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GREEN FINANCE AND CREDIT RISK IN NEPALESE BANKING INDUSTRY

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Abstract

The primary focus of this study is to analyze the effect of green loans on credit risk in Nepalese banks. To achieve this objective, this study follows a quantitative approach considering the objective reality and uses the quarterly secondary data, sourced from the website of Nepal Rastra Bank [NRB] over the period starting from 2021Q2 to ending with 2025Q2. The fixed-effect model (FEM) and the random-effect model (REM) are used to estimate results. The best model is selected using the Hausman and Breusch-Pagan LM tests. The result demonstrated that green loans, as measured by hydroelectricity loans, increase credit risk in the Nepalese banking sector. This unexpected result is also robust, shown by the REM. This indicates that a 1 percent increase in green loans is associated with a 0.384 percent increase in credit risk. Conversely, the capital adequacy ratio (CAR) reduces credit risk. The credit-to-deposit ratio (CD ratio) stimulates credit risk in the Nepalese banking sector. Similarly, holding more liquid assets and a larger size, as measured by deposit volume, increases credit risk in the Nepalese banking sector. The positive impact of green loans on credit risk indicates that the regulator (or NRB) should give financial incentives, such as concessional loans, to banks, by which banks grant green loans at a concessional rate, which increases borrowers' debt-paying capability and thus reduces credit risk. Similarly, bankers should enhance their own capacity for credit evaluation and develop a monitoring mechanism to help reduce credit risk in the Nepalese banking sector.

Keywords: bank capital, green finance, liquidity, bank size, panel data

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1. Introduction

The non-performing loan (NPL) is an indicator of credit risk that diminishes banks' lending capacity by reducing their capital base, profits, liquidity, and increasing the cost of funds (Gjeçi et al., 2023). The growth in NPL also raises depositors' perceptions of risk, lowering bank deposit volumes as new depositors are reluctant to open accounts and existing depositors withdraw funds. The higher volume of NPL reduces banks' ability to lend to green project/s. The banks, on the other hand, should be compelled to lend to green projects to mitigate climate change risks, which can helps to decrease the frequency of natural disasters. For instance, NRB (2023) issued Unified Directives-2080, and the Directive Number 17/080 [15 (1)] stated that commercial banks should compulsorily invest at least 8% of their total loan balance in the energy sector by mid-July 2026, and increase this to at least 10% by mid-July 2027. Similarly, "the Paris Agreement" intends to limit "global warming to no more than 1.5°C above pre-industrial levels" (Xiang & Ma, 2025) to protect the environment. One hundred thirty countries, including Nepal, have pledged to achieve a balance of CO_2 by the mid-21st century. Hence, Nepal needs to increase its investments in renewable energy and green infrastructure to meet this objective.

To achieve this objective, Nepal Infrastructure Bank Limited (NIFRA, 2025) issued the first public "Green Bond" worth NPR 5 billion. This bond issue was made possible by a partnership between "the Korea International Cooperation Agency (KOICA) and the Global Green Growth Institute (GGGI)". It is NIFRA's first step to raise funds for "renewable energy and climate-resilient infrastructure", which can help to achieve sustainable growth by encouraging investors to contribute to the development of a more dynamic, environmentally friendly Nepal.

Previous empirical studies revealed that green loans have both favorable and adverse effects on credit risk. The carbon-emission-reduction policy enacted by the regulator effectively reduces the carbon emission produced by polluting firms; however, it increases the banks' credit risk, which can lead to bank instability and economic downturns, as the regulator can impose an additional carbon tax on polluting firms. An increase in carbon tax adversely affects the social welfare goals by stimulating credit risk in the banking industry (Zhang et al., 2025). Climate change resulting in unwanted "natural disasters such as droughts, floods, landslides, and storms" (Zhang et al., 2022, p.1914). It can destroy borrowers' assets, which deteriorates the debt service capacity of borrowers, thus causing an upward shift in credit risk profiles of banks. Furthermore, natural disasters reduce the volume of bank deposits because depositors withdraw comparatively more deposits to fulfill their basic requirements, and enterprises need more funds to install new production facilities during the disaster periods. Zhang et al. (2022) arrived at a similar conclusion of climate change due to deforestation and the rise in CO_2 has a direct influence on disasters, and disasters increase credit risk and reduce capital ratio.

It is contended, on the other hand, that green loans/credits increase banks' competitiveness by protecting them from external economic shocks, boosting efficiency and profitability, fulfilling CRS requirements, enhancing banks' prestige, and strengthening public confidence. Furthermore, improved competitiveness reduces credit risk (Wu, 2025). The previous study by Mirza et al. (2023) found that extending green loans to SMEs increases banks' performance and reduces credit risk by implementing effective monitoring and control systems and granting green loans at lower interest rates. Banks also charge lower interest rates to businesses that place a high priority on corporate social responsibility (CSR) (Cheung et al., 2018). From the bankers' perspective, regulators can also provide financial support to banks so they can lend to businesses and technologies that are environmentally beneficial (Zhang et al., 2008; Sarkis, 2004). From the borrowers' perspective, green loans can lower loan loss provisions and capital requirements by reducing credit risk, thereby enabling more stable profits and cash flow from businesses (Umar et al., 2021). Green loans also help polluting companies avoid sharp declines in their stock prices by closely monitoring their capital structures and obtaining reliable information (Chen et al., 2023).

