Sustainable development and bank non-performing loans: are they correlated?

Peterson K. Ozili

Central Bank of Nigeria, Abuja, Nigeria

Abstract

Purpose – This paper aims to investigate the correlation between banking sector non-performing loans (NPLs) and the level of sustainable development.

Design/methodology/approach – Pearson correlation test statistic was used to assess the correlation between bank NPLs and sustainable development.

Findings – There is a significant positive correlation between banking sector NPLs and the level of sustainable development measured by the sustainable development index (SDI). The significant positive correlation is evident in European countries and in countries in the region of the Americas. There is a significant negative correlation between banking sector NPLs and achieving SDG3 and SDG7 in African countries and European countries. There is also a significant negative correlation between NPLs and achieving SDG10 in European countries. There is a significant positive correlation between banking sector NPLs and achieving SDG4 and SDG7 in the region of the Americas. There is also a significant positive correlation between NPLs and achieving SDG10 in African countries and in countries in the region of the Americas.

Originality/value – The present study is unique and different from other studies because it used a unique SDI to capture the level of sustainable development. The analysis is also unique because it covers several regions, which have not been covered in previous studies.

Keywords Sustainable development, Non-performing loans, Sustainable development goals, SDGs, SDG3, SDG4, SDG7, SDG10, Sustainable development index, Correlation

Paper type Research paper

1. Introduction

Banks need the planet for their survival. They need to operate in a habitable planet. This means that the goal of saving this planet, which is the reason for the sustainable development goals (SDGs), is not exogenous to banking/financial institutions. Banks need to own the SDGs by supporting the realization of the SDGs. They also need to strengthen their risk management and ensure that their involvement in SDG activities would improve the non-performing loans (NPLs) of the banks involved SDG activities.

This paper investigates the correlation between banking sector NPLs and the level of sustainable development. Banks have the financial resources that are needed to finance SDG-related activities. Banks can use the financial resources at their disposal to speed-up the realization of the SDGs by 2030. Recently, banks are being pressured to show their commitment to the United Nations SDGs by providing tailored financial products, financial services and financial instruments that can help to accelerate the realization of the United Nation's SDGs by 2030 (Ozili, 2021). Pressuring banks to make a commitment to support one or more SDGs can push banks to extend credit to high-risk SDG-related activities that give

rise to credit risk which manifest in the form of high NPLs in the banking sector when borrowers default on loan repayments (Ozili, 2023b). Pressuring banks to make a commitment to support one or more SDGs can also compel banks to diversify into low-return high-risk SDG activities so that they can appear to be supportive of the sustainable development agenda (Naqvi, Mirza, Rizvi, Porada-Rochoń, & Itani, 2021). This can pose a risk to banks, and I argue that this risk can show up in the size of bank NPLs through the increase in the size of bank NPLs.

Few studies have examined how banks' involvement in financing sustainable development activities or projects can affect bank risk (see, for example, Umar, Ji, Mirza, & Naqvi, 2021; Ozili, 2023b). But none of these studies have examined whether bank lending to support the realization of the SDGs affect the size of bank NPLs. This study fills this gap in the literature by analyzing the correlation between sustainable development and banking sector NPLs. Using country-level data from 2011 to 2019, the findings show that achieving specific SDGs lead to increase in banking sector NPLs, while achieving other SDGs lead to a decrease in banking sector NPLs.

This study contributes to the existing literature by investigating banks' contribution to the realization of the SDGs. It also contributes to the bank risk literature that analyze the size of NPLs as an important indicator of credit risk in the banking sector. This study is the first in the literature to investigate the correlation between bank NPLs and the SDGs.

The remainder of the study is organized as follows. Section 2 presents the literature review. Section 3 presents the methodology. Section 4 presents the empirical results. Section 5 The final section presents the conclusion of the study.

2. Literature review and hypothesis

2.1 Related literature

There is limited literature on the relationship between sustainable development and bank risk. Sachs, Woo, Yoshino, and Taghizadeh-Hesary (2019) point out that financial institutions seem to be more interested in fossil fuel projects than in green projects mainly because there are still several risks associated with investment in green projects and they offer a lower rate of return which makes them unattractive. In simple terms, Sachs, Woo, Yoshino, and Taghizadeh-Hesary (2019) is emphasizing that banks consider investment in some sustainable development projects to be risky. Gambetta, Azcárate-Llanes, Sierra-García, and García-Benau (2021) examine the impact of Spanish financial institutions' risk profile on their contribution to the SDGs 2030 Agenda. They show that financial institutions that have less capital risk, lower management efficiency and higher market risk usually make higher contributions to the SDGs. This implies that banks that are more risky try to downplay their riskiness by contributing to the SDGs. Gangi, Meles, D'Angelo, and Daniele (2019) analyze the effect of corporate social responsibility (CSR) on the financial performance of banks. They focus on the factors that encourage banks to be more environmentally friendly. They analyze 142 banks from 35 countries from 2011 to 2015, and find that banks that are more sensitive to environmental issues have less bank risk. Choudhury, Kamran, Djajadikerta, and Sarker (2021) examine the relationship between the share of renewable energy and bank risk. They analyze 80 international banks from 20 countries during the 2006 to 2017 period. They find that higher share of renewable energy in a country significantly leads to a reduction in banks' default risk. Scholtens and van't Klooster (2019) investigate whether bank effort toward sustainability affects bank individual default risk. They find that banks that have higher sustainability scores experience lower default risk. Umar et al. (2021) examine the impact of green lending on the credit risk of 344 lending institutions from 19 Eurozone member states from 2011 to 2020. They find that green lending, or carbon-neutral lending, has a negative effect on loan loss provisions which is the measure of credit default risk in their study. The result suggests that

lending to carbon-neutral activities lead to a significant reduction in credit risk, implying that green lending contributes to achieving the SDGs.

