-0.1949***	-0.0141	-0.1704***	0.3674
Q40	-0.9060	-0.2054**	-0.0776***	-0.1673**	0.3058
Q50	-0.7476	-0.1999**	-0.0698**	-0.1844***	0.2551
Q60	-0.5910	-0.1371*	-0.0540	-0.1247*	0.2439
Q70	0.0202	-0.1861**	-0.0690	-0.2286**	0.2149
Q80	1.0071	-0.2914**	-0.0920***	-0.2769**	0.2904
Q90	1.1026	-0.2899***	-0.0846***	-0.2906***	0.4620
<b>Ordinary Least Squares</b>	-0.5006	-0.1697**	-0.0441*	-0.1804**	0.4450
<i>Notes:</i>					
✓ Q10, Q20, Q30, Q40, Q50, Q60, Q70, Q80, Q90: 0.1; 0.2; 0.3; 0.4; 0.5; 0.6; 0.7; 0.8 and 0.9 quantiles respectively.					
✓ *, **, ***: %, 5%, 1% significant level respectively.					
✓ Pseudo R2 is the coefficient expressing the fit of the model with the sample at quantile $\tau$ . Coefficient Pseudo R2 has a value in the range (0; 1) <sup>1</sup> .					

With the result that data series are stationary at the 1<sup>st</sup> difference, we continue running the Ordinary Least Squares and quantile regression models. Figure 1 shows that the Ordinary Least Squares estimators are the conditional mean of the dependent variables NPLs over the values of independent variables GDP, INF, M2, and RINT. The quantile regression gives specific values for each quantile of NPL, and to evaluate the impacts of GDP, INF, M2, and RINT on each quantile of NPL, we choose the quantiles correspondingly 0.1; 0.2; 0.3; 0.4; 0.5; 0.6; 0.7; 0.8 and 0.9. The results of Ordinary Least Squares and quantile regression estimations are shown in Table 2.

The findings from the results of Ordinary Least Squares and quantile regression estimations are pretty interesting. Firstly, GDP is not statistically significant in the Ordinary Least Squares model (Table 1) but significant in the quantile regression model at the low and not at the high quantile. In the quantile regression model, GDP negatively and significantly impacts NPL in the low quantile (0.1; 0.2 and 0.3). In the quantile

bigger than 0.3, we don't find the impact of GDP on NPL. Because the coefficients of GDP are not significant at the quantile of NPL, so in the Ordinary Least Squares model, the coefficient of GDP is not significant.

In addition, in the quantile regression models, the sign of GDP coefficients changes into positive at the high quantile of NPL. It is shown that at the low loan levels, the impact of GDP on NPLs is negative. The economy strongly grows and reduces the NPLs ratio of banks. However, when the NPL ratio is high, then the more the economy grows, the worst NPLs of the banking system become.

Followed by the money supply variable M2 results, the Ordinary Least Squares regression shows that, in general, the influence of M2 on NPLs is negative and statistically significant at the low significant level of 10%. When looking at the quantile regression results, M2 has a negative impact on NPLs at quantiles 0.4; 0.5; 0.7; 0.8; 0.9, and on average, this effect has a low significance level in the Ordinary Least Squares regression.

<sup>1</sup> Fang Chen, 2014

The negative impact of supply money M2 on NPLs shows that an increase in money supply is one factor that reduces interest rates, making market liquidity better and the banking system and the whole economy less stressed. In that condition, enterprises operate more efficiently and increase debt repayment capacity, from which banks' non-performing loans tend to decrease. At some quantiles of NPLs, the effect of money supply M2 on NPL is insignificant. This result implies that with deficient levels of non-performing loans (below 0.3) or relatively high levels (0.6 and 0.7 quantiles), money supply M2 is not a factor affecting the bank's non-performing loans.