This study offers valuable insights into how green loans affect credit risk in least developed countries, such as Nepal. To the best of our knowledge, this study is the first to examine the link between green loans and NPLs in Nepal, where green finance concepts are relatively new and the regulator has given top priority to green financing for projects. However, the credit evaluation and monitoring system is relatively weak. The a priori expectation is that green loans reduce banks' NPLs, but the question arises whether this expectation always holds in least developed countries like Nepal. Hence, this study presents three key novel contributions to the existing literature and fills a research gap. First, this study examines the influence of green loans—specifically hydroelectricity/energy loans—on NPL in Nepalese banks using a new dataset from the NRB. Second, this study also examined other relevant factors, such as the CAR, the CD ratio, liquidity, and size, as measured by deposit volume that affect NPLs. Finally, this study provides policy implications for increasing green loans by reducing credit risk in Nepal.

The other section of this study is arranged as follows. Second section, review theories and more recent empirical studies under the literature review heading. Section Three describes the methods used in the study, including model specification. Sections Four, Five, and Six present the results, discussion, and conclusion.

2. Literature Review

2.1. Theoretical underpinning

This section presents theoretical reviews that can help develop a better theoretical framework to achieve the research objective. First, the popular Stakeholder Theory, pioneered by Freeman (1984), can explain the connection between green finance and the credit risk of banks. It posits that "the success of the firms depends solely on their

ability" (Feng et al., 2024) to manage good links with all their stakeholders, including shareholders, employees, consumers, society, regulators, and other relevant parties. Banks' lending decisions must comply with the regulation imposed by the regulator and government to foster more sustainable development by mitigating environmental threats. This theory posits that a bank's decision to lend to a firm with poor environmental practices is more likely to result in fines, lawsuits, and operational shutdowns, thereby increasing the likelihood of loan default and, consequently, the NPL ratio. Conversely, bank lending to green projects can save from these difficulties and thus reduce the likelihood of credit default.

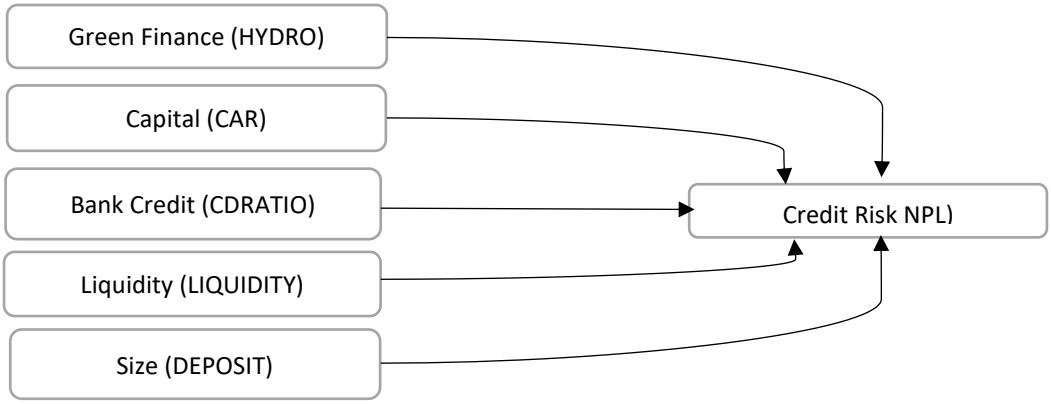
Additionally, banks' commitment to green finance can enhance their brand reputation, attract more deposits, especially from the younger generation, at lower interest rates, and attract high-quality borrowers through lower lending rates, thus reducing the credit risk of banks. Similarly, green finance reduces climate risk, protecting farmers from droughts and floods, and saving them from the rising prices of agricultural products, thereby preventing inflation. The "interest rate is directly linked to the inflation rate" (Budhathoki et al., 2025a, p.22), and a lower inflation rate increases a borrower's debt-paying ability, while also reducing the credit risk of banks (Dikau & Volz, 2019).

In a similar vein, the "Moral Hazard Theory" outline the nexus between capital adequacy and credit risks in banks. This theory posits that a bank with higher equity capital is less motivated to take on more risk because its owners are expected to bear the losses arising from loans. Conversely, a bank with a lower level of capital is motivated to take more risk by lending a risky loan portfolio because shareholders will get more return if loans turn into performing loans, but losses will be borne by depositors if loans turn into non-performing loans (Furlong & Keeley, 1989; Berger & DeYoung, 1997). Furthermore, the strong equity base can help to absorb unexpected economic shocks, which protects banks from insolvency. It also boosts depositors' confidence, and banks can obtain funds at lower interest rates, which reduces the cost of funds and reduces NPL. Similarly, the "Moral Hazard Hypothesis" explains the link between CD ratio and NPL. This hypothesis states that the banks with a poor equity capital base invest in more risky loan portfolios by lowering credit standards and holding lower volumes of liquidity, which can increase NPL (Berger & DeYoung, 1997; Dutta & Saha, 2021). The liquidity problem due to the higher CD ratio can raise the cost of deposits, which directly impacts lending rates and increases credit risk.

