



# The impact of green lending on credit risk: evidence from UAE's banks

Anas Ali Al-Qudah<sup>1</sup> · Allam Hamdan<sup>2</sup> · Manaf Al-Okaily<sup>3</sup> · Lara Alhaddad<sup>4</sup>

Received: 27 October 2021 / Accepted: 15 December 2021 / Published online: 24 January 2022  
© The Author(s), under exclusive licence to Springer-Verlag GmbH Germany, part of Springer Nature 2021

## Abstract

This study investigates the impact of UAE's Green Credit Policy on the non-performing loan. One of the main pillars in the UAE green agenda 2015–2030 is the green finance that has been growing in high acceleration in the Gulf Cooperation Council (GCC) countries and the whole world. Consequently, the main objective of this study is to investigate in the financial risks that associated with green lending and whether an increasing in green lending will decrease the non-performing loans ratio (NPLR) of UAE banks, based on the period 2015–2020 dataset of 23 UAE's banks. To achieve this objective, we have used a regression technique that includes a two-stage least square regression analysis and random-effect regression analysis to test if the increase in green credit ratio can reduce the NPL ratio in a sample of UAE's banks. The current study can be considered the first empirical attempt that conducted on the banking sector in UAE, to discover the variables that might have a direct impact on the NPL ratio. The results reveal that the ratio of green loans has a negative impact on the NPL ratio, as much as the return of equity, while the quality of credit, inefficiency, and the bank size have a positive impact on NPL ratio. But as was not as expected, we found that the impact of solvency ratio has a negative significant on the NPL ratio. Finally, the current study introduces a new value to the current literature about the impact of green lending policies and provides a new perspective which supports the financial sustainability in UAE.

**Keywords** Green Credit Policy · Non-performing loan ratio · Green finance · Solvency · UAE · Banking sector · GCC

**JEL Classification** Q01 · H81 · E51

## Introduction

The banking sectors have sought to significantly contributing to sustainable development through creative services and products (Weber 2014). The financial sectors are promoting new products and services that meet to consumer demand for sustainable choices, from paperless statements to co-branded credit cards. Banks, for instance, try to

support environmental projects and institutions in towns and cities in the country. For three decades, environmental issues have been addressed through voluntary codes of conduct by banks and other investors, for example, the United Nation's (UN) Environment Programme's Financial Initiative (UNEP 2017); participation in such voluntary programs helps participants to improve their public appreciation and reputation, and manage their risk when coupled with higher transparency and solid standards (Bai et al. 2013).

The loan markets have witnessed rapid growth since 2014. Also, sustainable financial instruments have become all around world; there has been increasing care from the public sector and the investors in the financial market, if there is a need to classify and how to develop these instruments to produce a clear guidance to all participants in the market. The proceeds made on the EU classification further accelerated the discussion about classification features all over the world (Park and Kim. 2020).

Responsible Editor: Nicholas Apergis

✉ Anas Ali Al-Qudah  
anas.alqudah@ect.ac.ae

- <sup>1</sup> Faculty of Business, Liwa College of Technology, Abu Dhabi, United Arab Emirates
- <sup>2</sup> Ahlia University, Manama, Bahrain
- <sup>3</sup> School of Business, Jadara University, Irbid 733, Jordan
- <sup>4</sup> Yarmouk University, Irbid, Jordan

Newer generation has gone beyond voluntary codes of behavior to create mandatory guidelines and suitable regulations for green loans. Both the International Capital Market Association (ICMA 2021) and International Finance Corporation-World bank group (IFC 2021) have produced general rules and principles for Sustainable Finance and Green Finance classifications. A good number of highly manufacturing countries and most of these countries are members in the Sustainable Banking Network (SBN) that is managed by the IFC that has introduced sustainability regulations for banks. UAE is one of these groups that provide a financial package of \$17 million to Smart Energy Solutions (SES), and their 2015 Green Credit Policy has been addressed in many academic studies. The Green Credit Policy requires banks to offer green credit for environmental protection, energy conservation projects, and emission reduction, in addition to restrict loans to high-pollution, high-emission, and overcapacity industries. This will lead to add benefit of improving financial sector stability (Aizawa and Yang, 2010).

It is significant to ask whether the risk of financial industry can be eliminated or decreased using Green Credit Policy and introduce more green credit in a parallel manner. In this context, previous studies present mixed results about increasing the lending to greener clients and decreasing financial credit risk at the same time. One of these studies related to Hill (2014) when he criticized that the banking sectors are committed to ensure that loans minimize the social and environmental impacts of the projects that they finance, and it even indicates that a loan can be broken, if social and environmental regulations are not covered and some multilateral banks have similar principles. Likewise, in the study of Zhang et al. (2011) that analyzed the exercise of the Green Credit Policy both at the local and regional levels, they found that there is not fully implemented for the green credit policies in China. And the study of Jiguang and Zhiquan (2011) resulted a lot of issues that related to the implementation of low carbon finance, and they must find active strategic planning of low carbon to finance development, provide the legal base for financial supervision, and organize the development of carbon finance.

In addition to the above studies, Raad (2015) presented in his study that a conventional bank becomes a green bank by directing its core operations toward the improvement of environment and also they focused on the green financing activities of the commercial banks of Bangladesh and explore the main reasons this policy was adopted and make a comparison between the green financing practices of the commercial banks.

At the theoretical level, this article will try to fill the shortfall of the literature that dealt with the NPL ratio in UAE' banks, because some previous studies around the world dealt with the credit policies rather than the credit

risk, while others take in consideration the opportunities and challenges of green finance, at the same time, some studies take into account green finance in the light of capital constraint and cost sharing contracts and the potential sources of climate finance for developing countries, but we did not find any previous study that related to the credit risk in general in GCC countries or particularly in UAE. Accordingly, the lack in the literature that dealt with the NPL ratio in UAE's banks was a big motivation to us to conduct the current study.

Accordingly, at the practical level, we believe that the results of the current study can provide an empirical output that may be useful in regard to reducing credit risks in UAE's banks, at the same time can be generalized to all GCC countries, because all these countries are under the same investment's environment. But when we meditate in the main goals in UAE economy, we can find that one of them is to benefit from a sustainable, flexible, and diversified economy in adopting the new economic models and capitalizing on global economic partnerships to guarantee long-term prosperity for current and future generations of Emiratis. Therefore, we believe that the output of this study can be useful in banking sector strategy in UAE that will provide financial support to businesses and start-ups, which will put the green finance at the top of the pyramid of the banking sector.

The current study came to conduct an empirical test of the Green Credit Policy success. We have used the ratio of non-performing loan (NPL ratio) as a main indicator for credit risk in the UAE banks. The interest on loans will be suspended under the regulation of Central Bank of the UAE that have 90 days past due or have been provisioned (CB UAE 2021). Suspended interest cannot be considered as a part of non-performing loans (NPL) because it will not be credited to the profit and loss accounts (CFI 2021). The research objective in this study is to investigate the financial risks that are associated with green lending. Accordingly, our main question is whether an increase in green lending will decrease the NPL ratio of UAE banks. The sample of this study includes 23 UAE banks, to examine whether the UAE banks' green finance practices reduce financial risk; the study used a regression technique that includes a two-stage least squares regression analysis (2SLS) and random-effect regression analysis (REM). As concluded, the UAE Green Credit Policy can increase the ratio of green credit in lending portfolios and decrease the credit risks.

This paper is organized to be in five main sections as follows: we started with "Introduction," while in "Literature review and hypothesis development" section, we presented the literature review and the development of the study hypothesis. The "Research Design" section contained the research design, including selection of the sample, method, and empirical models; and the "Results" section analyzed

the results; and finally, the “[Discussion and conclusion](#)” section presented the paper’s conclusion.