Other studies examined the relationship between finance and different dimensions of sustainable development. For example, Ozili and Iorember (2023) argue that financial stability is beneficial for sustainable development because financial institutions operating in a stable financial system might be willing to support the realization of the SDGs. They analyze the effect of financial stability on sustainable development, and find that financial stability has a significant effect on the level of sustainable development, and the effect is negative in Asian countries. Wahab, Imran, Safi, Wahab, and Kirikkaleli (2022) analyze the influence of financial stability on consumption-based-carbon emission for BRICS countries from the period of 1995 to 2018, and finds that financial stability contributes to consumption-based carbon emissions.

Studies such as Li, Zhang, Feng, and Wang (2022) examine whether financial support in the form of digital finance improves sustainable development by mitigating environmental inequality. They find that digital finance has a significant positive effect on sustainable development by mitigating environmental inequality. Bhutta, Tariq, Farrukh, Raza, and Iqbal (2022) show that financing is an essential factor to support sustainable development and green bonds are one of the financial instruments to finance such tasks. Bhattacharyya (2022) shows that green finance not only prevents environmental degradation but also generate social benefits and adequate financial returns for investors. Wang, Zhao, Jiang, and Li (2022) argue that green finance is a vital financing tool for the sustainable development agenda. Xue, Feng, Chen, and Li (2022) explore the relationship between digital finance and carbon emissions using data from 278 cities in China from 2011 to 2019. They find that digital finance can mitigate regional carbon emissions.

Other studies focus on how financial development affects sustainable development. Zhou, Liu, and Luo (2022) analyze the relationship between ESG performance, financial performance, and find that the improvement of ESG performance of listed companies improve the market value of the company. Samour, Baskaya, and Tursoy (2022) explore the impact of financial development on renewable energy consumption in the UAE from 1989–2019. They find that financial development significantly increases renewable energy consumption in the UAE. Wu, Adebayo, Yue, and Umut (2023) analyze the heterogeneous impact of financial development on CO_2 emissions, and find that financial development decreases CO_2 emissions in the short and long term. Ahmed, Kousar, Pervaiz, and Shabbir (2022) analyze the role of institutional quality and financial development in green growth in the long-run in South Asian economies over the period 2000–2018. They find that institutional quality and financial development are significant factors promoting green economic growth in the long run. Abbasi, Hussain, Haddad, Salman, and Ozturk (2022) examine the impact of financial development on consumption and territory-based emissions from 1990Q1 to 2019Q4 in Pakistan. They find that financial development stimulates both consumption and territory-based emissions in the short and long run. Ozili (2023b) considers the possibility of a sustainable (or green) loan loss provisioning system that align bank loan loss provisioning with the SDGs. Ozili (2023b) argued that a sustainable (or green) loan loss provisioning system will align bank loan loss provisioning with the SDGs by adjusting loan loss provisions estimates to reflect the environmental benefits and costs of borrowers' business activities. While the above studies examined how sustainable development efforts by banks affect bank risk, none of these studies have examined how achieving the SDGs is correlated with bank NPLs.

2.2 Hypothesis development
Banks need the planet, and the planet need banks to help sustain it because banks have the financial resources that are needed to make significant progress in attaining high levels of

sustainable development (Ozili, 2021). Existing studies show that finance play a key role in achieving the SDGs because banks can provide loans to fund the realization of the SDGs (Ozili, 2021). Existing studies also show that achieving the SDGs has positive benefits for firms because it would give firms access to sustainable resources which they can use to conduct their business and improve their performance (e.g. Choudhury *et al.*, 2021; Ozili, 2023a). For instance, Choudhury *et al.* (2021) show that an increase in the share of renewable energy of a country significantly improves bank performance through a reduction in banks' default risk. However, banks' financing of SDG activities may have credit risk implications for banks depending on the riskiness of specific SDG activities. On one hand, banks may show their support for achieving the SDGs by extending loans to high-risk SDG-related activities. This will increase the risk of loan default, increase credit risk and lead to an increase in the size of NPLs. On the other hand, banks may focus on issuing loans to low-risk SDG-related activities and refuse to fund high-risk SDG-related activities. This will decrease the risk of loan default, decrease credit risk and lead to a decrease in the size of NPLs. These two arguments or hypotheses suggest that there may be a correlation between NPLs and achieving the SDGs through bank lending.

H1. There is a significant correlation between NPLs and the level of sustainable development.