The "Financial Intermediation Theory" explains the association between liquidity and NPL. This theory states that banks accept deposits with short maturities and lend on long-term loans and advances. This mismatch in maturity between liabilities and assets can create liquidity problems for banks. The bank's ability to monitor loans may decline liquidity, which can lead to an increase in the bank's credit risk more rapidly (Diamond, 1984). The "Too-Big-to-Fail Theory" can explain how the size of a bank (its deposits) affects its credit risk. This theory posits that if major banks fail, the entire financial system is at risk. The government provides financial assistance to these banks during the crisis. As a result, larger banks take on more lending risk by lowering their credit

standards and not closely monitoring loans, which increases credit risk (Stern & Feldman, 2004). This study establishes the following theoretical model on the basis of the above mentioned theories.

Figure 1 Theoretical model for credit risk analysis



Source: Authors

2.2. Empirical studies

This section presents the current literature on the tie between the predictors and the response variable. In the first section, we review the empirical literature on the nexus between green finance and credit risk.

Green finance (Hydro finance) and credit risk

Environmental protection has become a recent agenda for the sustainable development of any country. Most current empirical studies show that green finance is tie with bank credit risk. For instance, Al-Qudah et al. (2023) surveyed the green loans influence on NPL across the time span 2015-2020 of UAE banks. Using REM and 2SLS estimators, the study found that green loans adversely affect banks' NPLs. It indicates that granting loans to green projects will enhance banks' reputations, helping them attract more deposits at lower rates and extend more loans to creditworthy borrowers, thereby increasing profitability and reducing credit risk. This study also concluded that inefficient banks might be involved in risky lending, which ultimately increases banks' NPL.

Using the RE estimator, Miroshnichenko and Mostovaya (2019) found an inverse relationship between green loans and NPL. It signals that banks that invest in green project/s increase their reputation. Using the REM and 2SLS, Cui et al. (2018) investigated the association between green loans and NPL in China. The outcome revealed that climate change risk stimulates green loans, and the green loans reduce credit risk. It signals that banks offer green loans at concessional rates, which reduces the interest expenses of borrowers and thus reduces NPLs.

Similarly, Arintoko et al. (2024) found that carbon emissions do not affect NPL; however, firm performance is adversely affected by pollution. Also, this study found that a higher interest rate boosts the NPL. This finding signals that banks must "impose higher interest

rates" (Zhang et al., 2025) on industries that degrade the environment and lower interest rates on green projects. Conversely, Zhou et al. (2022) analyzed the link between green loans and NPL utilizing the 41 Chinese banks as a sample for the period 2007-2018. The finding revealed that the effect of green loans on NPL depends on the information available about borrowers and on expertise in green loan lending practices. For instance, they found that green loans adversely affect the NPL of state-owned banks, whereas they are positive for city/regional banks. In light of the empirical evidence presented above, this study proposes the First hypothesis as follows.
H1: Green finance favorably affects NPL.

CAR and credit risk

The CAR can affect NPL positively or negatively. On the one hand, banks with higher capital may engage in riskier lending due to the greater risk-resistance capacity offered by a strong capital base. In addition, substantial capital improves a bank's reputation and enables it to obtain deposits at a lower interest rate; as a result, the cost of capital diminishes, and banks can lend at a lower rate, thereby decreasing NPLs. Conversely, raising capital through share issuance increases banks' cost of capital, potentially raising lending rates. This higher lending rate may reduce borrowers' debt-servicing capacity, thereby increasing NPLs. For instance, using the RE and 2SLS estimators, Cui et al. (2018) observed the connection between green loans and NPL in China, and finds that a higher equity ratio simultaneously produce higher NPL, but the impact is insignificant. Umar et al. (2021) looked into the impact of green loans on credit risk for the period 2011-2020 and found that CAR negatively affects NPLs. It indicates that banks with capital that boost their loss-absorbing ability enhance public trust, enabling them to attract deposits at lower rates and thus offer loans at cheaper rates; as a result, borrowers' debt-paying ability can rise and NPLs can be reduced.

Wu and Zhang (2025) analyzed the mediating role of the CD ratio in the link between green loans and credit risk, as measured by Z-score in Chinese banks over the period 2009-2023. Using a stepwise regression estimator, the findings showed that CAR decreases credit risk in Chinese banks. Mirza et al. (2023) observed the tie between green loans and performance in BRIC' SME loan portfolios for the period 2011-2021. Utilizing the FEM estimator, CAR reduces banks' performance as measured by NIM. Similarly, it also found that CAR reduces default risk in the BRIC countries. However, Ferreira (2022) found that bank regulation, as measured by CAR, hurts NPLs worldwide. In the Nepalese context, Koju et al. (2018) found that CAR reduces NPLs in Nepalese banks. Similarly, a study by Rehman et al. (2025) also found that capital is inversely correlated with NPL. In consideration of the aforementioned empirical studies, this study develops another second hypothesis.
H2: *CAR reduces credit risk.*

Bank credit-to-deposit ratio (CD ratio) and credit risk

Earlier studies have shown divergent impacts of the CD ratio on NPL. For instance, Umar et al. (2021) analyzed the effect of green loans on NPL for the period 2011-2020. The

finding demonstrated that the CD ratio increases NPL. Poor credit appraisals and liberal credit criteria, inadequate monitoring, insufficient follow-up, and ineffective recovery mechanisms might increase banks' NPL. Additionally, liquidity crisis might boost both deposit and lending rates, which increase NPL. Wu and Zhang (2025) analyzed the mediating role of the CD ratio in the association between green loans and credit risk in China for the period 2009-2023. Using a stepwise regression estimator, the findings showed that green loans increase the CD ratio and decrease credit risk at Chinese banks. Conversely, Ferreira (2022) examined NPL factors across 80 countries worldwide for the period 1999-2019. Using the system GMM estimator, the results demonstrated that the CD ratio stimulates NPL. Additionally, the interest and non-interest margins are negatively associated with NPL. Using REM, Ramesh (2019) uncovered that the CD ratio reduced NPL in India. With reference to these results, this study proposes the next Third hypothesis.