## Literature review and hypothesis development

The green loans are not only the financing of green investment, but it goes beyond that, because the green financing contains some aspects like the climate-friendly design and environment of the financial processes, and how to manage the risk of environmental and climate finance corporations (Raberto, et al. 2019). The use of business processes and sensitivity to environmental issues are combined in one concept; it will be known as a green finance. Most definitions used behavior of all participants in the supply chain of services and goods. At the financing institutions’ level, participants include but not limited to the producers of goods and services, customers of these goods and services, and the suppliers of financial resources (Al-Okaily et al. 2021). But in this regard, the most important thing is the Green Credit Policy has achieved its stated environmental objectives, or no? This issue will remain an open question. In the last five years, a lot of research addressed this topic, especially in the European Union, China, and the USA; however, there is still a lack of literature related to GCC region that has addressed this topic (Al-Sheryani and Nobanee 2020), (Polzin, 2017).

One of the most important evidences about the opportunities and challenges surrounding green finance is the study of Falcone and Sica (2019) that presented empirical evidence in the light of the financial issues that might prevent the investment decisions of green companies, which indicates that active policy interventions must ensure that objectives are focusing on the long-run vision, to make sure that the perceived risks are reduced by financial institutions in funding biomass producers. Also, in the light of the concept of green finance, the study of Zheng et al. (2021) that mentioned the green finance is conceptually ambiguous, without final agreement among researchers on its meaning, when they tried to identify the bankers’ perception of various dimensions of GF and identify the major challenges affecting its implementation.

In the study of Peng et al. (2018), they confirmed that the development of green finance can reflect two main elements, the sense of social responsibility of financial organizations that must be adopted to ensure the development of green financial institutions and the sustainable development of green finance, for example, China started relatively late, if compared with financial institutions in the developed countries, this will be clearly appeared in the lack of improvement of the green financial system until now, in addition to no enhancement yet of green financial capabilities.

Miroshnichenko and Mostovaya (2019) described one of the important elements of green loans—the green financing; this type of loan is produced for agriculture purpose in the environmental projects, environmentally friendly industry, and renewable energy sources; they have made a conclusion about the rapid development and expansion of the green loan due to the flexible conditions for its provision and availability. In addition, Banga (2018) discovered that the green bond market in the developing countries remains incipient, and the full potential seems to be underappreciated; also, there is no appropriate arrangements in the institutions that issued for green bonds and determined the key barriers to the development of green bonds, high transaction costs associated with green bond issuance, and the issue of minimum size. Some studies suggest that green lending improves banks’ credit of risk exposure; in the study of Park and Kim (2020), they introduced new theory regarding the change conceptual framework at the institutional, combined, and sectoral level as an element to identify barriers in green banking and analyze transactions that are needed to reduce those barriers and to reach desirable results.

United Nations Environment Programme (UNEP 2017) mentioned in the light of the massive investments that needed to get about a transformation to green financing that all financial institutions must play a primary role in allocating resources across a green and sustainable economy, and then stop introducing funding to the activities that may harm the economy and environment. Accordingly, the study of Höck et al. (2020) investigated the effect of sustainability in environmental aspects on the costing of credit risk for European institutions, and they analyzed if the credit eligibility of an institution has a moderating impact on the relationship between the sustainability in environmental aspects and the premium of credit risk, the study found that lower credit risk premiums will be resulted by more sustainable institution if they also have a high credit eligibility. On the other side, the study of Sisaye (2021) found that the diffusion of institutions’ sustainability is worldwide, but differences exist among countries; institutions have a board of directors that is elected and/or appointed from both outside and inside the organization, while there are variations in the relative impact of board among countries; they all are in charge for institutions’ sustainability.

Zhang (2018) confirmed that under the impetus of the government in China’s green finance is progressively developing and prospering, and he mentioned that green investment is one of the primary features of green finance that aimed to change the bank’s credit structure, and the primary audience in the green finance is environmentally friendly SMEs. In the study of Abdul Razak et al. (2020), they sought to identify empirical evidence of a relationship between sustainability measures and credit risk by addressing three main elements: the first one is using a measure that considers the

financial materiality of sustainability issues through various industries; secondly, by using corporate default swap (CDS) spreads as a market-based measure of credit risk; and finally, by detecting the context-dependent nature of the relationship.

Previous studies have presented various results about the tradeoff between the lending to greener clients and financial credit risk, mainly dealt with the content of the Green Credit Policy or on the financial consequences of green lending outside of each country; all results in this regard were mixed and there is a lack of empirical studies analyzing the financial risks of green credit; this leaves a gap that needs to be filled by answering the important question: Would an increase in the green credit ratio will lead to a reduce a credit risks?

Also, some of the above articles criticized the financial institutions for ignoring international projects and applying green credit guidelines only to local projects, and on the other side, some of them addressed the policies that related to carbon pricing that are in line with the Green Credit Policy. Furthermore, some studies discussed the achievement issues of the credit policy. We note that all literatures across the different countries in the banking sector have concluded a correlation between green lending and credit risks. Accordingly, it is significant to ask if the green credit policies can reduce the risks in the financial industry and provide more green credit at the same time in UAE. This leads us to formulate the following hypothesis:

H: An increase in green lending will lead to a decrease in the non-performing loans ratio in the UAE banks

## Research design

### Sample selection

To examine the impact of Green Lending on Credit Risk in UAE, we follow the methodology of Cui et al. (2018) who selected the main banks in China (24 Chinese banks) based on a five-year dataset. In this study, banks were selected based at least on one of two criteria. Initially, the banks that are considered “major banks” in UAE were included. Second, publicly listed banks were also considered for our sample. Initially, 52 banks met at least one of the two criteria. Due to the non-availability of data, or the bank is not listed in the financial market, 29 of these banks were removed from our dataset, and we choose our sample to be 23 UAE’s banks, all of them are local banks. The remaining banks in the sample are presented in Table 1.

In January 2015, the Cabinet of the United Arab Emirates issued a decision to implement the UAE Green Agenda 2015–2030. The Green Agenda resulted from concerted

**Table 1** Banks in the sample\*

No	Bank name	Bank code
1	National Bank of Abu Dhabi P.J.S.C	NBADAEEA
2	Abu Dhabi Commercial Bank P.J.S.C	ADCBAAEA
3	Arab Bank for Inv.& Foreign Trade	ARABAEAD
4	Union National Bank	UNBEAEAA
5	Commercial Bank of Dubai P.J.S.C	CBDAUEAD
6	Dubai Islamic Bank P.J.S.C	DUIBAEAD
7	Emirates NBD Bank P.J.S.C	EBILAEAD
8	Emirates Islamic Bank P.J.S.C	MEBLAEAD
9	Mashreq Bank P.S.C	BOMLAEAD
10	Sharjah Islamic Bank P.J.S.C	NBSHAEAS
11	Bank of Sharjah PSC	SHARAEAS
12	United Arab Bank P.J.S.C	UARBAEAA
13	Invest Bank PLC	AEINAEAD
14	The National Bank of R.A.K P.J.S.C	NRAKAEAK
15	Commercial Bank International PLC	CLBIAEAD
16	National Bank of Fujairah PSC	NBFUAEAF
17	National Bank of U.A.Q PSC	UMMQAEAD
18	First Gulf Bank	FGBMAEAA
19	Abu Dhabi Islamic Bank P.J.S.C	ABDIAEAD
20	Dubai Bank	DBXPAEAD
21	Noor Islamic Bank P.J.S.C	NISLAEAD
22	Al Hilal Bank P.J.S.C	HLALAEAA
23	Ajman Bank P.J.S.C	AJMNAEAJ

\*Source: Organized by authors - CB UAE, EBU: Electronic Banking Service Unit (2021)

efforts of the federal and local authorities to concretize the UAE Green Growth Strategy. The strategy was launched in January 2012. It aims to put forward the country’s ambition to become a global hub and a successful model for the low-carbon green economy to enhance the competitiveness and sustainability of its development and preserve its environment for future generations. The data is selected from short panel data and small sample, and the main reason for this is that only 23 banks (of 52) met the criteria that we mentioned before, in addition to the implementation of the green agenda (2015–2030) that started to be forced in 2015, that is why it cannot select a time panel outside the implementation of the green agenda (EGDC 2015).