3. Methodology

3.1 Data and sample

Country-level data were collected for 26 countries. The countries were selected based on the availability of data. Annual banking sector NPL ratio data were collected from the Global Financial Development Indicators (GFDI) of the World Bank. Annual sustainable development indicators data were also collected from the World Development Indicators (WDI) of the World Bank. The sample is an unbalanced panel data of 26 countries from 2011 to 2019. See Table 1 for variable description and source. The countries were grouped into regions as shown in Table 2. The countries included in the sample are reported in the footer of

Symbol	Variables	Definitions and measurement	Source
SDI	Composite Sustainable development index	The SDI variable is a composite sustainable development index (SDI) derived from the combination of the four SDG variables (SDG3, SDG4, SDG7 and SDG10) using the principal component analysis	Author
SDG3	SDG: Good health and well-being	The proxy measure of SDG3 is current health expenditure as a percentage of GDP	WGI
SDG4	SDG: Quality education	The proxy measure of SDG4 is current education expenditure as a percentage of total expenditure in public institutions	WGI
SDG7	SDG: Affordable and clean energy	The proxy measure of SDG7 is renewable energy consumption as a percentage of total final energy consumption	WGI
SDG10	SDG: Reduced inequalities	The proxy measure of SDG10 is the vulnerable employment ratio. It is measured as vulnerable employment as a percentage of total employment	WGI
NPL	NPL ratio	The non-performing loans (NPL) ratio is the ratio of bank non-performing loans to total gross loans. It is a measure of bank credit risk and an important measure of banking sector stability	GFDI

Table 1.
Variables description and source

Source(s): *Credit*: World Bank database

Full sample	NPL (%)	SDI (%)	SDG3 (%)	SDG4 (%)	SDG7 (%)	SDG10 (%)
Mean	4.51	−0.19	6.03	92.06	29.63	40.21
Median	2.71	−0.02	4.96	92.66	23.34	42.52
Observations	205	208	208	92	208	208
African countries subsample						
Mean	9.62	1.59	4.29	93.12	61.81	64.48
Median	9.80	1.89	4.09	94.21	77.37	72.49
Observations	45	48	48	10	48	48
European countries subsample						
Mean	3.96	−1.231	8.26	92.31	11.51	20.88
Median	3.06	−1.52	8.92	91.75	5.86	12.68
Observations	32	32	32	22	32	32
Asian countries subsample						
Mean	3.36	−0.025	4.83	90.27	21.88	38.60
Median	2.13	0.18	4.17	90.66	22.71	45.66
Observations	104	104	104	44	104	104
Region of Americas subsample						
Mean	2.42	−1.39	10.09	94.79	18.10	19.78
Median	2.27	−1.05	9.44	95.70	9.49	23.75
Observations	32	32	32	23	32	32

Note(s): The countries in the full sample are: Cameroun, Egypt, Ghana, Kenya, Nigeria, Tanzania, Georgia, Netherlands, Russian Federation, the United Kingdom, Cambodia, China, India, Indonesia, Japan, South Korea, Malaysia, Pakistan, Philippines, Singapore, Thailand, Vietnam, Argentina, Brazil, Mexico and the United States. The African countries in the sub-sample are: Cameroun, Egypt, Ghana, Kenya, Nigeria and Tanzania. The European countries in the sub-sample are: Georgia, Netherlands, Russian Federation and the United Kingdom. The Asian countries in the sub-sample are: Cambodia, China, India, Indonesia, Japan, South Korea, Malaysia, Pakistan, Philippines, Russian Federation, Singapore, Thailand and Vietnam. The countries in the region of the Americas sub-sample are: Argentina, Brazil, Mexico and the United States
Source(s): *Credit*: Author computation

Table 2.
Summary of
descriptive statistics

Table 2. Table 2 presents the summary of the descriptive statistics. The mean of the full sample NPL ratio is 4.52%. The mean or average NPL ratio is higher in African countries at 9.63% and is much lower in the region of the Americas at 2.52%. This suggests that African banking sectors are more fragile due to their high NPL ratio. The mean of the full sample sustainable development index (SDI) variable is −0.20%. The average SDI variable is higher in African countries at 1.60% and is much lower in the region of the Americas at −1.49%.

3.2 Method of analysis and model

The statistical technique used to measure the correlation between the sustainable development indicators and the NPLs ratio is the Pearson correlation test statistic. The Pearson correlation test statistic is widely used to measure the strength of the correlation between two variables (Gujarati & Porter, 1999; Piaw, 2013). In this study, the Pearson correlation test statistic is used to measure the strength of the linear correlation between the variables and their correlation with each other. The Pearson correlation coefficient yields a positive or negative correlation between two variables, and the correlation coefficient ranges between −1 and +1 (Gujarati & Porter, 1999).

3.3 Variable justification

The NPL ratio is widely used as an important measure of credit risk and bank stability (such as Lepetit & Strobel, 2015; Ozili, 2019, 2022). Lower values of the NPL ratio indicates greater

banking sector stability or low bank risk, while higher values of the NPL ratio indicates greater banking sector fragility or high bank risk.