H_3: *CD ratio reduces credit risk.*

Liquidity and credit risk

Excess liquidity, either favorably or unfavorably, can affect NPL of banks. Excess liquidity, on the one hand, decreases loan income and deteriorates credit quality by fostering competition, which increases banks' credit risk (Wu & Zhang, 2025). Conversely, excess liquidity, on the other hand, protects banks from unexpected exogenous shocks, such as short-term high demand for liquidity or withdrawals from deposits. It also protects from banks' rising cost of deposit funds. Mirza et al. (2023) observed the tie between green loans and performance in BRIC's SME loan portfolios for the period 2011-2021. Using the FE estimator, liquidity reduces banks' performance, as measured by NIM. Conversely, it also found that liquidity stimulates credit risk in the BRIC countries. Shrama and Jain (2025) analyzed the effect of capital and liquidity on systematic risk using a sample of 169 banks from 25 countries for the period 2000-2021. Using both OLS and GMM estimators, this study found that liquidity can reduce systematic risk and enable the absorption of macroeconomic shocks and contagion effects. Similarly, Saliba et al. (2023) analyzed the factors of NPL in BRICS for the period 2004-2020. Using the quantile regression estimator, the findings showed that both liquidity and capital reduce NPLs. These findings support the "Moral Hazard Hypothesis", which states that capital and liquidity regulations protect banks from investing in risky assets. In light of the empirical evidence presented above, this study proposes the following Fourth hypothesis.

H_4: *Liquidity increases credit risk.*

Size (deposit) and credit risk

The current empirical literature demonstrated conflicting outcomes on the effects of size on NPL. The larger banks, in terms of size, engage in risky lending activities because the government needs to protect them by supplying financial aid while they face serious problems in restoring financial stability. It is interesting to note that larger banks earn higher returns while loan businesses succeed, but the government must pay from public

funds while banks fail. Conversely, larger banks reap the benefit of diversification and economies of scale, which reduce their NPLs. In this context, Al-Qudah et al. (2023) found that bank size increases NPLs in the UAE. Similarly, using the REM and 2SLS estimators, Cui et al. (2018) investigated the nexus between green loans and NPL in China using a sample of 24 banks, and the results demonstrated that larger banks have higher NPL. Zhou et al. (2022) investigated the link between green loans and NPL utilizing the 41 Chinese banks as a sample for the period 2007-2018. Using the GLS estimator, the results showed that bank size increases NPLs.

Similarly, Umar et al. (2021) analyzed the effect of green loans on credit risk using a sample of 344 banks for the period 2011-2020, and the results demonstrated that bank size reduces NPL. It signals that larger banks reap the benefit of efficiency. Mirza et al. (2023) investigated the nexus between green loans and performance using a sample of BRIC SME loan portfolios for the period 2011-2021. Using the FE estimator, size, as measured by total assets, increases banks' performance, as measured by NIM. Conversely, it also found that size reduces credit risk in the BRIC countries. A more recent study by Rehman et al. (2025) also reports convergent results: size is inversely correlated with NPL. However, the study by Hossain et al. (2025) observed that size has a negligible effect on NPL. Drawing upon the aforementioned evidences, this study put forward the Fifth hypothesis as follows.

H_5: Size favorably/unfavorably affect NPL.

3. Methods

This study is guided by positivist philosophy under the assumption of objective single reality. This study follows quantitative approach to analyze the nexus between green finance and credit risk in the Nepalese banking industry, by extracting secondary data from website of the Nepal Rastra Bank (https://www.nrb.org.np) covering the period from 2021Q2 to 2025Q2. Furthermore, the study employed descriptive as well as explanatory research designs. The descriptive characteristics of study variables are evaluated by graph, mean, standard deviation, minimum, and maximum values. Similarly, correlation analysis is conducted to analyze the strength and direction of the link between predictors and response variable. The Pearson's correlation analysis also helps "to check multicollinearity issues within predictor variables" (Budhathoki et al. 2024b, p.158). We do not run regression in a same regression model while relation between independent variables exceeds the threshold value 0.8 (Gujarati & Porter, 2009; Field, 2024). This study further check the multicollinearity issues by using Variance Inflation Factor (VIF). While he VIF value more than 10, it is often taken as problematic multicollinearity (Gujarati et al., 2009; O'Brien, 2007). Finally, explanatory research design is employ to analyze the impact of green finance on NPL, utilizing POLS, FEM, and REM. Moreover, the Breusch-Pagan (BP) LM test (Breusch & Pagan, 1980) is utilize to select between the POLS and REM. Similarly, the Hausman test is used to decide between REM and FEM estimators. Finally, best estimator is used as baseline regression and other estimator/s are used for robustness check.