The banking sector in UAE financial markets include around 35.41% of total value of trading by AED3,039,997,543 of AED8,585,443,036 in all sectors at the end of 2020 as published in Abu Dhabi stock exchange ADX (ADX 2020). By looking at the biggest five banks from the view of credit rating, we find that all these banks are included in our sample; Table 2 shows the credit rating for these banks.

All rated UAE’s banks carry a pessimistic prediction; predictions could be revised to stable if the decision makers

**Table 2** Credit rating 2021\*

No	Bank	Credit rating
1	First Abu Dhabi Bank	AA-/Negative/A-1+
2	Abu Dhabi Commercial Bank	A/Negative/A-1
3	Mashreq Bank	A-/Negative/A-2
4	Sharjah Islamic Bank	A-/Negative/A-2
5	National Bank of Fujairah	BBB +/Negative/A-2

\*Source: S&P Global Rating. Ratings as of Jan. 25, 2021

realized that asset quality retrogradation will stay within the base-line prediction, banks maintain strong capital reserves, and risks related to the operating environment retract. In contrast, it could lower the ratings if asset quality retrogradation was significantly in parallel with increasing pressure on the operating environment (S&P Global Rating 2021).

**Methods**

As mentioned before, the methodology of the current study was followed based on the study conducted by Cui et al. (2018). That is why we have used the “NPL ratio” because it has been widely used before as a main variable to express the risk a lender holds at a specific point in time (Krugman 1999). A non-performing loan is a loan in which the client enabled to meet a scheduled premium for at least three months (90 days) (ECB 2016). Then, when the loan is considered non-performing, the probability of repaid will be very low. In general, non-performing loan is one of two situations, the loan in default repayment, or close to be in default repayment, in both situations, that financial institutions must raise the red flags (Ferri 2009).

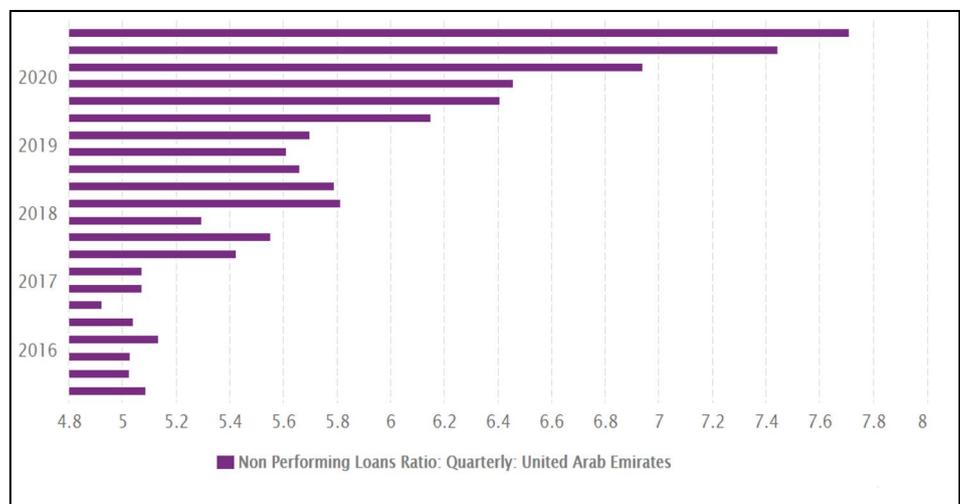
Studies found that the NPL ratio of a bank is affected by two main factors, bank-specific determinants and

macroeconomic, and the empirical studies showed that the low growth in economic is the main factor of higher NPLs and suggest that effective financial policies and efficient management are required for a constant economy and stability of financial system (Koju, et al. 2018). To express the NPL ratio, we must find the amount of non-performing loans relative to all loans in any financial institution.

To analyze the credit risk to lenders, the NPL ratio will be in the line with many other studies in most of the countries. As mentioned in world bank policy notes, the loan restructuring is a concession granted to the contractual terms of the loan in response to repayment difficulties that otherwise would not be considered by the lender, while NPL is the ratio of the amount of nonperforming loans in a bank’s loan portfolio relative to the total amount of outstanding loans the bank holds, and because the NPL ratio is able to predict banking crises, it will be rationale to use it rather than the restructured loans ratio (World Bank 2020).

United Arab Emirates NPL ratio stood at 7.7% in Sep 2020, compared with the ratio of 7.4% in the previous quarter. UAE NPL ratio data is updated quarterly, available from Mar 2009 to Sep 2020 (CB UAE 2020). The data reached an all-time high of 7.7% in Sep 2020 and a record low of 2.5% in Mar 2009. The International Monetary Fund (IMF) provides quarterly NPL ratio (IMF 2020). Figure 1 shows UAE NPL ratio for the study period for the whole sectors in country not only for the banking sector that we concern about in this study. In this context, as per the UAE Green Agenda 2015–2030 that conducted the first survey on contributions of financial institutions to Green Economy in UAE, 32 financial institutions (40.5%) responded that they are willing to introduce additional products and services in green finance, in which were fewer than those who already have at least one green product or service (EGDC 2015).

**Fig. 1** United Arab Emirates NPL ratio\*. \* Source: CEIC DATA ([www.ceicdata.com](http://www.ceicdata.com))



## Regression model

To achieve the objective of this study by testing the impact of green credit on the NPL ratio of UAE banks in this study, we have used two-stage least squares model (2SLS). The two-stage model is appropriate right here due to the endogenous feature of many economic models (Wooldridge, 2015). To test which of the two models are more efficient (random-effect model and two-stage model), we have used the Hausman specification test (Hausman, 1978). This test can estimate the consistency of an estimator if compared with less efficient alternative, but it must be known that the alternative is already consistent. This process can help to evaluate whether the model has consistency to the data.

As per William (2011), the endogeneity in the model can appear due to simultaneity, misspecification, or ignored some variables and or mensuration errors. To address endogeneity, 2SLS is commonly used by mentioning the instrumental variable, while instrumental variable must be correlated with the endogenous variables, but we must make sure that the instrumental variable is not correlated with the error term (Wooldridge 2015).

Based on the above criteria, two-stage regression model started through allocation the endogenous variable (ratio of green credit) with an estimated version, which was formative by regression of this variable on the instrumental variable and all other exogenous variables. And finally, the endogenous variable is used to regress the dependent variable as mentioned in Eq. (1):

$$\begin{aligned} \text{1st : } \hat{X} &= \gamma_0 + \gamma_1 \hat{Z} + \gamma_2 \hat{W} + \tilde{u} \\ \text{2nd : } Y &= \beta_0 + \beta_1 \hat{X} + \beta_2 \hat{W} + \tilde{u} \end{aligned} \quad (1)$$

where  $\hat{X}$  is the ratio of green credit in terms of total loans,  $Y$  is the NPL ratio,  $\hat{Z}$  is the instrumental variable (as mentioned in Table 2), and  $\hat{W}$  is the exogenous variables (size of bank, return on equity (ROE), quality of credit, solvency, inefficiency).

