Research article

Does loan growth impact on bank risk?

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\textbf{ABSTRACT}

In the context of competition between domestic banks but also foreign banks become more and more fierce. The increasing penetration of foreign banks brings certain risks to domestic banks. This study was conducted to assess the effect of loan growth on banking risk in Vietnam. The study collects data on 29 banks listed on the Vietnam stock exchange from 2010 to 2020. The results of panel data analysis with Generalized least squares (GLS) have shown a relationship between loan growth and bank risk. In which loan growth has a negative impact on Non-performing loans (NPL), liquidity risk equity on asset (ETA); loan growth has a positive impact on return (ROA). In addition, the study also conducts a comparative assessment by bank size and loan growth rate. The results indicate a difference in loan growth's impact on banks' bank risk with lower and higher assets and lower and higher loan growth rates. From the results of this study, the authors also provide some implications to help banks reduce bank risk based on loan growth strategy.

1. Introduction

The loan is the main income-generating activity for banks [1]. The bank’s loan activities will help other economic actors have the capital for development: Enterprises have the capital to expand production and business, individuals have the capital for consumption and business, etc. Therefore, the development of banks brings opportunities to mobilize business capital for business entities in society [1, 2]. Therefore, banking activities bring not only advantages to the economy but also risks to customers. For example, customers are worried about their deposits if the banking system is in recession and the bank’s capital mobilization or lending activities are in trouble [3, 4]. At the same time, the loan is also an important indicator to assess the risk level of banks [5].

The large/over loan growth can bring risks to banks [1, 5, 6, 7, 8]. Strong growth in banks’ loan activities lowers credit quality and increases credit risk [9, 10, 11, 12]. However, if loan growth and effective risk management methods help banks develop more sustainably. Risks of non-performance loans or liquidity are well controlled despite the high loan growth rate [1]. In other words, how much loan growth is not as crucial as how risk is managed in the bank [1, 3].

The studies have investigated the impact of credit growth on bank risk as well as operational efficiency [1, 5, 13, 14]. In particular, studies are showing that loan growth increases the level of bank risk in South Asian countries [1, 9, 10, 15]. However, some studies have the opposite result, saying that loan growth will reduce bank risk when good capital mobilization ability offsets the bank’s liquidity when managing risk effectively [3]. Some studies show that high credit growth will make banks under-perform in the third year after that due to lower return on assets (ROA) [16]. In contrast to rapidly growing banks, the authors also argue that slow loan growth leads to better outcomes [16]. Vietnam is a developing country, and the financial market is still on the way to completion. Therefore, research in emerging markets will examine how loan growth and bank risk differ for developed countries. There are conflicting research results in different research settings. Therefore, studying and assessing the impact of loan growth on bank risk is necessary for the environment of developing countries like Vietnam. At the same time, this is also the first study in Vietnam to assess the impact of loan growth on bank risk. Therefore, this study will help examine the impact of loan growth and bank risk, as well as help bank managers have strategies in changing loans.

In the context of the economic and social crisis caused by the COVID-19 pandemic, the banking industry will suffer specific impacts when the business situation of enterprises is delayed. Interest payment activities may be eased to support businesses in difficult times. At the same time, new business activities are also limited due to the risk that COVID-19 may persist [17, 18, 19]. Therefore, raising capital or loan may need to be considered in light of the ongoing COVID-19 pandemic in Vietnam. However, research on loan growth and bank risk in Vietnam is limited...
before and during the crisis period due to COVID-19. Therefore, this study was conducted to determine the effect of loan growth on bank risk at Vietnamese joint-stock commercial banks. The study will theoretically contribute to the relationship between loan growth and bank risk in the context of a developing country like Vietnam. In addition, the research results will help banks have reasonable loan policies to minimize risks as well as increase the bank’s sustainability.

2. Literature review

2.1. Bank lending activities

Bank credit or lending is an asset transaction between a bank and a borrower (an economic organization or individual in the economy). The bank transfers assets to the borrower for use. Within a specific time, as agreed, the borrower is responsible for unconditionally repaying both principal and interest to the bank when the payment is due. Thus, banks’ credit can be understood as the relationship of transferring the right to use capital or assets from commercial banks to customers within a certain period with a specific cost based on the principle of unconditional return. Sue both principal and interest to the lender when the payment is due.