Four SDGs out of the 17 SDGs were selected which are SDG3, SDG4, SDG7 and SDG10. The reason for selecting the four SDG variables is because existing studies have identified meaningful economic indicators that can be used to measure SDG3, SDG4, SDG7 and SDG10 and the selected SDG variables are influenced by the size of bank lending to support the realization of the SDGs which in turn can affect the size of bank NPLs. However, the effect on bank NPLs will depend on the banking sector's credit exposure to specific SDG-related activities. Another reason for selecting the four SDGs is because proxy variables for the four SDGs are available and there is sufficient data for each of the four SDG proxy variables.

Regarding SDG3 "good health and well-being", Brollo, Hanedar, and Walker (2021) show that increase in healthcare expenditure can improve people's health and well-being. The study linked healthcare expenditures to GDP and argue that greater healthcare expenditures relative to GDP improves the level of sustainable development. Banks can show their support for SDG3 activities by extending loans for SDG3-related healthcare expenditures. Such lending can increase credit risk if lending to SDG3-related expenditure is risky. It can lead to loan defaults and rising non-performing loans depending on the extent of banks' credit exposure to SDG3-related activities.

Regarding SDG4 "quality education", Vorisek and Yu (2020) show that higher education spending is a necessary SDG-related expenditure for greater sustainable development. Their study suggests that higher education spending is associated with improvement in sustainable development outcomes. Banks can show their support for SDG4 activities by providing loans for SDG4-related education expenditures. Such lending can increase credit risk if lending to SDG4-related expenditure is risky. It can lead to loan defaults and rising non-performing loans depending on the extent of banks' credit exposure to SDG4-related activities.

Regarding SDG7 "clean and affordable energy", existing studies such as Shahbaz, Raghutla, Chittedi, Jiao, and Vo (2020) show that clean energy such as renewable energy does not pollute the environment, thereby promoting sustainable development. Banks can show their support for SDG7 activities by providing loans for SDG7-related clean energy expenditures. Such lending can increase credit risk if lending to SDG7-related expenditure is risky. It can lead to loan defaults and rising NPLs depending on the extent of banks' credit exposure to SDG7-related activities.

Regarding SDG10 "reduced inequalities", existing studies such as De Paz, Muller, Munoz Boudet, and Gaddis (2020) show that efforts to reduce inequality will give vulnerable people equal opportunities in society especially with regard to employment. Banks can show their support for SDG10 activities by providing loans for SDG10-related inequality reduction programs. Such lending can increase credit risk if lending to SDG10-related expenditure is risky. It can lead to loan defaults and rising NPLs depending on the extent of banks' credit exposure to SDG10-related activities.

Regarding the SDI variable, SDI represents the SDI. The SDI variable is a composite SDI which is derived from the combination of the four SDG variables (i.e. SDG3, SDG4, SDG7 and SDG10) using the principal component analysis.

4. Empirical results
4.1 Pearson correlation results: full sample analysis
The full sample Pearson correlation result is reported in Table 3. Only the significant correlation coefficient results are interpreted.

Regarding the SDI, the correlation result in Table 3 shows that the NPL ratio is significant and positively correlated with the SDI variable. This indicates that achieving higher levels of the SDI is correlated with higher NPLs in the banking sector. This implies that achieving high levels of sustainable development is significantly associated with higher NPLs in the banking

Variables	NPL	SDI	SDG3	SDG4	SDG7	SDG10
NPL	*1.000*					
	–					
SDI	*0.422****	1.000				
	((0.00))	–				
SDG3	*−0.311****	−0.654***	1.000			
	((0.00))	((0.00))	–			
SDG4	*−0.091*	0.011	0.087	1.000		
	((0.38))	((0.91))	((0.41))	–		
SDG7	*0.375****	0.851***	−0.211**	0.130	1.000	
	((0.00))	((0.00))	((0.04))	((0.21))	–	
SDG10	*0.361****	0.955***	−0.505***	−0.030	0.821***	1.000
	((0.00))	((0.00))	((0.00))	((0.77))	((0.00))	–

Note(s): *T*-statistics are reported in single parenthesis. *p*-values are reported in double parenthesis. *** and ** denote statistical significance at the 1% and 5% levels
Source(s): *Credit*: Author computation

Table 3.
Full sample correlation of sustainable development and non-performing loans

sector. A possible explanation for the significant positive correlation could be that banks extend loans to high-risk SDG-related activities to signal their commitment to the SDGs but such effort leads to rising NPLs. This result does not support the findings of Choudhury *et al.* (2021) who show that banks' involvement in more SDG-related activities reduce bank risk.