The above model (two stages estimation) was introduced by Berger and DeYoung (1997); we believe that this model is in the line of our study, and the model contains four main types of variables as follows:

- ( $\hat{X}$ ): Endogenous variables
- ( $\hat{W}$ ): Exogenous variables
- ( $\hat{Z}$ ): Instrumental variables
- ( $Y$ ): Dependent variable

## Study variables

The four main variables that are used in the model (Eq. 1) and mentioned in the previous section ( $\hat{X}$ ,  $\hat{W}$ ,  $\hat{Z}$ , and  $Y$ ) will be defined in this section as follows:

### Dependent variable ( $Y$ )

The dependent variable in our model is defined as the ratio of non-performing loans (NPL ratio); the common method to calculate the NPL ratio is simply known in the banking sectors by dividing the total of NPL by the total amount of current loans in the portfolio of any bank. Or this ratio will be shown as a percentage amount of the total bank's NPL. The following equation (Eq. 2) was used in our study to express NPL ratio:

$$\text{NPL ratio} = \frac{\text{TotalNPL}}{\text{totalamountofoutstandingloans}} \quad (2)$$

### Endogenous variable ( $\hat{X}$ )

As mentioned before in the hypothesis development, we mainly assume in this study that an increase in green lending will lead to a decrease in the non-performing loan ratio in the UAE banks. Accordingly, we need to calculate the ratio of green loans relative to the total bank's loan portfolio. This part of endogenous variable that related to the ratio of green loans to the total loans (ROGL) was calculated as shown in the following equation:

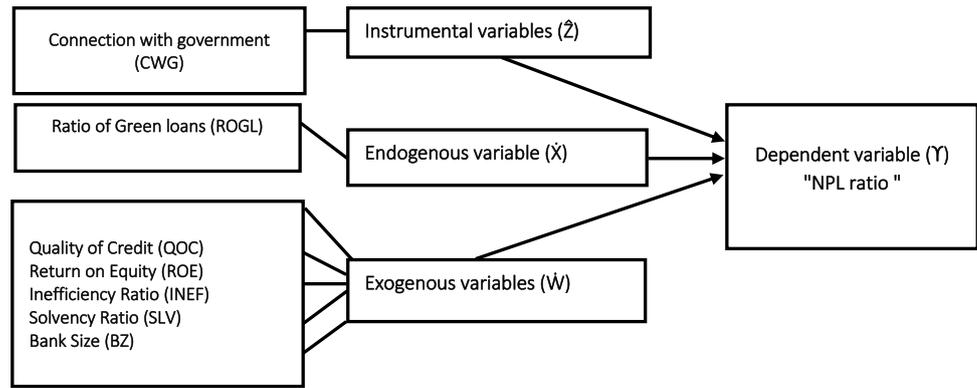
Ratio of Green loans (ROGL):

$$\text{ROGL} = \frac{\text{GreenLoanBalance}}{\text{Totalofoutstandingloansportfolio}} \quad (3)$$

### Instrumental variables ( $\hat{Z}$ )

As shown in Table 2, the credit rating for five banks that have significant influence when dealing with the UAE government, because of this strong dealing with the government, we have used those five banks to control instrumental variables. Also, these banks have more reaction to the Green Loan Policies than the other banks that have low connections with the government. According to the study of Weber (2017), he coded the banks as per the type of bank, but in this study, the coding of the (23) banks was conducted as per the connection with government, to reflect the government impact on the banks and the reaction to the Green Loan Policies. The ordinal scale for coding was 0: no connection, 1: low connection, and 2: strong connection.

Fig. 2 Regression model



**Exogenous variables (Ŵ)**

As known in the loan portfolio of any bank, there is a loan loss provision, and this provision can help us to calculate the bank’s quality of credit; the ratio of quality of credit has an impact on the NPL ratio. The ratio of quality of credit was calculated using the following equation:

$$QOC = \text{Loanlossprovision} / \text{Totalloans} \tag{4}$$

As per the study of Makri et al. (2014) that they recorded a strong relationship between NPL ratio and return on equity when they identified the factors that affect the non-performing loans’ rate (NPL ratio) for banking sector in Eurozone, we have added return on equity to be one of our exogenous variables; the ROE ratio was calculated as the following:

$$ROE = \text{NetProfitafterTax} / \text{TotalCommonEquity} \tag{5}$$

In the study of Berger and DeYoung (1997), they employed Granger-causality techniques to analyze cost-efficiency relationship with the problem loans precede; they found ambiguous results concerning whether the decision makers should control for problem loans in efficiency estimation. But in the study of Cui et al. (2018), they recorded a significant impact of inefficiency on the NPL ratio when they analyzed relationship between green lending and credit risks. Accordingly, in the current study, we decided to keep inefficiency variable to be one of the exogenous variables. The inefficiency ratio will be calculated as a proportion of operating expenses relative to the operating income as following:

$$INEF = \text{operatingexpenses} / \text{operatingincome} \tag{6}$$

The study results of Zhang et al. (2016) support the hypothesis of moral hazard, an increase in the NPL ratio will increase lending risk which may lead to instability financial system. Also, moral hazard issue will be rising due to the low solvency ratio, and then, it will lead to higher NPL ratio; solvency ratio will be calculated as the following:

$$SLV = \text{TotalEquity} / \text{TotalAssets} \tag{7}$$

In addition to the above exogenous variables, we added the bank’s size to be calculated as a proportion of total assets for each bank relative to the total assets for all banks in the study sample:

$$BZ = \text{Bank's Total Assets} / \text{Accumulated Bank Total Assets} \tag{8}$$

The figure below (Fig. 2) shows the study model that includes all above variables (X̂, Ŵ, Ẑ and Y).

**Results**

**Descriptive results**

Table 3 shows the descriptive results for the variables that are used in the regression model, ratio of green loans (ROGL), quality of credit (QOC), return on equity (ROE), inefficiency ratio (INEF), solvency ratio (SLV), and bank size (BZ).

Overall average of ROGL is 4.36% for all years in the study period, with 3.3% in the year 2015 and 5.1% in 2020. This result told us that there is a growth in the ratio of green loans but still this ratio is modest. In addition to the descriptive statistics, Table 4 shows the correlations between the dependent variable (NPL ratio) and the endogenous variable and exogenous variables (independent variables: ROE, BZ, QOC, INEF, SLV, and ROGL).

**Regression results**

To make sure that the models were significant, the authors used ANOVA test, to check the differences between banks in regard to their connection with government or not. This test was conducted depending on their NPL ratios. As a result, there are strong differences which showed between the banks that have connection with government and the other

**Table 3** Descriptive results\*

Year	Variable	ROGL	NPLR	ROE	INEF	SLV	BZ	QOC
2015	Average	3.3%	1.7%	1.2%	56.3%	6.1%	6.1%	3.1%
	St. D	3.2%	0.8%	0.4%	12.9%	1.4%	7.8%	0.7%
2016	Average	3.4%	1.8%	1.1%	53.2%	6.0%	6.1%	3.2%
	St. D	3.1%	0.7%	0.3%	11.2%	0.92%	7.8%	0.6%
2017	Average	4.7%	1.2%	1.0%	50.6%	6.2%	6.2%	3.3%
	St. D	3.9%	0.2%	0.1%	12.8%	0.39%	6.7%	0.6%
2018	Average	4.8%	1.1%	1.2%	46.7%	6.8%	6.1%	3.4%
	St. D	4.1%	0.18%	0.3%	13.4%	1.3%	6.6%	0.6%
2019	Average	4.9%	1.2%	1.1%	44.1%	6.9%	6.2%	3.4%
	St. D	4.2%	0.21%	0.2%	11.5%	0.8%	6.5%	0.5%
2020	Average	5.1%	1.4%	1.0%	42.2%	7.3%	6.1%	3.6%
	St. D	4.3%	0.3%	0.2%	10.3%	1.2%	6.4%	0.6%
Overall	Average	4.36%	1.28%	1.1%	48.85%	6.55%	6.1%	3.3%
	St. D	4.41%	0.5%	0.3%	12.6%	1.2%	7.1%	0.8%