The bank’s lending activities ensure that the production process takes place on a regular and continuous basis. This is a significant and constant source of capital for the economy so that businesses or individuals will receive stable funding to serve production and business activities [1, 2]. In addition, with continuous improvement efforts to improve credit quality, economic entities’ access to loan capital has been faster and easier, contributing to maintaining the smooth operation of credit institutions. This is a powerful lever that promotes the development of the process of accumulation and concentration of capital. Through the financial intermediation function, commercial banks have been maximizing the positivity of capital attraction through attractive credit policies to meet the market’s diverse needs, creating financial leverage for banks. Business development and production enterprises [1, 2]. Bank credit helps promote the equalization of profit rates across industries and is essential in organizing people’s lives.

2.2. The relationship between loan growth and bank risk

Some studies in developing countries have suggested that excessive loan growth will cause many bad loans in banks [20, 21, 22, 23, 24]. The growth of loans may loosen banks’ loans standards because of the high competition in the market. However, when the norms are eased, it will quickly lead to NPL risks when the customer’s ability to repay will be reduced to the process of application appraisal and approval being relieved [25]. Therefore, activities on controlling the loans activities of banks are also introduced by scientists to avoid the risk of an explosive credit boom in the future [1, 21].

A sharp increase in loans may reduce banks’ loan risk provisions at the moment but will tend to increase risk in the 2nd to 4th years [5, 26]. The rapid increase in loans may weaken banks’ solvency in a short time [1, 5]. When loans are increased but benefits are not added to equity, the bank continues to extend loans accordingly [5]. At the same time, lending using mobilized capital and equity will increase the bank’s liquidity risk in the short term [1, 5, 20]. In an unstable economy, the negative impact of loan growth on liquidity will be even more severe [26].

The high loan growth indicates the expectation to gain more interest income [1, 27, 28]. However, over-developed banks will have lower earnings than slow-growing banks [29, 30, 31]. Loan growth can bring short-term benefits to banks when interest income increases and firm performance measurement criteria show positive signs. However, in the long run, it brings risks for shareholders and successor managers [32]. Therefore, in this case, agency theory can be supported when the profitability benefits are maximized by managers while reducing the bank’s liquidity.

Agency theory can explain the positive relationship between loan growth and bank risk when the CEO will do everything to increase the bank’s revenue during his term to the maximum. However, if lending increases too much, it will reduce liquidity and increase NPL in the future [32]. Given the effects as mentioned above of loan growth on bank risk, adjusting loan growth plays an essential role in achieving optimal returns while minimizing possible risks. This adjustment lies not only in the decision-making and strategic management of the banks but also in the bank owners. In other words, owners need to increase agency costs to control decisions detrimental to the shareholders. Thus, agency costs will help increase the value of the bank and shareholders in the long term.

3. Method

3.1. Research mode

From studies previous, the authors show the research model:

\[
NPL_i = \alpha_1 + \beta_1 LG_i + \beta_2 LTA_i + \beta_3 CI_i + \beta_4 SIZE_i + \epsilon_i
\]  
(1)

\[
ETA_i = \alpha_1 + \beta_1 LG_i + \beta_2 LTA_i + \beta_3 CI_i + \beta_4 SIZE_i + \epsilon_i
\]  
(2)

\[
ROA_i = \alpha_1 + \beta_1 LG_i + \beta_2 LTA_i + \beta_3 CI_i + \beta_4 SIZE_i + \epsilon_i
\]  
(3)

The variables are calculated in Table 1.

3.2. Variable definition and hypotheses

3.2.1. Dependent variables

NPL: Non-performing loans are loans that cannot be recovered and turned into bad debt. NPL is measured by the ratio of uncollectible debt/total loan. A higher NPL ratio indicates that banks are at increased risk of losing the loan and the costs related to the loan.

ETA: equity to total assets ratio measures the liquidity or capital adequacy of banks. The higher the ETA ratio, the better the liquidity of the bank and the lower the bank’s risk.

ROA: bank’s rate of return describes how profitable a bank is. Larger ROA indicates higher profitability and more stable bank or lower bank risk [27]. In other words, the larger the ROA, the lower the bank’s risk. Therefore, the increase in ROA is also an important indicator for banks to evaluate performance.