Table 1 outlines the chosen variables, their measurements, and sources, based on theoretical and empirical studies. The study employs NPL as the response variable, measured as "non-performing loans divided by total loans". A larger value of NPL indicates a higher credit risk prevails in the banks. The primary predictor variable is green loans, which is measured as "hydroelectricity loans divided by total loans" and denoted by HYDRO. A higher green loan ratio signals that the bank is injecting a higher volume of loans into green projects. Another predictor variable, the CAR, is scaled as "total capital funds divided by total risk-weighted assets". A higher CAR signals that banks are heavily financed by equity capital. Another predictor variable, the CD ratio (CDRATIO), is measured as "total credit divided by total deposits". Similarly, liquidity is measured as "net liquid assets divided by total deposits", and a higher liquidity ratio indicates that banks are holding more liquid assets and lending less. Finally, the deposit is expressed in rupee volume.

Table 1 Variables selection

Variables	Measurements	Sources
NPL	$\frac{Non-performing\ loans}{Total\ loans}$	Patra and Padhi (2016), Ramesh (2019), Umar et al. (2021), Ferreira (2022), Saliba et al. (2023), Hossain et al. (2025)
HYDRO	$\frac{Hydropower/\ energy}{Total\ loans}$	Umar et al. (2021), Wu and Zhang (2025)
CAR	$\frac{Total\ capital\ fund}{Total\ risk\ weighted\ exposures}$	Patra and Padhi (2016), Koju et al. (2018), Umar et al. (2021), Saliba et al. (2023), Dhananjaya (2024),Wu (2025), Wu and Zhang (2025), Sharma and Jain (2025)
CDRATIO	$\frac{Total\ credit}{Total\ deposits}$	Ramesh (2019), Umar et al. (2021), Ferreira (2022), Wu and Zhang (2025), Wu (2025)
LIQUIDITY	$\frac{Net\ liquid\ assets}{Total\ deposits}$	Saliba et al. (2023), Mirza et al. (2023), Sharma and Jain (2025)
DEPOSIT	Deposit (NPR. In Million)	Wu (2025)

Model specification

The primary aim of this study is to analyze the effect of green loans as measured by hydroelectricity loans (HYDRO) on NPL in Nepalese banking industry for the period 2021Q2 to 2025Q2. This study also analyze the effect of CAR, CDRATIO, LIQUIDITY, and DEPOSIT on credit risk. We formulate the following function to fulfill the aim of the study.

$NPL = \int (HYDRO, CAR, CDRATIO, LIQUIDITY, DEPOSIT)$

This study deployed POLS, FEM, and REM to examine the abovementioned effect of predictors on response variables. The pooled OLS estimator pool all observation without considering "the cross-section and time series nature of data" (Gujarati et al., 2009).

$$\ln NPL_{it} = \beta_1 + \beta_2 \ln HYDRO_{it} + \beta_3 \ln CAR_{it} + \beta_4 \ln CDRATIO_{it} + \beta_5 \ln LIQUIDITY_{it} + \beta_6 \ln DEPOSIT_{it} + u_{it} \quad \ldots\ldots\ldots (1)$$

The FEM considers the heterogeneity among 20 banks and offers individual intercept, however it is time-invariant (Gujarati, 2015). The purpose fixed-effect estimator for this study is as follow.

$$\ln NPL_{it} = \beta_{1i} + \beta_2 \ln HYDRO_{it} + \beta_3 \ln CAR_{it} + \beta_4 \ln CDRATIO_{it} + \beta_5 \ln LIQUIDITY_{it} + \beta_6 \ln DEPOSIT_{it} + u_{it} \ldots\ldots\ldots (2)$$

The REM assume that 20 banks have the common (mean) intercept, which is denoted by β_1 and each bank has own intercept, which is accounted by ε_i. Hence, β_{1i} is the sum of β_1 and ε_i (Gujarati, 2015). The random-effect estimator outlined below is designed to examine the effect of predictors on response variables.

$$\ln NPL_{it} = \beta_1 + \beta_2 \ln HYDRO_{it} + \beta_3 \ln CAR_{it} + \beta_4 \ln CDRATIO_{it} + \beta_5 \ln LIQUIDITY_{it} + \beta_6 \ln DEPOSIT_{it} + \varepsilon_i + u_{it} \quad \ldots\ldots\ldots (3)$$

where, NPL indicates non-performing loans. HYDRO refers to hydroelectricity loans (green loans). CAR represents capital adequacy ratio. CDRATIO symbolizes the credit-to-deposit ratio. LIQUIDITY refers to net liquidity and DEPOSIT signifies deposits accepted by banks, which measures banks' size. β_1 denotes constant term. β_2, β_3, β_4, β_5, and β_6 are the coefficients of HYDRO, CAR, CDRATIO, LIQUIDITY, and DEPOSIT, respectively. u_{it} corresponds to the error component, and ε_i designates the bank-specific intercepts.