Regarding the individual sustainable development indicators, the correlation result in Table 3 also shows that the NPL ratio is not significantly correlated with SDG4 in the full sample. The NPL ratio is significant and negatively correlated with the SDG3 variable. This indicates that achieving higher levels of good health and wellbeing is significantly correlated with fewer NPLs in the banking sector. This implies that achieving the SDG of good health and wellbeing is significantly associated with fewer NPLs in the banking sector. A possible explanation for the significant negative correlation could be that banks extend loans only to low-risk SDG3-related activities which helps to reduce the size of NPLs. The result supports the findings of Umar *et al.* (2021) who show that bank lending to finance SDG-related activities lead to credit risk reduction. The NPL ratio is significant and positively correlated with the SDG7 variable. This indicates that achieving higher levels of affordable and clean energy is significantly correlated with higher NPLs in the banking sector. This implies that achieving the SDG of affordable and clean energy is significantly associated with higher NPLs in the banking sector. A possible explanation for the significant positive correlation could be that banks extend loans to high-risk SDG7-related activities to signal their commitment to the SDGs but such effort leads to rising NPLs. This result does not support the findings of Choudhury *et al.* (2021) who show that banks' involvement in more SDG-related activities reduce bank risk. The NPL ratio is significant and positively correlated with the SDG10 variable. This indicates that achieving higher levels of reduced inequalities is significantly correlated with higher NPLs in the banking sector. This implies that achieving the SDG of reduced inequalities is significantly associated with higher NPLs in the banking sector. A possible explanation for the significant positive correlation could be that banks extend loans to high-risk SDG10-related activities to signal their commitment to the SDGs but such effort leads to rising NPLs. This result does not support the findings of Choudhury *et al.* (2021) who show that banks' involvement in more SDG-related activities reduce bank risk.

Variables	NPL	SDI	SDG3	SDG4	SDG7	SDG10
NPL	1.000					
	–					
SDI	0.300	1.000				
	((0.39))	–				
SDG3	−0.921***	−0.550*	1.000			
	((0.00))	((0.09))	–			
SDG4	−0.232	−0.678**	0.548*	1.000		
	((0.52))	((0.03))	((0.10))	–		
SDG7	−0.708**	0.443	0.463	−0.227	1.000	
	((0.02))	((0.19))	((0.17))	((0.52))	–	
SDG10	0.907***	0.611*	−0.915***	−0.422	−0.427	1.000
	((0.00))	((0.06))	((0.00))	((0.22))	((0.21))	–

Note(s): *p*-values are reported in double parenthesis. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels
Source(s): *Credit*: Author computation

Table 4.
African subsample correlation: correlation of sustainable development and non-performing loans in African countries

4.2 Regional correlation analysis
4.2.1 Pearson correlation results: African countries subsample analysis. The full sample Pearson correlation result for the African countries in the sample is reported in Table 4. Only the significant correlation coefficient results are interpreted.

Regarding the SDI, the correlation result in Table 4 shows that the NPL ratio is not significant although positively correlated with the SDI variable in the African countries sub-sample.

Regarding the individual sustainable development indicators, the correlation result in Table 4 also shows that the NPL ratio is significant and negatively correlated with the SDG3 variable in the African countries sub-sample. This indicates that achieving higher levels of good health and wellbeing is significantly correlated with fewer NPLs in the banking sector of African countries. This implies that achieving the SDG of good health and wellbeing is significantly associated with fewer NPLs in the banking sector of African countries. A possible explanation for the significant negative correlation could be that African banks extend loans only to low-risk SDG3-related activities which helps to reduce the size of NPLs among African banks. This result supports the findings of Choudhury *et al.* (2021) who show that banks' involvement in more SDG-related activities reduce bank risk. The NPL ratio is not significant although negatively correlated with the SDG4 variable in the African countries sub-sample. The NPL ratio is significant and negatively correlated with the SDG7 variable in the African countries sub-sample. This indicates that achieving higher levels of affordable and clean energy is significantly correlated with fewer NPLs in the banking sector of African countries. This implies that achieving the SDG of affordable and clean energy is significantly associated with fewer NPLs in the banking sector of African countries. A possible explanation for the significant negative correlation could be that African banks extend loans only to low-risk SDG7-related activities which helps to reduce the size of NPLs among African banks. This result supports the findings of Choudhury *et al.* (2021) who show that banks' involvement in more SDG-related activities reduce bank risk. The NPL ratio is significant and positively correlated with the SDG10 variable in the African countries sub-sample. This indicates that achieving higher levels of reduced inequalities is significantly correlated with higher NPLs in the banking sector of African countries. This implies that achieving the SDG of reduced inequalities is significantly associated with higher NPLs in the banking sector of African countries. A possible explanation for the significant positive correlation could be that

African banks extend loans to high-risk SDG10-related activities to signal their commitment to the SDGs but such effort leads to rising NPLs. This result does not support the findings of Choudhury *et al.* (2021) who show that banks' involvement in more SDG-related activities reduce bank risk.

4.2.2 Pearson correlation results: European countries subsample analysis. The full sample Pearson correlation result for the European countries in the sample is reported in Table 5. Only the significant correlation coefficient results are interpreted.

Regarding the SDI, the correlation result in Table 5 shows that the NPL ratio is significant and positively correlated with the SDI variable in the European countries sub-sample. This indicates that achieving higher levels of the SDI are correlated with higher NPLs in the banking sector of European countries. This implies that achieving high levels of sustainable development is significantly associated with higher NPLs in the banking sector of European countries. A possible explanation for the significant positive correlation could be that European banks extend loans to high-risk SDG-related activities to signal their commitment to the SDGs but such effort leads to rising NPLs. This result does not support the findings of Choudhury *et al.* (2021) who show that banks' involvement in more SDG-related activities reduce bank risk.