3.2.2. Independent variables

LG: Loan growth represents the bank’s loan growth in consecutive years. A positive LG indicates an increase in loan from the previous year and vice versa when a negative LG means a decrease in loan compared to last year. The higher the LG ratio, the stronger the loan increase compared to the previous year. As LG increases, it is expected to bring more interest income and help increase ROA [1]. At the same time, when

| Table 1. Variables defines. |
|-----------------------------|
| Variables name             | Content                     |
| Dependent variables adapted from [1, 5, 27, 33, 34, 35] | NPL = Non-performing loan |
|                            | ETA = Equity on total assets|
|                            | ROA = Return on total assets|
| Independent variable adapted from [1, 2, 5] | LG = \( \text{Loan}_{i+1}/\text{Loan}_{i-1} \) |
| Control variables adapted from [1] | LTA = Loan to total assets |
|                            | CI = Cost to income          |
|                            | SIZE = ln (Total assets)    |

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LG increases, the NPL ratio may increase if the customer loan portfolio is not well managed [1]. However, if debt management is good, the NPL ratio can be reduced [5]. LG’s rise could hurt ETA if the bank used a lot of equity in loans. This reduces the liquidity of banks and increases bank risk [1].

3.2.3. Control variables

LTA: ratio of loans to total assets overall assessment of loans. When this ratio is large, it can affect the bank’s risk when the amount of loans is too large, making the liquidity and bad debt challenging to control, but it is also an opportunity to increase the profit rate for the bank [1]. Therefore, LTA will tend to have the same effect on NPL and ROA, but will negatively impact ETA.

CI: cost-per-income ratio assesses the costs involved when getting a dollar of income (mostly calculated from interest income or lending activities). An increase in the cost per dollar of income may indicate that lending is costing more, reducing the bank’s profit margin [1]. At the same time, when CI increases, it will indicate that lending activities may be inefficient and need to incur other costs that have not brought much income. Therefore, CI tends to have a positive effect on ETA.

SIZE: firm size based on total assets of banks. When the scale increases, it can cause the bank’s activities to increase (open more branches, add new services or business models to increase non-interest income). In the case of effective scaling, ROA will increase due to more assets through equity will reduce solvency, or in other words, SIZE can reduce the ETA of the bank.

3.3. Data analysis

The initial data before analysis will be processed outliers by winsorized between 5% and 95%. After the data is cleaned, 29 banks of complete data from 2010 to 2020. With balance sheet data are used. Fundamental analysis models such as Fixed effect model (FEM) and random effect model (REM) will initially be used [27, 35, 37, 38, 39]. Then Hausman test will be used to select the model that is suitable for the research data. With the model selected after the Hausman test, the test of autocorrelation and heteroskedasticity will be of interest. In case of violating these tests, the authors calibrate the model via Generalized least squares (GLS). Stata uses feasible generalized least squares to fit panel-data linear models. This command enables estimation in the presence of AR(1) autocorrelation within panels as well as cross-sectional correlation and heteroskedasticity between panels.

The data must be evenly spaced in time to fit a model with autocorrelated errors (corr (ar1) or corr (psar1)). Panels must have the same number of observations to construct a model with cross-sectional correlation (panels (correlated)) (be balanced).

The equation from which the models are developed is given by Eq. (4):

\[ Y_{it} = \alpha_i + \beta X_{it} + \epsilon_{it} \]  

(4)

where \( i = 1, \ldots, m \) is the number of units (or panels) and \( t = 1, \ldots, T_i \) is the number of observations for panel \( i \). This model can equally be written as Eq. (5):

\[
\begin{bmatrix}
Y_1 \\
Y_2 \\
\vdots \\
Y_m \\
\end{bmatrix} = 
\begin{bmatrix}
X_1 \\
X_2 \\
\vdots \\
X_m \\
\end{bmatrix} \beta + 
\begin{bmatrix}
\epsilon_1 \\
\epsilon_2 \\
\vdots \\
\epsilon_m \\
\end{bmatrix}
\]  

(5)

The variance matrix can be expressed according to the disturbance terms in Eq. (6):

\[
E(\epsilon^2) = \Psi = 
\begin{bmatrix}
\sigma_{1,1} \Psi_{1,1} & \sigma_{1,2} \Psi_{1,2} & \cdots & \sigma_{1,m} \Psi_{1,m} \\
\sigma_{2,1} \Psi_{2,1} & \sigma_{2,2} \Psi_{2,2} & \cdots & \sigma_{2,m} \Psi_{2,m} \\
\vdots & \vdots & \ddots & \vdots \\
\sigma_{m,1} \Psi_{m,1} & \sigma_{m,2} \Psi_{m,2} & \cdots & \sigma_{m,m} \Psi_{m,m} \\
\end{bmatrix}
\]  

(6)

For the \( \Psi \) i,j matrices to be parameterized to model cross-sectional correlation, they must be square (balanced panels).