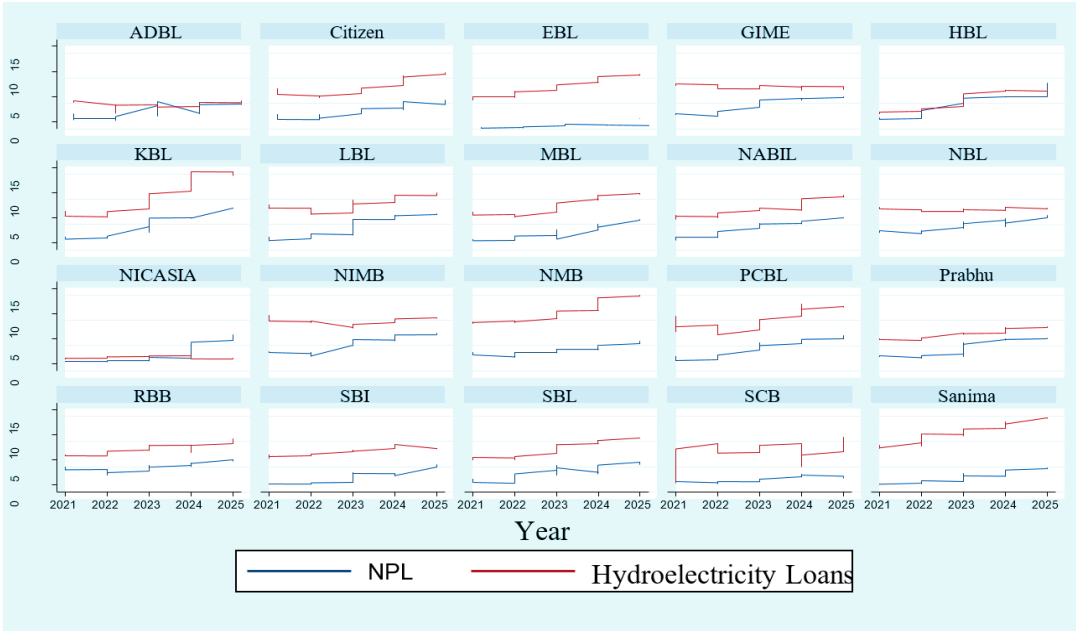
4. Results

Figure 2 illustrates the trend of the main study variables, credit risk as measured by NPL and green finance as measured by hydroelectricity loans, over the period from 2021Q2 to 2025Q2 for 20 banks operating in Nepal. The findings demonstrated that most of the banks' NPLs are in an upward trend, indicating an increasing trend of credit risk prevailing across Nepalese banks in recent periods. Similarly, the loans granted by banks to hydroelectricity projects have increased in recent years. The co-movement of these two variables indicates that as hydroelectricity loans increase, NPL also increases. However, results showed that NPLs are more stable compared to hydroelectricity loans. The co-movement of these variables suggests that the failure of projects deteriorates the quality of assets, which in turn stimulates credit risk and thus contributes to financial instability.

Table 2 presents the descriptive characteristics of the response variable—NPL—and the predictor variables—HYDRO, CAR, CDRATIO, LIQUIDITY, and DEPOSIT. The results reveal that the spread of NPL between the maximum and minimum is 7.57 percent, with a mean score of 2.585 percent. It indicates that NPL is highly volatile. Similarly, the spread of hydroelectricity loans (HYDRO) is 13.59 percent with a standard deviation of 2.505. It indicates that this variable is also highly volatile during the study period. The spreads of CAR, CDRATIO, and LIQUIDITY are 13.15%, 39.3%, and 31.92%, respectively. Finally, the spread of DEPOSIT is NPR 453,592 with a mean score of NPR 233315.2. The overall

results indicate that all variables under study exhibit high volatility over the period from 2021Q2 to 2025Q2.

Figure 2 Current position of NPL and hydroelectricity loans granted by Nepalese banks



Source: Authors

Table 2 Descriptive statistics

Variables	Observations	Mean	Std. Dev.	Min.	Max
NPL	340	2.585	1.686	0.11	7.68
HYDRO	340	6.962	2.505	0.49	14.08
CAR	340	13.212	1.443	10.16	23.31
CDRATIO	340	82.724	6.048	60.39	99.69
LIQUIDITY	340	27.381	5.811	15.44	47.36
DEPOSIT	340	233315.2	96496.48	84102	537694

Note: *NPL denotes non-performing loan, which is an indicator of credit risk. HYDRO indicates the percentage of loans given by banks to hydroelectricity projects (green finance). CAR represents the capital adequacy ratio. CDRATIO denotes the credit-to-deposit ratio. Liquidity represents net liquidity. Finally, the deposit represents the total deposits of commercial banks, which denotes the size of the bank.*

Table 3 outlines the results of correlation analysis and the Variance Inflation Factor (VIF), which are specifically computed to check for multicollinearity issues within the predictor variables. All the VIFs of the predictor variables are less than three, indicating no multicollinearity issues with the predictor variables. Therefore, we can proceed with further statistical analysis to explain the impact of HYDRO, CAR, CDRATIO, LIQUIDITY, and DEPOSIT on NPL in Nepalese banks. Moreover, a favorable association was found between HYDRO and NPL, which states that they tend to move in the same direction.

Conversely, the CAR and NPL move in the opposite direction. Similarly, the CDRATIO and NPL move in the opposite direction. By contrast, the LIQUIDITY and NPL, as well as the DEPOSIT and NPL, move in the same direction.