**Table 4** Correlations between the study variables

	NPL R	ROE	BZ	QOC	INEF	SLV
ROE	-0.18					
BZ	0.29 **	0.32 **				
QOC	0.59 **	-0.02	0.28 **			
INEF	-0.03	-0.58 **	-0.12 *	-0.06		
SLV	0.09	0.48 **	0.31 **	0.18	-0.26 **	
ROGL	-0.11	-0.17	0.16	-0.08	-0.15	-0.31 **

(\*:  $p < 0.05$ ; \*\*:  $p < 0.01$ )

**Table 5** Results of REM and 2SLS

	REM NPL R	Stage-one ROGL	2SLS Stage-two NPL R	Std. Beta Coeff
ROGL	-0.047 ( $P < 0.0001$ )		-0.334 ( $P = 0.001$ )	-0.625
CWG		0.028 ( $P < 0.001$ )		
QOC	0.027 ( $P < 0.0001$ )	0.051 ( $P = 0.062$ )	0.052 ( $P < 0.001$ )	0.512
ROE	-144.21 ( $P < 0.001$ )	-62.59 ( $P = 0.407$ )	-124.11 ( $P = 0.001$ )	-0.429
INEF	0.012 ( $P = 0.0001$ )	0.021 ( $P < 0.001$ )	0.005 ( $P = 0.019$ )	0.522
SLV	0.365 ( $P = 0.073$ )	-1.87 ( $P = 0.716$ )	-0.101 ( $P = 0.391$ )	-0.139
Years	-0.002 ( $P = 0.344$ )	0.009 ( $P = 0.233$ )	0.011 ( $P = 0.476$ )	-0.009
BZ	0.004 ( $P = 0.003$ )	0.002 ( $P = 0.557$ )	0.015 ( $P < 0.001$ )	0.667
Cons	2.33 ( $P = 0.256$ )	7.67 ( $P = 0.341$ )	1.32 ( $P = 0.569$ )	19.02
Sig	$P < 0.00001$	$P < 0.00001$	$P < 0.00001$	
R <sup>2</sup>	0.3967		0.3531	
Obs	138	138	138	
RMSE		0.022		

banks, while the models were significant with  $P < 0.0001$ , and  $F$ -value = 10.55. As a conclusion, the banks that have a good connection with government have a lower NPL ratio than the other type of banks (as mentioned in instrumental

variable the coding was coding 0: no connection, 1: low connection, and 2: strong connection).

Table 5 shows the regression analyses that conducted which depend on two main models, the random-effect

(*REM*) and two-stage least square regression (*2SLS*), in addition to beta coefficients.

Regression analyses results that are produced based on the first model (*REM*) and the second model (*2SLS*) show a significant impact of *ROGL* on the *NPLR*; the coefficient in the first model was  $\text{Coeff.}_{\text{ROGL, NPLR}} = -0.047$ ,  $P < 0.0001$  and the coefficient in the second model was  $\text{Coeff.}_{\text{ROGL, NPLR}} = -0.334$ ,  $P = 0.001$ . Based on this result, we can accept our hypothesis that an increasing in green lending will lead to a decrease in the non-performing loans ratio in the UAE banks.

Using the test of the exogeneity assumption (Hausman 1978) to analyze the validity of the first and second models, we found that the result was  $P = 0.6107$ , and this result indicates presence endogeneity in the first model. Furthermore, we have used VIF (variance inflation factor) to check the multicollinearity (Allison 1999). The value of VIF (average) was 1.44, and it appeared that the variable *ROE* was the highest VIF with value 1.67. In addition to the previous, *RMSE* is close to zero, which means that the first-stage model is fit enough, and also the residuals' mean was  $\mu = 0.001$ , with a standard deviation of  $(\sigma) = 0.05$ .

Also, we have used two more methods to make sure about the validity of the model; in the first one, we used the LOOCV method (leave-one-out cross-validation) to check if the model holds if any bank is removed from the study sample. The LOO method showed in a pseudo-code-algorithm  $R\text{-square} = 0.395$ , with a  $\text{RMSE} = 0.031$  and a  $\text{MAE} = 0.019$ . These results can grant validity of the model (Molinaro, et al. 2005). In the second, a regression analysis used the banks as clusters to observe if any input does not fit the rest of the data and the impact of the banks on the result. The results show the  $R\text{-square}$  value for the regression alignment with a significant coefficient for *ROGL* ( $P = 0.059$ ).

Table 5 also shows that the impact of *ROGL* on the *NPLR* is higher than the impact of the variables (*QOC*, *ROE*, *INEF*, and *SLV*) as presented by the value of standardized beta coefficients (Std. Beta Coeff.). The two-stage model shows that a reduction of *NPLR* by 0.334% resulted from the increase of 1% of *ROGL*. Also, as mentioned in literature review, the (*QOC*) has a significant impact on the (*NPLR*) (Coeff. *QOC* = 0.052). On the other side, *ROE* shows a strong negative impact on the *NPLR* (Coeff. *ROE* = 124.11), at the same time the impact of (*INEF*) is significant as well (Coeff. *QOC* = 0.005).

In addition to the previous results, the *BZ* with Coeff. *BZ* = 0.015 shows a positive impact on the *NPLR*, and the last interesting result was not as expected, the impact of *SLV* is a negative significant on the *NPLR* with Coeff. *SLV* = -0.101. And finally, the model explanatory power shows that the model can explain 35.31% of the variance of the *NPLR*.

## Discussion and conclusion

This article came due to the lack of the literature that dealt with the *NPL* ratio in UAE banks; some previous studies around world dealt with the credit policies rather than the credit risk (Zhang, et al. 2011), while others take in consideration the opportunities and challenges of green finance (Falcone, et al. 2019), in the same time some studies take in account green finance in the light of capital constraint and cost sharing contracts (Qin, et al. 2018), and a potential source of climate finance for developing countries (Banga 2018), also the subject of the role of green finance in environmental protection (Wang et al. 2019), but we did not find any previous study that related to the credit risk in general in GCC countries or particularly in UAE. Accordingly, the lack in the literature that dealt with the *NPL* ratio in UAE banks was a big motivation to us to conduct the current study.

After the results that we have introduced, we believe that we have provided an empirical output that may be useful in regard to reducing credit risks in UAE's banks; the main result in this study that allocates more green loans to the total loan portfolio does reduce a banks' *NPL* ratio in UAE. This study provides empirical evidence about the four main aspects, the *NPLR* as a dependent variable and each of ratio of green loans (*ROGL*), quality of credit (*QOC*), return on equity (*ROE*), inefficiency ratio (*INEF*), solvency ratio (*SLV*), and bank size (*BZ*) as independent variables; in this section, we will discuss each result and compare it with the previous studies.