In these models, we assume that the coefficient vector \( \beta \) is the same for all panels and consider a variety of models by changing the assumptions on the structure of \( \Psi \).

The classic OLS regression model is presented in Eq. (7):

\[
E(\epsilon_{it}) = 0 \quad \text{Var}(\epsilon_{it}) = \sigma^2 \quad \text{Cov}(\epsilon_{i1}, \epsilon_{ij}) = 0 \quad \text{if} \; t \neq s \; \text{or} \; i \neq j
\]

(7)

This amounts to assuming that \( \Psi \) has the structure given by Eq. (8):

\[
\Psi = 
\begin{bmatrix}
\sigma^2 I & 0 & 0 \\
0 & \sigma^2 I & 0 \\
0 & 0 & \sigma^2 I
\end{bmatrix}
\]

(8)

whether the panels are balanced or not (the 0 matrices may be rectangular). This command’s default panels (iid) and corr (independent) options are classic OLS assumptions.

Heteroskedasticity across panels.

In many cross-sectional datasets, the variance varies by panel. It is common to have data on countries, states, or other units with different scales. The panels (heteroskedastic) option is used to specify the heteroskedastic model, which assumes in Eq. (9):

\[
\Psi = 
\begin{bmatrix}
\sigma_{1,1}^2 I & 0 & 0 \\
0 & \sigma_{2,2}^2 I & 0 \\
0 & 0 & \sigma_{3,3}^2 I
\end{bmatrix}
\]

(9)

Correlation across panels (cross-sectional correlation).

In addition to having various scale variances, we may wish to suppose that the error terms of panels are interrelated [40, 41]. Include the panels (correlated) option to specify the variance structure, which is given by Eq. (10):

\[
\Psi = 
\begin{bmatrix}
\sigma_{1,1}^2 I & \sigma_{1,2} I & \cdots & \sigma_{1,m} I \\
\sigma_{2,1} I & \sigma_{2,2}^2 I & \cdots & \sigma_{2,m} I \\
\vdots & \vdots & \ddots & \vdots \\
\sigma_{m,1} I & \sigma_{m,2} I & \cdots & \sigma_{m,m} I
\end{bmatrix}
\]

(10)

Within panels, there is autocorrelation.

To allow for serial correlation, the individual identity matrices along the diagonal of can be substituted with more general structures. You can use corr (independent) (no autocorrelation), corr (ar1) (serial correlation with the same correlation parameter for all panels), or corr (psar1) to presume a structure with corr (independent) (no autocorrelation) (serial correlation where the correlation parameter is unique for each panel).

GLS result is given in Eq. (11):

\[
\tilde{\beta}_{\text{GLS}} = (X' \Psi^{-1} X)^{-1} X' \Psi^{-1} y \quad \text{Var}(\tilde{\beta}_{\text{GLS}}) = (X' \Psi^{-1} X)^{-1}
\]

(11)

For all our models, the \( \Psi \) matrix may be written in Eq. (12):
\[
\psi = \sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_{ij} E_i E_j
\]  
(12)

Substituting the estimator E1 for E2 yields the estimated variance matrix as given in Eq. (13):

\[
\hat{\sigma}^2_{ij} = \frac{\hat{e}_i \hat{e}_j}{T} 
\]  
(13)

OLS regression is used to get the residuals utilized in estimation. The residuals are obtained from the last fitted model if the estimation is iterated. For models with no autocorrelation, maximum likelihood estimates can be derived by iterating the Feasible generalized least squares (FGLS) estimates to convergence (independent).