Regarding the individual sustainable development indicators, the correlation result in Table 5 also shows that the NPL ratio is significant and negatively correlated with the SDG3 variable in the European countries sub-sample. This indicates that achieving higher levels of good health and wellbeing are significantly correlated with fewer NPLs in the banking sector of European countries. This implies that achieving the SDG of good health and wellbeing is significantly associated with fewer NPLs in the banking sector of European countries. A possible explanation for the significant negative correlation could be that European banks extend loans only to low-risk SDG3-related activities which helps to reduce the size of NPLs among European banks. This result supports the findings of Choudhury *et al.* (2021) who show that banks' involvement in more SDG-related activities reduce bank risk. The NPL ratio is not significant although negatively correlated with the SDG4 variable in the European countries sub-sample. The NPL ratio is significant and negatively correlated with the SDG7 variable in the European countries sub-sample. This indicates that achieving higher levels of affordable and clean energy is significantly correlated with fewer NPLs in the banking sector of European countries. This implies that achieving the SDG of affordable and clean energy is significantly associated with fewer NPLs in the banking sector of European countries.

Variables	NPL	SDI	SDG3	SDG4	SDG7	SDG10
NPL	*1.000*					
	–					
SDI	*0.789****	1.000				
	((0.00))	–				
SDG3	*−0.879****	*−0.978****	1.000			
	((0.00))	((0.00))	–			
SDG4	*−0.178*	0.172	−0.020	1.000		
	((0.42))	((0.44))	((0.92))	–		
SDG7	*−0.821****	*−0.491***	0.659***	0.543***	1.000	
	((0.00))	((0.02))	((0.00))	((0.00))	–	
SDG10	*−0.931****	*−0.917****	0.977***	0.108	0.770***	1.000
	((0.00))	((0.00))	((0.00))	((0.63))	((0.00))	–

Note(s): *p*-values are reported in double parenthesis. *** and ** denote statistical significance at the 1% and 5% levels
Source(s): *Credit*: Author computation

Table 5.
European countries subsample correlation: correlation of sustainable development and non-performing loans in European countries

A possible explanation for the significant negative correlation could be that European banks extend loans only to low-risk SDG7-related activities which helps to reduce the size of NPLs among European banks. This result supports the findings of Choudhury *et al*. (2021) who show that banks' involvement in more SDG-related activities reduce bank risk. The NPL ratio is significant and negatively correlated with the SDG10 variable in the European countries sub-sample. This indicates that achieving higher levels of reduced inequalities are significantly correlated with fewer NPLs in the banking sector of European countries. This implies that achieving the SDG of reduced inequalities is significantly associated with fewer NPLs in the banking sector of European countries. A possible explanation for the significant negative correlation could be that European banks extend loans only to low-risk SDG10-related activities which helps to reduce the size of NPLs among European banks. This result supports the findings of Choudhury *et al*. (2021) who show that banks' involvement in more SDG-related activities reduce bank risk.

4.2.3 Pearson correlation results: Asian countries subsample analysis. The full sample Pearson correlation result for the Asian countries in the sample is reported in Table 6. Only the significant correlation coefficient results are interpreted. Regarding the SDI, the correlation result in Table 6 shows that the NPL ratio is not significant although negatively correlated with the SDI variable in the Asian countries sub-sample. Regarding the individual sustainable development indicators, the correlation result in Table 6 shows that the NPL ratio is not significant although negatively correlated with the SDG3 variable in the Asian countries sub-sample. Similarly, the NPL ratio is not significant although negatively correlated with the SDG4 variable in the Asian countries sub-sample. Also, the NPL ratio is not significant although negatively correlated with the SDG7 variable in the Asian countries sub-sample. The NPL ratio is also not significant although negatively correlated with the SDG10 variable in the Asian countries sub-sample.

4.2.4 Pearson correlation results: countries in the region of the Americas subsample analysis. The full sample Pearson correlation result for the countries in the region of the Americas in the sample is reported in Table 7. Only the significant correlation coefficient results are interpreted.

Regarding the SDI, the correlation result in Table 7 shows that the NPL ratio is significant and positively correlated with the SDI variable in the countries in the region of the Americas sub-sample. This indicates that achieving higher levels of the SDI is correlated with higher NPLs in the banking sector of countries in the region of the Americas. This implies that

Variables	NPL	SDI	SDG3	SDG4	SDG7	SDG10
NPL	*1.000*					
	–					
SDI	*−0.019*	1.000				
	((0.89))	–				
SDG3	*−0.151*	−0.538***	1.000			
	((0.32))	((0.00))	–			
SDG4	*−0.134*	0.019	−0.010	1.000		
	((0.38))	((0.89))	((0.95))	–		
SDG7	*−0.014*	0.843***	−0.045	0.116	1.000	
	((0.92))	((0.00))	((0.77))	((0.45))	–	
SDG10	*−0.135*	0.959***	−0.333**	−0.057	0.873***	1.000
	((0.38))	((0.00))	((0.03))	((0.71))	((0.00))	–

Note(s): *p*-values are reported in double parenthesis. *** and ** denote statistical significance at the 1% and 5% levels