The main result in this study is that the ratio of green loans (*ROGL*) has a negative significant impact on the *NPL* ratio (*NPLR*) all over the UAE's banks, and this result was confirmed in both models that used the regression analyses. This result consists with the study of Cui et al. (2018) that they found the correlation between a credit risks and green lending in China, and the study of Zhou et al (2020) that they found that the association between a bank's (relative) green lending as a proportion of its overall loan portfolio, and its credit risk, depends critically on the size and structure of state ownership. Also, in the study of Dipika (2015) they found that India extremely needs to produce awareness, implement, and follow green financing as much as can in today's business world of creation technologies to make their environment human friendly and perform the sustainability. Another study that was conducted in Russia (Miroshnichenko and Mostovaya (2019) discovered that the green loan portfolio in the banks contributes to the overdue loans' decrease.

In the empirical evidence, we found that the quality of credit (*QOC*) has a significant impact on the *NPL* ratio (*NPLR*); this result is matching with the study of Ben

Saada (2018) that she concluded that the NPL is affected by control quality, and the merging of effective measures to strengthen guidelines of the Central Bank and the banking governance practices will lead a better evaluation of reforms' implementation. And in the study of Singh et al. (2021) regarding the control quality on NPL by bankers and policymakers that need to consider the green loans, they found that GDP growth has a significant and positive effect on the NPL of commercial banks.

In regard to return on equity (ROE), we found a strong negative impact on the NPL ratio (NPLR). However, the study of Sebayang (2020) found that an increase in the non-performing loans (NPLs) can have a positive effect and increase return on equity (ROE); in the study of Nursiana (2017), the effect of non-performing loans to profitability of banks in Indonesia found that NPL ratio has significant effect to ROE, while the ROE showed no significant relationship with green financing of the banks in the study of Julia and Kassim (2016). Also, in this study, we found that the impact of inefficiency ratio (INEF) is significant on the NPL ratio (NPLR), and in the study of Vatansever and Hepsen (2013), they found that inefficiency ratio of all banks affect negatively on the unemployment rate, ROE, and NPL ratio, while the NPL ratio positively affected by the capital adequacy. And the study of Christaria and Kurnia (2016) also investigated the impact of operational efficiency proxies to operating income ratio and non-performing loan (NPL); they found that the banks perform lending selectively and banks maintain the level of NPL to be low as much as they can to manage their risks.

In regard to the result that related to solvency ratio (SLV), it was not as expected, and we found that the impact of SLV has a negative significant on the NPLR, while the impact of solvency is not significant on the NPL ratio as introduced in the study of Cui et al. (2018), also in the study of Psaila et al (2019), their study presented that the non-performing loans ratio was correlated significantly with the ROA, whereas the solvency ratio and liquidity ratio which were used as the control variables are not correlated with the return on assets. And the study of Derbali (2021) indicates a negative relationship between ROE and some internal variables such the size of the bank, the operating expenses, and the banks performance. When we found these results and after comparing it with the new studies in this field, we decided to dig deeper and review the older studies that deal with the solvency ratio and its impact on NPL ratio; the study of Dichevska et al (2017) found that one of the main reasons for systemic insolvency of the financial sector is the high amount of non-performing loans, which make a permanent threat and obstacle not only to the development of the banking system, but also to the whole economic system. Also, in the study of Hou and Dickinson (2007), to improve the economic position, we must reduce the non-performing loans,

and the impairment of problematic loans reduces the solvency position and risk profile of banks. And in the study of Gutiérrez-López and Abad-González (2020), they found that loan loss reserves (LLR) and NPL ratio coefficients reveal a negative impact on bank solvency.

For the last result regarding the bank size (BZ) that shows a positive impact on the NPL ratio, this result is in line with some previous studies like the study of Ekanayake and Azeez (2015); they concluded that the NPLs have a positive correlation with the efficiency of the banks and the size of banks, in their study that addressed the factors that affected the NPLs in the banking sector of Sri Lanka for the period between 1999 and 2012. And in the study of Ahmed et al. (2021) using dynamic-GMM estimations, they found that credit growth and bank diversification significantly increase NPLs, while operating efficiency and bank size decrease NPL ratio. But in the study of Hu et al. (2007), they found that the banks' size is negatively related to the rate of NPLs, which supports our argument that larger banks have more resources for determining the quality of loans.

The current study concludes some interesting results; most of them are consistent with the previous studies, and others are not in the line with the provided output in this study. The current study can be considered the first empirical attempt that was conducted on the banking sector in UAE, to discover variables that might have a direct impact on the NPL ratio; the main results were as follows: ratio of green loans has a significant impact on NPL ratio, quality of credit also has a significant impact on NPL ratio, while the strong negative significant impact on the NPL ratio belonged to the ROE variable, and the positive impact was under the bank size variable, and finally, the solvency ratio was in contrast to what we found in the previous studies, has a positive impact on NPL ratio.

One of the main goals in UAE economy is to benefit from a sustainable, flexible, and diversified economy in adopting the new models of economic and capitalizing on global economic partnerships to guarantee long-term prosperity for current and future generations of Emiratis. At the same time, the economy in UAE is considered the highest one if compared with the whole economy in GCC countries; under banking sector strategy in UAE, the banks will provide financial support to businesses and start-ups; this strategy aims to drive the national economy by financing SMEs and creating jobs.

This study can introduce a new vision into green loans from a UAE perspective, to produce a sustainable and diversified economy, and be flexible in adopting new economic models, and merge smoothly with the global economy. In spite of the investment environment in the GCC countries is similar, especially in the banking sectors, and we can generalize these results to all GCC countries, and the possibility of implementation the results to the practical

reality in these countries, but from our point of view, we need more research that will be conducted on green loans and its impact on credit risk in UAE and all GCC countries. Expected researchers can take in their account longer periods and new variables didn't mention in this study and the previous studies. We believe that conducting more comparative research between the UAE Green loans and similar cases elsewhere would introduce a high knowledge about the impact of green lending policies. Finally, all these kinds of research can provide a new perspective which supports the financial sustainability.

**Abbreviations** UAE: United Arab Emirates; NPLR: Non-performing loans ratio; ROGL: Ratio of green loans; QOC: Quality of credit; ROE: Return on equity; INEF: Inefficiency; SLV: Solvency ratio; BZ: Bank size; REM: Random-effect regression analysis; 2SLS: Two-stage least squares regression analysis; RMSE: Root mean square error; LOOCV: Leave-one-out cross-validation

**Author contribution** All authors contributed to the study conception and design the model. Literature review preparation, data collection and analysis were performed by Anas Al-Qudah, Allam Hamdan, Lara Haddad, and Manaf Al-Okaily. The first draft of the manuscript was written by Anas Al-Qudah, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

**Data availability** All data generated, collected, or analyzed during this study are included in this article, all of them are public data; authors cited all publicly available data on which the conclusions of the paper rely in the manuscript. Data citations included a persistent identifier (such as a DOI) and ideally included in the reference list.

## Declarations

**Ethics approval** We confirm that the manuscript follows compliance with ethical standards; authors confirm that the study does not need any approval from any ethics committee.

**Consent to participate** “Not applicable,” manuscript does not report on or involve the use of any animal or human data or tissue.