The variable INF shows that inflation has a negative effect on NPLs and is statistically significant in both the Ordinary Least Squares method and all quantiles of NPLs in the quantile regression. Thus, for Vietnam's NPLs market, our research results support the theory that inflation causes the value of debts to become less, and borrowers easily fulfill their debt repayment obligations, thus limiting NPLs arising.

For the RINT variable, the research results show that interest rates negatively and significantly affect NPLs in both the Ordinary

Least Squares estimation and on each quantile of NPLs in the quantile regression estimation. This result is in contrast to the studies reviewed in the above section. This probably reflects the unique nature of the NPLs market of Vietnam's banking system because the real interest rate is the difference between the nominal interest rate and expected inflation. The negative impact of real interest rates on NPLs can be explained by the negative impact of inflation on NPLs is much stronger than the positive impact of interest rates on NPL. In other words, for Vietnam's NPL market, the negative influence of inflation is much stronger than the positive effect of interest rates.

**Causality Test**

To evaluate how stable and balanced the impact of GDP, INF, M2, and RINT on NPLs is in the long run, we will test the causal relationship between the variables in the model as a basis for cointegration assessment. Using the Granger test on stationary series to find the causal relationship between variables, the test results are presented in Table 3.

**Table 3:** Granger Causality Test

Null hypothesis: H <sub>0</sub>	T-Statistic	P-value	Significant 1%	Conclusion
<b>Causal relationship between NPLs and GDP/INF/M2/RINT</b>				
NPLs has no impact on GDP	4.3670	0.113	Accept H <sub>0</sub>	NPLs and GDP have no causal relationship.
GDP has no impact on NPLs	1.6496	0.438	Accept H <sub>0</sub>	
NPLs has no impact on INF	6.1461	0.046	Reject H <sub>0</sub>	NPLs and INF have causal relationship.
INF has no impact on NPLs	15.266	0.000	Reject H <sub>0</sub>	
NPLs has no impact on M2	3.8772	0.144	Accept H <sub>0</sub>	NPLs and M2 have causal relationship.
M2 has no impact on NPLs	28.404	0.000	Reject H <sub>0</sub>	
NPLs has no impact on RINT	16.067	0.000	Accept H <sub>0</sub>	NPLs and RINT have causal relationship.
RINT has no impact on NPLs	2.0002	0.368	Reject H <sub>0</sub>	
<b>Causal relationship between GDP and INF/M2/RINT</b>				
GDP has no impact on INF	3.0147	0.221	Accept H <sub>0</sub>	GDP and INF have causal relationship.
INF has no impact on GDP	9.8919	0.007	Reject H <sub>0</sub>	
GDP has no impact on M2	3.7898	0.046	Accept H <sub>0</sub>	GDP and M2 have no causal relationship
M2 has no impact on GDP	6.7809	0.034	Accept H <sub>0</sub>	
GDP has no impact on RINT	1.1034	0.576	Accept H <sub>0</sub>	GDP and RINT have no causal relationship
RINT has no impact on GDP	0.6573	0.720	Accept H <sub>0</sub>	

Table 3: Continued

Causal relationship between INF and M2/RINT				
INF has no impact on M2	90.263	0.000	Reject H <sub>0</sub>	INF and M2 have causal relationship
M2 has no impact on INF	43.115	0.000	Reject H <sub>0</sub>	
INF has no impact on RINT	5.8552	0.054	Accept H <sub>0</sub>	INF and RINT have no causal relationship.
RINT has no impact on INF	8.4476	0.015	Accept H <sub>0</sub>	
Causal relationship between M2 and RINT				
M2 has no impact on RINT	63.3370	0.000	Reject H <sub>0</sub>	M2 and RINT have causal relationship
RINT has no impact on M2	18.9900	0.000	Reject H <sub>0</sub>	

Granger test results presented in Table 3 show that NPLs have a causal relationship with INF, M2 and RINT but no causal relationship with GDP. This result shows that fluctuations in NPLs lead to fluctuations in inflation, money supply, and real interest rates, and at the same time, fluctuations in inflation, money supply, and real interest rates will also lead to fluctuations in real interest rates and NPL. The GDP variable only has a causal relationship with the INF variable. In addition, there is no causal relationship with the other variables. There is a causal relationship between INF and M2 and there is no causal relationship between INF and RINT. In

conclusion, there is a causal relationship between M2 and RINT.