Source(s): *Credit*: Author computation

Table 6.
Asian countries subsample: correlation of sustainable development and non-performing loans in Asian countries

Variables	NPL	SDI	SDG3	SDG4	SDG7	SDG10
NPL	*1.000*					
	–					
SDI	*0.713****	1.000				
	((0.00))	–				
SDG3	*−0.021*	−0.511**	1.000			
	((0.92))	((0.01))	–			
SDG4	*0.361**	0.465**	−0.494**	1.000		
	((0.09))	((0.02))	((0.02))	–		
SDG7	*0.759****	0.673***	0.288	0.076	1.000	
	((0.00))	((0.00))	((0.18))	((0.72))	–	
SDG10	*0.591****	0.903***	−0.705***	0.583***	0.374*	1.000
	((0.00))	((0.00))	((0.00))	((0.00))	((0.07))	–

Note(s): p-values are reported in double parenthesis. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels
Source(s): *Credit*: Author computation

achieving high levels of sustainable development is significantly associated with higher NPLs in the banking sector of countries in the region of the Americas. A possible explanation for the significant positive correlation could be that banks in the Americas extend loans to high-risk SDG-related activities to signal their commitment to the SDGs but such effort leads to rising NPLs. This result does not support the findings of Choudhury *et al.* (2021) who show that banks' involvement in more SDG-related activities reduce bank risk. The result also does not support the findings of Umar *et al.* (2021) who show that bank lending to finance SDG-related activities lead to credit risk reduction.

Regarding the individual sustainable development indicators, the correlation result in Table 7 also shows that the NPL ratio is not significant although negatively correlated with the SDG3 variable in the countries in the region of the Americas sub-sample. The NPL ratio is significant and positively correlated with the SDG4 variable in the countries in the region of the Americas sub-sample. This indicates that achieving higher levels of quality education is significantly correlated with higher NPLs in the banking sector of countries in the region of the Americas. This implies that achieving the SDG of quality education is significantly associated with higher NPLs in the banking sector of countries in the region of the Americas. A possible explanation for the significant positive correlation could be that banks in the Americas extend loans to high-risk SDG4-related activities to signal their commitment to the SDGs but such effort leads to rising NPLs. This result does not support the findings of Choudhury *et al.* (2021) who show that banks' involvement in more SDG-related activities reduce bank risk. The result also does not support the findings of Umar *et al.* (2021) who show that bank lending to finance SDG-related activities lead to credit risk reduction. The NPL ratio is significant and positively correlated with the SDG7 variable in the countries in the region of the Americas sub-sample. This indicates that achieving higher levels of affordable and clean energy is significantly correlated with higher NPLs in the banking sector of countries in the region of the Americas. This implies that achieving the SDG of affordable and clean energy is significantly associated with higher NPLs in the banking sector of countries in the region of the Americas. A possible explanation for the significant positive correlation could be that banks in the Americas extend loans to high-risk SDG7-related activities to signal their commitment to the SDGs but such effort leads to rising NPLs. This result does not support the findings of Choudhury *et al.* (2021) who show that banks' involvement in more SDG-related activities reduce bank risk. The result also does not support the findings of Umar *et al.* (2021) who show that bank lending to finance SDG-related activities lead to credit risk

reduction. The NPL ratio is significant and positively correlated with the SDG10 variable in the countries in the region of the Americas sub-sample. This indicates that achieving higher levels of reduced inequalities is significantly correlated with higher NPLs in the banking sector of countries in the region of the Americas. This implies that achieving the SDG of reduced inequalities is significantly associated with higher NPLs in the banking sector of countries in the region of the Americas. A possible explanation for the significant positive correlation could be that banks in the Americas extend loans to high-risk SDG10-related activities to signal their commitment to the SDGs but such effort leads to rising NPLs. This result does not support the findings of Choudhury *et al.* (2021) who show that banks' involvement in more SDG-related activities reduce bank risk. The result also does not support the findings of Umar *et al.* (2021) who show that bank lending to finance SDG-related activities lead to credit risk reduction.

4.3 Some diagnostic tests
Some correlation diagnostic tests were conducted on the full sample correlation results to verify the initial results.

4.3.1 Kendall's tau correlation test. First, I run a diagnostic test using the Kendall's tau-b correlation coefficient analysis. This test is a nonparametric measure of the strength of the dependence between two variables measured on at least an ordinal scale. This test addresses situations when the data violates one or more of the assumptions underlying the Pearson correlation test. The Kendall's tau-b correlation result is reported in Table 8 below. The result shows that the NPL and SDI coefficient are positively significant which confirm the earlier result in Table 3, thereby indicating that bank NPLs and sustainable development are positively correlated. Also, the results for the correlation of the NPL variable with the SDG3, SDG4 SDG7 and SDG10 variables in Table 8 remain robust with the earlier result in Table 3.