4. Results

4.1. Summary statistics

After collecting research variables, they will be included in STATA software version 16 for analysis. Initially, the variables will be descriptive statistics to get an overview of loan growth as well as bank risk. The average NPL ratio is 0.0192, with the largest being 0.0516. The mean of ETA is 0.0898, the maximum is 0.2564, and the smallest is 0.0003. The mean of LG is 0.2084, the largest was 0.6257, and the smallest was -0.0259. The mean of LTA is 0.5534, the largest is 0.7315, and the smallest is 0.3386. The mean of CI is -0.7994, the maximum is 0, and the smallest is -86.3024. The mean of banks’ total assets reached 230 trillion, the largest was 1570 trillion, and the smallest was 12.6 trillion as shown in Table 2.

4.2. Regression

Regression analysis results using panel data using Hasman test to choose a suitable model with FEM or REM research data. The analysis results show that the FEM model is consistent with the research data. However, the phenomena of autocorrelation and variable variance do exist in FEM. Therefore, the GLS error correction model is used for analysis.

Regarding the regression analysis results from Table 3 show that LG has a negative impact on NPL (beta = -0.013 and significant p-value at 5%). This result indicates that increasing the annual loan rate will increase the bad debt ratio of the bank. This result is consistent with previous studies that have found the opposite effect of LG on NPL [5, 26, 42]. An increase in the loan ratio means an increase in the expected return on interest. But the risk of not being able to recover the debt is also high [5]. In this case, when the bank increases the loan ratio but reduces the bad debt ratio, it shows the lending efficiency of the banks. The appraisal process and support for reasonable loan repayment lead to a decrease in the bad debt ratio due to better management of loans [1, 3]. It can be realized that the NPL control process of banks tends to be better, making the NPL ratio decrease, especially in the context of increasing the lending rate.

CI positively affects NPL (beta = 0.000279 and p-value is statistically significant at 5%). An increase in operating expenses based on income reduces NPL. It can be seen that the increase in expenses has a negative effect on the bank through the NPL index. Increasing income-based costs affect banks’ overall performance as resources are allocated, causing other activities to be affected in terms of both human resources and financial capital. At the same time, firm size has a negative effect on NPL (beta = -0.00144 and p-value is statistically significant at 5%). The results show that increasing scale will reduce NPL. Thus, growth to scale has positive implications for controlling the NPL ratio. The expansion of banks is based on an efficient credit process and easy application to new facilities. This has resulted in increased staffing and effective uniform application of credit processes, resulting in better control of NPL.

### Table 3. Regression results for NPL

| Dependent Variable: NPL | OLS | FEM | REM | GLS |
|-------------------------|-----|-----|-----|-----|
| LG                      | -0.0136*** | -0.0164*** | -0.0140*** | -0.0130*** |
| (0.00452)               | (0.00504)   | (0.00464)   | (0.00438)   |
| LIQ                     | 0.000875    | 0.00979    | 0.00126    | 0.00596 |
| (0.00664)               | (0.0103)    | (0.00756)   | (0.00820)   |
| CI                      | 0.000271*   | 0.000288*   | 0.000263*   | 0.000279*** |
| (0.00148)               | (0.00151)   | (0.00147)   | (0.00130)   |
| SIZE                    | -0.00128**  | -0.00538*** | -0.00178**  | -0.0044** |
| (0.00648)               | (0.00164)   | (0.000823)  | (0.000841)  |
| LG                      | 0.0633**    | 0.192**     | 0.0794***   | 0.0651** |
| (0.0201)                | (0.0507)    | (0.0255)    | (0.0261)    |
| Observations            | 319          | 319         | 319         | 319 |
| Number of banks         | 29 29 29 29 |
| Hausman test            | 0.1560      | -           | -           | -   |
| Heteroskedasticity test | -           | -           | -           | -   |
| Autocorrelation test    | 0.0003      | -           | -           | -   |
| Standard errors in parentheses. | ***p < 0.01, **p < 0.05, *p < 0.1. |