**Cointegration Test**

The causal relationship shows the trend of cointegration in the long term. Performing the Johansen cointegration test introduced by Engle and Granger in 1987 (Table 4) on the sample, the results determine that there are two cointegration vectors. This also shows that there is a long-run equilibrium relationship between GDP, INF, M2, RINT, and NPL.

Table 4: Cointegration Test

Hypothesis		Trace statistic	5% critical value
H <sub>0</sub>	H <sub>1</sub>		
r=0	r≥1	164.4778	68.52
r≤1	r≥2	52.0565	47.21
r≤2	r≥3	<b>29.4457*</b>	29.68
r≤3	r≥4	13.2467	15.41
r≤4	r≥5	2.6314	3.76

The coefficients of the cointegration model are represented in Table 5, and its equation has form as follows:

$$d\_NPLs = 0.3468 + 0.7105^{***}d\_GDP + 0.2584^{***}d\_INF + 0.2374^{***}d\_M2 + 0.1510^{***}d\_RINT(3)$$

The cointegration model (3) shows that GDP, INF, M2, and RINT positively impacts NPLs in the long term at the high significant level of 1%. It means that in the long term, economic growth,

inflation, money supply, real interest rate will all increase the NPLs of banks.

Table 5: Cointegration Model

Dependent Variable d_NPL	Coefficient	Standard Error	Z-Statistic	P>z	[Confidence interval 95%]	
d_GDP	<b>0.7105</b>	0.1943266	3.660	0.000	0.32966	1.0914
d_INF	<b>0.2584</b>	0.0079861	32.36	0.000	0.24279	0.2741
d_M2	<b>0.2374</b>	0.0021507	110.43	0.000	0.23328	0.2417
d_RINT	<b>0.1510</b>	0.0079087	19.1	0.000	0.13559	0.1666
_cons	0.3468	.	.	.	.	.

### CONCLUSION AND POLICY IMPLICATION

This research is conducted using the quantile regression method to evaluate the impacts of macro variables such as economic growth (GDP), inflation (INF), money supply M2, and real interest rate on NPLs of the Vietnam banking system. The research also compares the results between the Ordinary Least Squares and the quantile regression methods to determine the outstanding advantages of quantile regression in considering the research issues.

The research result shows that in Ordinary Least Squares estimation, the coefficient of economic growth is not statistically significant, but in quantile regression estimation, GDP has a negative impact on NPLs at low quantiles, and there is no impact in the quantiles higher than 0.3. Moreover, the sign of the GDP coefficient changes direction from negative to positive at the high quantiles of NPLs. The effect of inflation on NPLs is negative, allowing us to support the theory that high inflation will limit NPLs arising. The impact of money supply M2 on NPLs is negative. This result is consistent with the previous studies. However, the result of the impact of real interest rate is not the same as the previous studies. But it reflects the situation of the Vietnam NPLs market that the impact of inflation on NPLs is stronger than the impact of interest rate on NPLs.

The obtained results show that economic growth, inflation, money supply and real interest rate negatively affect NPLs. This result indicates that when the economy declines, it will increase systemic NPLs of the banking system. Due to the impact of the global covid pandemic, Vietnam's economy is also negatively affected. Forecasting a decline in GDP and an increase in inflation in the Vietnamese market is inevitable. In anticipation of an increase in NPLs, the State Bank of Vietnam has proactively proposed

scenarios to deal with an increase in NPLs to 7.1-7.7%, approximately 8%. The initiative in response policies will help the Vietnamese economy have the lowest losses and quickly recover.

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