**Consent to publish** “Not applicable,” manuscript does not contain data from any individual person.

**Competing interests** The authors declare no competing interests.

## References

- Abdul Razak L, Ibrahim MH, Ng A (2020) Which Sustainability Dimensions Affect Credit Risk? Evidence from Corporate and Country-Level Measures. *J Risk Financial Manag* 13(12):316. <https://doi.org/10.3390/jrfm13120316>
- ADX Abu Dhabi Stock Exchange, ADX Monthly Bulletin - December 2020 (Accessed July 2021) [www.adx.ae](http://www.adx.ae)
- Ahmed S, Majeed ME, Thalassinos E, Thalassinos Y (2021) The Impact of Bank Specific and Macro-Economic Factors on Non-Performing Loans in the Banking Sector: Evidence from an Emerging Economy. *J Risk Financial Manag* 14:217. <https://doi.org/10.3390/jrfm14050217>
- Aizawa M, Yang C (2010) Green Credit, Green Stimulus, Green Revolution? China's Mobilization of Banks for Environmental Cleanup. *J Environ Dev* 19(2):119–144. <https://doi.org/10.1177/1070496510371192>
- Allison PD (1999) *Multiple Regression: A Primer*. Pine Forge Press, Thousand Oaks
- Al-Sheryani K and Nobanee H (2020) Green Finance: A Mini-Review. Available at SSRN <https://doi.org/10.2139/ssrn.3538696>
- Al-Okaily A, Al-Okaily M, Ai Ping T, Al-Mawali H, Zaidan H (2021) An empirical investigation of enterprise system user satisfaction antecedents in Jordanian commercial banks. *Cogent Bus Manag* 8(1):1918847
- Banga J (2018) The green bond market: a potential source of climate finance for developing countries. *J Sustain Finance Invest* 9(1):17–32. <https://doi.org/10.1080/20430795.2018.1498617>
- Ben Saada M (2018) The impact of control quality on the non-performing loans of Tunisian listed banks. *Manag Audit J* 33(1):2–15. <https://doi.org/10.1108/MAJ-01-2017-1506>
- Berger AN, DeYoung R (1997) Problem loans and cost efficiency in commercial banks. *J Bank Finance* 21(6):849–870. [https://doi.org/10.1016/S0378-4266\(97\)00003-4](https://doi.org/10.1016/S0378-4266(97)00003-4)
- CB UAE, The Central Bank of the UAE (2021) List Of National Banks & Distribution of Their Branches in The UAE As At 30/04/2021. <https://centralbank.ae/en/taxonomy/term/34>
- CB UAE (2020) The Central Bank of the UAE, Annual reports, Enhanced Methodology for Non-performing Loans Ratio, [https://www.centralbank.ae/sites/default/files/2019-06/PR\\_EnhancedNPLMethodology\\_En\\_27062019.pdf](https://www.centralbank.ae/sites/default/files/2019-06/PR_EnhancedNPLMethodology_En_27062019.pdf).
- Central Bank of the U.A.E (2020) Key Banking Indicators for UAE Banking system, Financial Stability Report, <https://centralbank.ae/sites/default/files/2021-06/2020%20FSR%20Report%20EN.pdf>
- Christaria F, Kurnia R (2016) The Impact of Financial Ratios, Operational Efficiency and Non-Performing Loan Towards Commercial Bank Profitability. *Account Finance Rev (AFR)* 1(1):43–50. <https://EconPapers.repec.org/RePEc:gtr:gatrjs:af116>
- Corporate Finance Institute (CFI). Non-Performing Loan (NPL): A loan in which the borrower is in default. Available online: <https://corporatefinanceinstitute.com/resources/knowledge/finance/non-performing-loan-npl/> Accessed 17 July 2021
- Cui Y, Geobey S, Weber O, Lin H (2018) The Impact of Green Lending on Credit Risk in China (June 14, 2018). *Sustainability* 10(6):2018. Available at SSRN: <https://ssrn.com/abstract=3196031>
- Derbali A (2021) Determinants of the performance of Moroccan banks. *J Bus Socio-Econ Dev* 1(1):102–117. <https://doi.org/10.1108/JBSED-01-2021-0003>
- Dichevska S, Karadzova V, Jolevski L (2017) Non-performing loans and profitability indicators: The case of the Republic of Macedonia, *Journal of Contemporary Economic and Business Issues*, ISSN 1857–9108, Ss. Cyril and Methodius University in Skopje, Faculty of Economics, Skopje, Vol. 4, Iss. 2, pp. 5–20. <https://www.econstor.eu/bitstream/10419/193475/1/spisanie-vol-4-br-2-trud-1.pdf>
- Dipika (2015). Green Banking in India: A Study of Various Strategies Adopt by Banks for Sustainable Development, *International Journal of Engineering Research & Technology (IJERT) NCETEMS – 2015 (Volume 3 – Issue 10)*, <https://www.ijert.org/green-banking-in-india-a-study-of-various-strategies-adopt-by-banks-for-sustainable-development>
- Ekanayake E.M.N.N and Azeez A.A. (2015). Determinants of Non-Performing Loans in Licensed Commercial Banks: Evidence