### Table 4. Regression result for ETA

| Dependent Variable: ETA | OLS | FEM | REM | GLS |
|-------------------------|-----|-----|-----|-----|
| LG                      | -0.0266**  | -0.0236**  | -0.0204**  | -0.0266**  |
| (0.0105)                | (0.00981)   | (0.00974)   | (0.0104)   |
| LIQ                     | 0.0623***   | 0.0564***   | 0.0727***   | 0.0626***  |
| (0.0154)                | (0.0201)    | (0.0180)    | (0.0153)   |
| CI                      | 0.000704*** | 0.000892*** | 0.000793*** | 0.000704** |
| (0.000345)              | (0.000295)  | (0.000299)  | (0.000342) |
| SIZE                    | -0.0255***  | -0.0422***  | -0.0328***  | -0.0255**  |
| (0.00151)               | (0.00319)   | (0.00236)   | (0.00150)  |
| Constant                | 0.889***    | 1.410***    | 1.118***    | 0.889***   |
| (0.0466)                | (0.0986)    | (0.0728)    | (0.0463)   |
| Observations            | 319          | 319         | 319         | 319 |
| R-squared               | 0.486        | 0.390       | -           | -   |
| Number of banks         | 29 29 29 29 |
| Hausman test            | 0.000       | -           | -           | -   |
| Heteroskedasticity test | -           | -           | -           | -   |
| Autocorrelation test    | 0.0000      | -           | -           | -   |
| Standard errors in parentheses. | ***p < 0.01, **p < 0.05, *p < 0.1. |

### Table 2. Descriptive analysis

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|----------|-----|------|-----------|-----|-----|
| NPL (ratio) | 319   | 0.0192 | 0.0128 | 0 | 0.0516 |
| ETA (ratio) | 319   | 0.0898 | 0.0404 | 0 | 0.2564 |
| ROA (ratio) | 319   | 0.0081 | 0.0060 | 0.0003 | 0.0209 |
| LG (ratio) | 319   | 0.2084 | 0.1606 | -0.0259 | 0.6257 |
| LTA (ratio) | 319   | 0.5534 | 0.1174 | 0.3386 | 0.7315 |
| CI (ratio) | 319   | -0.7994 | 4.8046 | -86.3024 | 0 |
| ASSETS (trillion) | 319   | 230.00 | 306.00 | 12.60 | 1570.00 |
| SIZE (loganeppe) | 319   | 32.3963 | 1.1713 | 30.1629 | 34.9886 |
According to regression result for ETA in Table 4, LG also has a negative effect on ETA (beta = -0.0266 and p-value is significant at 5%). The higher the loan growth rate, the lower the solvency of the bank. This result is consistent with the theory as well as previous studies (cited). When the bank grows in loan, the liquidity will decrease due to the decrease in cash or equivalent. This result also has implications that banks lending too much can increase liquidity risk by reducing the equity in banks. Therefore, retained earnings are not used much by banks for a lending [1].

In terms of the dependent variable ROA from Table 5, LG positively affects ROA (beta = 0.00928 and p-value is statistically significant at 5%). This is because loan growth makes profits larger. This result is consistent with the theory as well as previous studies, all showing the same effect of LG on ROA [5, 42]. The growth of loans increases interest income, which is considered the main source of income for banks. Therefore, when the loan growth rate increased, it brought more profits to the banks and reduced the NPL ratio. This shows that the lending efficiency of banks is shown both in terms of growing loan volume and increasing the efficiency of loan management. LIQ has a positive effect on ROA at 10% significance level. This result shows that the loan growth rate positively impacts ROA, but just increasing the loan also increases the bank’s profit. The vital role of loans in banks can be seen when other business models are not contributing much to banks’ profits. According to studies in developing countries, business models other than bank interest income are ineffective [27].

Synthetic results were obtained in the study the impact of LG on bank risk through three indicators NPL, ETA, and ROA. It can be seen that LG has a negative impact on NPL (Figure 1-a) and ETA (Figure 1-b) but a positive impact on ROA (Figure 1-c). Therefore, LG’s growth is a more positive sign in controlling bad debt and profit. But in terms of capital mobilization, banks are limited as the on-lending reduces the equity ratio, leading to increased liquidity risks.

The main findings show that LG has a negative impact on ETA but a positive impact on ROA, demonstrating that the agency theory is applicable in this case. Typically, bank managers seek to maximize profits during their tenure. As a result, risks may arise from excessive loan growth. As a result, as LG rises, solvency will be jeopardized.

In terms of firm size aspects in Table 6, the analysis results for larger and smaller banks are based on the median calculation (assets of enterprises on average will be classified into the higher group, the rest will be classified into the lower group). The analysis results show that the banks of the Lower group, in terms of size, the influence of LG on bank sustainability is similar to the general trend (LG has a negative effect on NPL and ETA but a positive effect on ROA). Meanwhile, LG only has a negative impact on ETA for banks with higher size but does not affect NPL and ROA. However, it can be seen that larger banks have a more diverse way of handling NPL and other business models, making the impact of LG on NPL and ROA unclear.