Table 3 Correlation analysis

Variables	NPL	HYDRO	CAR	CDRATIO	LIQUIDITY	DEPOSIT
NPL	1					
HYDRO	0.376***	1				
	(0.000)					
CAR	-0.240***	-0.073	1			
	(0.000)	(0.180)				
CDRATIO	-0.257***	-0.107**	-0.096*	1		
	(0.000)	(0.048)	(0.076)			
LIQUIDITY	0.288***	0.178***	0.245***	-0.726***	1	
	(0.000)	(0.001)	(0.000)	(0.000)		
DEPOSIT	0.615***	0.087	-0.378***	-0.205***	0.161***	1
	(0.000)	(0.108)	(0.000)	(0.000)	(0.003)	
VIF		1.05	1.34	2.17	2.38	1.64

*Note: NPL denotes non-performing loan, which is an indicator of credit risk. HYDRO indicates the percentage of loans given by banks to hydroelectricity projects (green finance). CAR represents the capital adequacy ratio. CDRATIO denotes the credit-to-deposit ratio. Liquidity represents net liquidity. Finally, the deposit represents the total deposits of commercial banks, which denotes the size of the bank. ***p<0.01, ** p<0.05, * p<0.1.*

Baseline regression results

The baseline regression results are shown in Table 4. The Breusch-Pagan LM test reveals that the random-effect (RE) model is far better than the pooled OLS model ($p<0.01$). Similarly, the Hausman test outcome demonstrated that the FEM is superior to the REM ($p < 0.05$). F-statistic (F-stat. = 152.60, $p < 0.01$) indicates that this regression model is well-fitted, suggesting that at least one predictor variable can influence the response variable. Therefore, this study employed an FE model as the baseline regression model. The result shows that green finance, as measured by lnHYDRO, has a favorable influence on credit risk, as measured by lnNPL, in the Nepalese banking industry. It suggests that banks' asset quality will deteriorate as green finance, particularly hydroelectricity loans, increases. Conversely, holding more risk capital (as measured by lnCAR) reduces banks' credit risk. The credit-to-deposit ratio (as measured by lnCDRATIO) has a positive influence on NPL in the Nepalese banking industry. Similarly, banks' net liquidity (as measured by lnLIQUIDITY) and size (as measured by lnDEPOSIT) boost credit risk in the Nepalese banking sector.

Table 4 Baseline regression results (Fixed-effect model)

	Response variable: lnNPL			
Variables	Coefficient	Std. err.	t-statistics	p-value
lnHYDRO	0.384***	0.075	5.110	0.000

lnCAR	-0.430**	0.206	-2.080	0.038
lnCDRATIO	0.916***	0.297	3.080	0.002
lnLIQUIDITY	0.912***	0.133	6.860	0.000
lnDEPOSIT	0.823***	0.081	10.23	0.000
Constant	-15.662***	1.0858	-8.430	0.000
F-statistics	152.60			0.000
R-squares	0.497			
Hausman-test	14.270**			0.014
Breusch-Pagan LM test	759.53***			0.000
Observations	340			
Numbers of banks	20			
Bank FE	Yes			

*Note: NPL denotes non-performing loan, which is an indicator of credit risk. HYDRO indicates the percentage of loans given by banks to hydroelectricity projects (green finance). CAR represents the capital adequacy ratio. CDRATIO denotes the credit-to-deposit ratio. Liquidity represents net liquidity. Finally, the deposit represents the total deposits of commercial banks, which denotes the size of the bank. ***p<0.01, ** p<0.05, * p<0.1.*

Robustness check

The robustness check results are presented in Tables 5 and 6. We present the impact of HYDRO, CAR, CDRATIO, LIQUIDITY, and DEPOSIT on NPL using the RE GLS model in Table 4. This finding indicates that green finance positively influences credit risk in Nepalese banks, consistent with the baseline regression result. By contrast, the CAR has an adverse effect on NPL. However, the CDRATIO, LIQUIDITY, and DEPOSIT variables have a significant positive impact on NPLs for Nepalese banks, and these results are similar to those of the baseline regression.

Table 5 Robustness check results (Random-effects GLS model)

	Response variable: NPL			
Variables	Coefficient	Std. err.	t-statistics	p-value
lnHYDRO	0.387***	0.067	5.740	0.000
lnCAR	-0.386*	0.204	-1.890	0.058
lnCDRATIO	0.851***	0.297	2.870	0.002
lnLIQUIDITY	0.883***	0.129	6.840	0.000
lnDEPOSIT	0.815***	0.071	11.300	0.000
Constant	-15.289***	1.845	-8.290	0.000
Wald-test	742.830***			0.000
R-squares	0.498			
Hausman-test	14.270**			0.014
Breusch-Pagan LM test	759.53***			0.000
Observations	340			
Numbers of banks	20			

Note: NPL denotes non-performing loan, which is an indicator of credit risk. HYDRO indicates the percentage of loans given by banks to hydroelectricity projects (green finance). CAR represents

*the capital adequacy ratio. CDRATIO denotes the credit-to-deposit ratio. Liquidity represents net liquidity. Finally, the deposit represents the total deposits of commercial banks, which denotes the size of the bank. ***p<0.01, ** p<0.05, * p<0.1.*

Table 6 Random-effects GLS model (Robust)

Variables	Response variable: NPL			
	Coefficient	Robust Std. err.	t-statistics	p-value
lnHYDRO	0.387***	0.135	2.86	0.004
lnCAR	-0.386	0.319	-1.210	0.227
lnCDRATIO	0.851**	0.349	2.46	0.014
lnLIQUIDITY	0.883***	0..210	4.20	0.000
lnDEPOSIT	0.815***	0.081	10.10	0.000
Constant	-15.289***	1.876	-8.150	0.000
Wald-test	545.19***			0.000
R-squares	0.498			
Hausman-test	14.270**			0.014
Breusch-Pagan LM test	759.53***			0.000
Observations	340			
Numbers of banks	20			