- from Sri Lanka. *Asian Econ Financ Rev* 5(6):868–882. <https://doi.org/10.18488/journal.aefr/2015.5.6/102.6.868.882>
- Emirates Green Development Council (EGDC) (2015), UAE Green Agenda (2015–2030), State of Green Finance in the UAE, The first national survey on contributions of financial institutions to Green Economy, Existing green finance products and services. <https://www.moccae.gov.ae/assets/f0dbe459/state-of-green-finance-in-the-uae.aspx>
- European Central Bank (ECB), What are non-performing loans (NPLs)? 12 September 2016. Available online: <https://www.ecb.europa.eu/explainers/tell-me/html/npl.en.html>. Accessed 20 July 2021
- Falcone Pasquale M, Sica Edgardo (2019) Assessing the Opportunities and Challenges of Green Finance in Italy: An Analysis of the Biomass Production Sector. *Sustainability* 11(2):517. <https://doi.org/10.3390/su11020517>
- Ferri G (2009) Are new tigers supplanting old mammoths in China's banking system? Evidence from a sample of city commercial banks. *J Bank Financ* 33:131–140. <https://doi.org/10.1016/j.jbankfin.2007.06.013>
- Gutiérrez-López C, Abad-González J (2020) Sustainability in the Banking Sector: A Predictive Model for the European Banking Union in the Aftermath of the Financial Crisis. *Sustainability* 12:2566. <https://doi.org/10.3390/su12062566>
- Hausman J (1978) Specification Tests in Econometrics. *Econometrica* 46(6):1251–1271. <https://doi.org/10.2307/1913827>
- Hill D (2014) What Good Are China's Green Policies if Its Banks Don't Listen? *Guardian*, 16 May 2014. Available online: <http://www.theguardian.com/environment/andes-to-the-amazon/2014/may/16/what-good-chinas-green-policies-banks-dont-listen>. Accessed 17 July 2021
- Höck A, Klein C, Landau A et al (2020) (2020) The effect of environmental sustainability on credit risk. *J Asset Manag* 21:85–93. <https://doi.org/10.1057/s41260-020-00155-4>
- Hou Y, Dickinson D (2007) The non-performing loans: some bank level evidences. Asia-Link Program. Euro-Philippines Network in Banking and Finance Enhancing Teaching and Research. (Asialink/ASIE/B7–3010/2005/105–139) research conference on: Safety and Efficiency of the Financial System (27th August 2007)
- ICMA International Capital Market Association, Overview and Recommendations for Sustainable Finance Taxonomies, Zurich, May 2021. [www.icmagroup.org](http://www.icmagroup.org)
- IFC International finance corporation-World bank group. Sustainability, ESG Resources for Companies, Sustainable Finance. Global Progress Report and 30 Country Reports at [www.ifc.org](http://www.ifc.org). July 9, 2021
- IMF The International Monetary Fund (2020). Country Report No. 19/35. United Arab Emirates: Selected Macroeconomic Indicators. <https://www.imf.org/en/Countries/ARE>. Accessed July 2021
- Jiguang LIU, Zhiqun S (2011) Low carbon finance: Present situation and future development in China. *Energy Proc* 5:214–218. <https://doi.org/10.1016/j.egypro.2011.03.038>
- Hu J-L, Li Y, Chiu Y-H (2007) Ownership and nonperforming loans: Evidence from Taiwan's banks. *Dev Econ* 42(3):405–420. <https://doi.org/10.1111/j.1746-1049.2004.tb00945.x>
- Julia T, Kassim S (2016) Green financing and bank profitability: Empirical evidence from the banking sector in Bangladesh. *Al-Shajarah* 21(Specialissue):307–330
- Koju L, Koju R, Wang S (2018) Macroeconomic and Bank-Specific Determinants of Non-Performing Loans: Evidence from Nepalese Banking System. *J Cent Bank Theory Pract* 7(3):111–138. <https://doi.org/10.2478/jcbtp-2018-0026>
- Krugman P (1999) Balance Sheets, the Transfer Problem, and Financial Crises. *Int Tax Public Financ* 6:459–472. <https://doi.org/10.1023/A:1008741113074>
- Makri V, Tsagkanos A, Belles A (2014) Determinants of non-performing loans: the case of Eurozone. *Panoeconomicus* 61(2):193–206. <https://doi.org/10.2298/PAN1402193M>
- Miroshnichenko OS, Mostovaya NA (2019) Green Loan as a Tool for Green Financing. *Finance: Theory Pract* 23(2):31–43. (In Russ.) <https://doi.org/10.26794/2587-5671-2019-23-2-31-43>
- Molinaro AM, Simon R, Pfeiffer RM (2005) Prediction error estimation: a comparison of resampling methods. *Bioinformatics* 21(15):3301–3307. <https://doi.org/10.1093/bioinformatics/bti499>
- Nursiana A (2017) Effect of non-performing loans to profitability of banks in Indonesia. *Int J Appl Bus Econ Res* 15(10):203–208
- Weber O (2014) The financial sector's impact on sustainable development. *J Sustain Finance Invest* 4(1):1–8. <https://doi.org/10.1080/20430795.2014.887345>
- Park H, Kim JD (2020) Transition towards green banking: role of financial regulators and financial institutions. *AJSSR* 5:5. <https://doi.org/10.1186/s41180-020-00034-3>
- Peng H, Feng T, Zhou C (2018) International Experiences in the Development of Green Finance. *Am J Ind Bus Manag* 8:385–392. <https://doi.org/10.4236/ajibm.2018.82024>
- Polzin F (2017) Mobilizing private finance for low-carbon innovation – A systematic review of barriers and solutions. *Renew Sustain Energy Rev* 77:525–535. <https://doi.org/10.1016/j.rser.2017.04.007>
- Psaila A, Spiteri J, Grima S (2019) The Impact of Non-Performing Loans on the Profitability of Listed Euro-Mediterranean Commercial Banks. *Int J Econ Bus Admin (IJEBA)* 0(4):166–196. <https://EconPapers.repec.org/RePEc:ers:ijebaa:v:vii:y:2019:i:4:p:166-196>
- Qin Juanjuan, Zhao Yuhui, Xia Liangjie (2018) Carbon Emission Reduction with Capital Constraint under Greening Financing and Cost Sharing Contract. *Int J Environ Res Publ Health* 15(4):750. <https://doi.org/10.3390/ijerph15040750>
- Raad ML (2015) Green Banking: Going Green. *Int J Econ Finance Manag Sci* 3(1)34–42. <https://doi.org/10.11648/j.ijefm.20150301.15>
- Raberto M, Ozel B, Ponta L et al (2019) From financial instability to green finance: the role of banking and credit market regulation in the Eurace model. *J Evol Econ* 29:429–465. <https://doi.org/10.1007/s00191-018-0568-2>
- S&P Global Rating (2021) UAE Banking Sector 2021 Outlook A Long Recovery Road Ahead. Ratings as of Jan. 25, 2021. [www.spglobal.com](http://www.spglobal.com)
- Sebayang P (2020) The Impact of the Capital Adequacy Ratio, Non-Performing Loan Against to Return on Equity (Case Study Private Bank in Indonesia). *SHS Web of Conf* 76:01035. <https://doi.org/10.1051/shsconf/20207601035>
- Singh SK, Basuki B, Setiawan R (2021) The Effect of Non-Performing Loan on Profitability: Empirical Evidence from Nepalese Commercial Banks. *J Asian Finance, Econ Bus* 8(4):709–716. <https://doi.org/10.13106/JAFEB.2021.VOL8.NO4.0709>
- Sisaye S (2021) The influence of non-governmental organizations (NGOs) on the development of voluntary sustainability accounting reporting rules. *J Bus Socio-Econ Dev* 1(1):5–23. <https://doi.org/10.1108/JBSED-02-2021-0017>
- UNEP United Nations Environment Programme, 2017. On the role of central banks in enhancing green finance. Ulrich Volz, Source: Inquiry into the Design of a Sustainable Financial System (UN Environment Inquiry), (Accessed July 2021). <https://www.green-growthknowledge.org/research/role-central-banks-enhancing-green-finance>
- Vatansever M, Hepsen A (2013) Determining impacts on non-performing loan ratio in Turkey. *J Finance Invest Anal* 2(4):119–129. [https://EconPapers.repec.org/RePEc:spt:fininv:v:2:y:2013:i:4:f:2\\_4\\_7](https://EconPapers.repec.org/RePEc:spt:fininv:v:2:y:2013:i:4:f:2_4_7)

- Wang K, Tsai S-B, Du X, Bi D (2019) Internet Finance, Green Finance, and Sustainability. *Sustainability* 11(14):3856. <https://doi.org/10.3390/su11143856>
- Weber O (2017) Corporate Sustainability and Financial Performance of Chinese Banks. *Sustain Account Manag Policy J* 8(3):358–385. <https://ssrn.com/abstract=3118494>
- Wooldridge JM (2015) *Introductory Econometrics: A Modern Approach*. Nelson Education, South-Western College Publishing; 7th edition (4 January 2019). Toronto, Canada
- World Bank (2020) COVID-19 and Non-Performing Loan Resolution in the Europe and Central Asia region, lessons learned from the global financial crisis for the pandemic, POLICY NOTE - DECEMBER 2020. <https://pubdocs.worldbank.org>
- Bai Y et al (2013) The Role of China's Banking Sector in Providing Green Finance, 24 *Duke Environmental Law & Policy Forum* 89–140 (Fall 2013)
- Zhang B, Yang Y, Bi J (2011) Tracking the implementation of green credit policy in China: Top-down perspective and bottom-up reform. *J Environ Manag* 92(4):1321–1327. <https://doi.org/10.1016/j.jenvman.2010.12.019>
- Zhang D, Cai J, Dickinson DG, Kutan AM (2016) Non-performing loans, moral hazard and regulation of the Chinese commercial banking system. *J Bank Financ* 63:48–60. <https://doi.org/10.1016/j.jbankfin.2015.11.010>
- Zhang Q (2018) The Impacts of Green Credit on the Financial Performance and Risks of Chinese SMEs—Taking BOSSCO as an Example. *Open Access Libr J* 5:1–6. <https://doi.org/10.4236/oalib.1104892>
- Zheng Guang-Wen, Siddik Abu B, Masukujjaman Mohammad, Fatema Nazneen, Alam Syed S (2021) Green Finance Development in Bangladesh: The Role of Private Commercial Banks (PCBs). *Sustainability* 13(2):795. <https://doi.org/10.3390/su13020795>
- Zhou X, Caldecott B, Hoepner AGF, Wang Y (2020) Bank Green Lending and Credit Risk. Available at SSRN: <https://ssrn.com/abstract=3618744> or <https://doi.org/10.2139/ssrn.3618744>

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.