Regarding additional analysis of higher and lower Loan growth rates as given in Table 7, the results show that same as banks with lower and higher sizes. LG with a lower Loan growth rate has a negative effect on NPL and ETA, a positive impact on ROA. As for banks with higher LG, LG only has a negative impact on ETA. It can be seen that banks with high loan growth are among banks with larger assets, so lending activities or diversifying business models are similar. Therefore, the impact of LG on bank risk is identical between banks with larger sizes and higher loan growth.

5. Conclusions and implications

5.1. Conclusions

This study has systematized the theoretical basis related to lending and the risk of banks. In particular, the study gave three essential criteria to assess the bank risk in terms of both risks and return, such as NPL, ETA, and ROA. These indicators will determine the bank’s lending efficiency, liquidity as well as profitability. At the same time, the study also collected data to examine the impact of LG on bank risk. The results show that there is a relationship between LG and bank risk. Which, LG has the opposite effect on NPL and ETA. This result will show that banks have practical lending activities, but lending capital is concentrated more through equity. However, in the general context, the increase of LG has brought significant profits to banks as lending is still considered the largest contributor to earnings in banks when banking activities are diversified. However, the income conversion in banks has not yet brought about a clear effect. From the results of this study, the authors also provide some policy implications for banks to improve lending performance as well as reduce bank risk.

5.2. Theoretical implications

Research results have contributed theoretically to the relationship between loan growth and bank risk. The effect of loan growth on bank risk will help researchers extend the theory to assess in detail loans to the sustainability or performance of banks. At the same time, the research results show a negative effect of loan growth on liquidity but a positive effect on ROA. Therefore, this study is supported by agency theory. Accordingly, managers tend to increase the bank's profit as the primary goal in running the bank. For the sake of performance goals during the term, agency managers may leave the risks encountered for subsequent successors. The authors' research has contributed to the theory of agency theory in banks when measuring the effects of loan growth and bank risk. Therefore, related studies can refer to agency theory to explain the relationship between loan growth and bank risk.

5.3. Practical implications

The research results have important implications for banks when making loan growth strategies. Banks will have to consider the trade-off between their profitability and their liquidity risk when increasing loan growth. Bank risk also comes from lending activities, so the banks should consider diversifying business models to increase the bank's revenue in the coming period. At the same time, the operating model of increasing interest income will also transfer risks of banks through credit securitization and credit derivatives that need to be studied in more detail [5]. Credit rating and risk management activities need to be maintained at least for now as they are working well as increasing loan growth still reduces NPL.

Table 5. Regression result for ROA.

| Dependent Variable:ROA | OLS   | FEM   | REM   | GLS   |
|------------------------|-------|-------|-------|-------|
| LG                     | 0.00928*** | 0.00548*** | 0.00635*** | 0.00928*** |
|                        | (0.02010)  | (0.02000)  | (0.01919)  | (0.02068)  |
| LIQ                    | 0.00586*   | 0.00648   | 0.00546   | 0.00586*   |
|                        | (0.02030)  | (0.00408)  | (0.00359)  | (0.00306)  |
| CI                     | 6.99e-05  | 0.000121** | 0.000108* | 6.99e-05  |
|                        | (6.90e-05) | (6.00e-05)  | (5.92e-05)  | (6.83e-05)  |
| SIZE                   | 0.000172   | -0.000636  | -0.000186  | 0.000172   |
|                        | (0.000301) | (0.000650)  | (0.000477)  | (0.000298)  |
| Constant               | -0.00259   | 0.0241      | 0.009968   | -0.00259   |
|                        | (0.00930)  | (0.0201)   | (0.0148)   | (0.00923)  |
| Observations           | 319       | 319        | 319       | 319        |
| Number of banks        | 29        | 29         | 29        | 29         |
| Hausman test           | 0.000     |           |           |           |
| Heteroskedasticity test| 0.000     |           |           |           |
| Autocorrelation test   | 0.000     |           |           |           |

Standard errors in parentheses. 
***p < 0.01, **p < 0.05, *p < 0.1.
Figure 1. The regression of LG and bank risk: a) the relationship between LG and NPL; b) the relationship between LG and EQTA; c) the relationship between LG and ROA.