*Note: NPL denotes non-performing loan, which is an indicator of credit risk. HYDRO indicates the percentage of loans given by banks to hydroelectricity projects (green finance). CAR represents the capital adequacy ratio. CDRATIO denotes the credit-to-deposit ratio. Liquidity represents net liquidity. Finally, the deposit represents the total deposits of commercial banks, which denotes the size of the bank. ***p<0.01, ** p<0.05, * p<0.1.*

5. Discussion

This section compares the findings with the theories and empirical studies discussed in the literature review section. The first finding of this study—green loans induce credit risk— is not in line with the notion of "Stakeholders Theory", which states that the bank's ability to maintain good relationships with its stakeholders and the bank's lending decision align with the policies for sustainable development by mitigating environmental threats adopted by the regulator and government, and reducing NPL. This unexpected outcome in favor of the earlier findings of Zhou et al. (2022), who reported that green loans increase NPLs among city and regional banks. However, this finding is not similar to the findings of Cui et al. (2018), Miroshnichenko and Mostovaya (2019), and Al-Qudah et al. (2023).

The second finding of this study—CAR mitigates credit risk—is consistent with the "Moral Hazard Theory", which states that the strong equity capital base increases NPL. This result supports the findings of Koju et al. (2018), Ferreira (2022), Mirza et al. (2023), Wu and Zhang (2025), and Rehman et al. (2025). However, this finding contradicts the outcome of Cui et al. (2018). It is because a strong capital base helps to absorb losses and enhances public trust. Furthermore, this allows banks to collect sufficient deposits

at lower rates, which reduces the cost of capital and lending rate. This can increase borrowers' capacity to repay debt and decrease NPLs.

The third finding of this study—CD ratio increases credit risk—is consistent with the "Moral Hazard Theory", which states that banks with lower capital are more likely to invest in riskier portfolios by lowering credit standards, which raises their credit risk (Berger & DeYoung, 1997; Dutta & Saha, 2021). This finding supports the previous finding of Ferreira (2022) and contradicts the finding of Ramesh (2019). This may occur due to poor credit appraisals and a liberal credit policy adopted by banks due to higher competition prevailing in the banking system. The fourth finding of this study—liquidity increases credit risk—is consistent with the "Financial Intermediation Theory", which states that a higher level of liquidity forces banks to invest in risky assets. This outcome is similar to the previous findings of Mirza et al. (2023) and in contrast with the findings of Saliba et al. (2023). The final finding of this study—size increase credit risk—is consistent with the "Too-Big-to-Fail Theory", which states that if larger banks fail, it will bring contagion risk to the financial system, and the government should provide financial support to protect larger banks. As a result, the bigger banks take more risk on lending by lowering their credit standards and failing to monitor loans, which can increase their credit risk. This result aligns with the earlier findings of Cui et al. (2018), Zhou et al. (2022), and Al-Qudah et al. (2023). However, this result differs from the earlier findings by Umar et al. (2021), Mirza et al. (2023), Hossain et al. (2025), and Rehman et al. (2025).

6. Conclusion

This study analyzes the effect of green loans on NPL using a sample of all Nepalese commercial banks currently operating in Nepal. This study follows a quantitative approach considering the objective reality and uses the quarterly secondary data, sourced from the website of Nepal Rastra Bank [NRB] over the period starting from 2021Q2 to ending with 2025Q2. It uses the FEM as the baseline regression model, and the REM is used for a robustness check. The Hausman and the Breusch-Pagan LM tests are used to determine the choice of the optimal model. The findings indicated that green loans boost credit risk within the Nepalese banking industry. This outcome is also robust, as demonstrated by the REM. Conversely, the CAR reduces credit risk. The CD ratio, liquidity, and size stimulate credit risk in the Nepalese banking sector.

This study offers diverse contributions. First, our study fills a gap in the literature by analyzing the impact of green loans on NPLs in Nepalese banks. Second, this study investigates the current status of green loans injected by Nepalese banks to mitigate climate change risk. Third, this study further examines the effect of other factors on NPLs in Nepalese banks.

This study has some theoretical and practical implications. First, it provides knowledge about how green loans, specifically hydroelectric loans, positively or negatively affect NPL in the Nepalese banking sector. Second, this finding is more valuable to regulators who impose mandatory lending requirements on banks for green projects. Second, the

regulator, such as NRB, can run special training programs for bankers on credit evaluation and monitoring for green lending, which can help mitigate both environmental and credit risks and maintain financial stability. Similarly, this finding is also relevant for bankers to reduce credit and climate change risk. Finally, this finding is also relevant for the government to make fiscal policy that should promote green finance, which fulfils clean energy demand, protects environment, and fulfils our international commitment of predetermined "global warming to no more than 1.5°C above pre-industrial levels".

Our study provides new ground for future study. This study uses limited study variables and sample periods; future studies can use more variables and longer time periods. The future study can also include a subset of green loans, such as loans for electric vehicles, SMEs (which use clean energy and produce eco-friendly products), and the agriculture sector.

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