Table 6. Regression results of Lower and Higher firm size.

| VARIABLES | Firm size _Lower | | | Firm size_Higher | | |
|-----------|-----------------|---|---|-----------------|---|---|
|           | NPL             | ETA | ROA | NPL             | ETA | ROA |
| LG        | -0.0167***      | -0.0263** | 0.00876*** | -0.00190        | -0.0477*** | -0.000793 |
|           | (0.00591)       | (0.0116) | (0.00204) | (0.00749)       | (0.0141) | (0.00313) |
| LTA       | -0.00496        | -0.0131 | 0.000327 | 0.00214         | 0.00839 | 0.000478 |
|           | (0.0105)        | (0.0206) | (0.00364) | (0.0103)        | (0.0194) | (0.00430) |
| CI        | 0.000306*       | 0.00978*** | 8.2e-05 | -0.0178***      | 0.0832*** | 0.0329*** |
|           | (0.000165)      | (0.000324) | (5.7e-05) | (0.00685)       | (0.0129) | (0.00287) |
| SIZE      | -0.00241        | -0.0561*** | -0.00340*** | -0.00661        | -0.0172*** | -0.00234*** |
|           | (0.00181)       | (0.00354) | (0.000626) | (0.00149)       | (0.00281) | (0.000623) |
| Constant  | 0.102*          | 1.884*** | 0.112*** | 0.0306          | 0.690*** | 0.103*** |
|           | (0.0591)        | (0.116) | (0.0204) | (0.0485)        | (0.0914) | (0.0203) |
| Observations | 159           | 159     | 159     | 160             | 160     | 160     |

Table 7. Regression result of Lower loan growth and Higher loan growth.

| VARIABLES | LG_Lower | | | LG_Higher | | |
|-----------|----------|---|---|----------|---|---|
|           | NPL      | ETA | ROA | NPL      | ETA | ROA |
| LG        | -0.0331* | -0.0596 | 0.0316*** | -0.00245 | -0.0297* | -0.000738 |
|           | (0.0179) | (0.0385) | (0.00714) | (0.00722) | (0.0163) | (0.00281) |
| LTA       | 0.00258  | 0.104*** | 0.00507 | 0.00351 | 0.0151 | 0.000479 |
|           | (0.00985) | (0.0212) | (0.00393) | (0.00916) | (0.0207) | (0.00357) |
| CI        | 0.000296* | 0.000643* | 4.42e-05 | -0.0115* | 0.0904*** | 0.0313*** |
|           | (0.000158) | (0.000339) | (6.29e-05) | (0.00693) | (0.0157) | (0.00270) |
| SIZE      | -0.00107 | -0.0270*** | -0.000562 | -0.000434 | -0.0252*** | -0.000436 |
|           | (0.000882) | (0.00190) | (0.000352) | (0.000106) | (0.00239) | (0.000412) |
| Constant  | 0.0576** | 0.918*** | 0.0197* | 0.0244 | 0.950*** | 0.0394*** |
|           | (0.0274) | (0.0589) | (0.0109) | (0.0350) | (0.0791) | (0.0136) |
| Observations | 158      | 158 | 158 | 161 | 161 | 161 |
6. Limitation and future works

The study, though, found the impact of loan growth on bank risk at banks in Vietnam. However, the study also has certain limitations. First, the study only assessed loan growth to the bank’s overall risk and did not consider the risk-taking activity of interest income. Because profits can come from many different sources, such as non-interest income. Second, loan growth is calculated as a whole without disaggregating by short-term or long-term loans to assess in detail the impact of loans on bank risk. Third, the endogenous phenomenon in this study has not been considered. This can be viewed as a limitation.

From the above limitations, the authors also suggest future research directions that can overcome the above limitations: firstly, in the subsequent research, it is necessary to classify types of income from interest and non-interest for a detailed assessment of the risks associated with interest or non-interest income. Second, further research needs to collect data and analyze it according to short-term and long-term loans to examine the impact of loan growth. Third, the author proposes that the following studies may be interested in endogeneity through GMM or 2SLS models.

Declarations

Author contribution statement
Shih-Wei Wu: Conceived and designed the experiments; Wrote the paper.
Manh- Thao Nguyen: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.
Phi-Hung Nguyen: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data will be made available on request.

Declaration of interests statement
The authors declare no conflict of interest.

Additional information
No additional information is available for this paper.

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