4.3.2 Covariance test. Next, I run a covariance test as an alternative to the correlation test. The covariance test measures the direction of the relationship between two variables. The covariance result is reported in Table 9 below. The covariance result shows that the NPL variable and SDI variable move significantly in the same direction which confirm the

tau-b	NPL	SDI	SDG3	SDG4	SER07	SER10
NPL	1.000					
SDI	0.257	1.000				
SDG3	−0.108	−0.519	1.000			
SDG4	−0.023	0.156	0.045	1.000		
SER07	−0.302	−0.379	0.188	−0.089	1.000	
SER10	−0.053	0.493	−0.537	−0.080	−0.115	1.000
Source(s): *Credit*: Author computation						

Table 8.
Kendall's tau-b correlation analysis, Correlation of sustainable development and non-performing loans

Covariance	NPL	SDI	SDG3	SDG4	SER07	SER10
NPL	8.614					
SDI	1.527	1.514				
SDG3	−2.533	−2.217	7.640			
SDG4	−1.299	0.122	1.018	23.601		
SER07	−68.51	−32.062	44.487	−40.495	2519.06	
SER10	0.073	0.364	−0.852	−0.384	−3.109	0.227
Source(s): *Credit*: Author computation						

Table 9.
Correlation test correlation analysis, Correlation of sustainable development and non-performing loans

correlation result in Tables 3 and 8, thereby indicating that bank NPLs and sustainable development are positively correlated or related. Also, the results for the covariance of the NPL variable with the SDG3, SDG4 SDG7 and SDG10 variables in Table 9 remain robust with the earlier correlation result in Tables 3 and 8

5. Conclusion
This paper analyzed the correlation between sustainable development and banking sector NPL. Pearson correlation statistic was used to test the correlation between the sustainable development indicators and the NPL ratio.

The findings showed that there is a significant positive correlation between banking sector NPL ratio and the level of sustainable development measured by the SDI. This implies that achieving high levels of sustainable development is significantly associated with higher NPLs in the banking sector. The significant positive correlation is more evident in European countries and in countries in the region of the Americas. There is a significant negative correlation between banking sector NPLs and achieving SDG3 "good health and wellbeing", and the significant negative correlation is more evident in African countries and European countries. There is a significant positive correlation between banking sector NPLs and achieving SDG4 "quality education" in countries in the region of the Americas. The correlation between NPLs and achieving SDG7 "affordable and clean energy" is positive and significant in countries in the region of the Americas, and negative and significant in African countries and European countries. The correlation between NPLs and achieving SDG10 "reduced inequalities" is positive and significant in African countries and in countries in the region of the Americas, and negative and significant in European countries.

The practical implication of the observed significant positive correlation between sustainable development and banking sector NPLs is that achieving the SDGs may harm banking sector stability through higher bank risk in the form of higher NPLs. This calls for careful surveillance of banks' lending to sustainable development activities by bank regulators and supervisors. It is recommended that bank regulators and supervisors should monitor banks' lending to SDG-related activities to ensure that banks are not extending loans for high-risk SDG-related activities that will eventually become bad loans. Bank supervisors should identify specific low-risk SDG activities that banks can support through loans in order to minimize banks' credit risk exposure to SDG-related activities and to safeguard and preserve banking sector stability. Also, there may be a need to make changes in loan recovery regulations and laws to ensure that all loans extended for SDG-related activities are repaid to mitigate NPLs and preserve banking sector stability.

Meanwhile, the practical implication of the observed significant negative correlation between sustainable development and banking sector NPLs is that achieving the SDGs may improve bank loan performance which could manifest in the form of low NPLs. This will require banks to increase their support for the SDGs in order to lead a better planet that is good for everyone including banks.

A potential weakness of the study is its perceived advocacy for the banking industry. While the study has focused on how bank support for the SDGs might affect the size of NPL, it is important to emphasize that the findings should not be interpreted to mean that the goal of saving this planet, which is the reason for SDGs, is exogenous to banking/financial institutions. It also does not mean that the banks/financial institutions should not own the SDGs. After all, if there is no habitable planet, then there will not be any problem to solve including NPL. Rather, it is possible for banks to own the SDGs and witness an improvement in loan performance. Banks will need to strengthen their risk management and ensure that their involvement in SDG activities would improve, instead of worsen, the NPLs of the banks involved SDG activities.

The study also has other limitations. One, the sample period used in the study is limited to a few years. Two, the sample size is limited to 26 countries due to missing observations for many countries. Three, the study focused on four out of the 17 SDGs. This was largely due to data unavailability problems as other SDGs did not have sufficient data that could be used for the analysis. These limitations offer some fruitful areas for future research.

Future studies can re-examine the correlation between sustainable development and banking sector NPLs in other regional contexts such as in the MENA region and the ASEAN region. Second, it will be interesting to investigate the cause-and-effect relationship between sustainable development and banking sector NPLs using regression analysis and taking into account any potential endogeneity problems that may arise from such analysis. Finally, future studies can re-examine the correlation between sustainable development and banking sector NPLs by using a larger sample size and a longer sample period.

Reference

Abbasi, K. R., Hussain, K., Haddad, A. M., Salman, A., & Ozturk, I. (2022). The role of financial development and technological innovation towards sustainable development in Pakistan: Fresh insights from consumption and territory-based emissions. *Technological Forecasting and Social Change*, *176*, 121444.

Ahmed, F., Kousar, S., Pervaiz, A., & Shabbir, A. (2022). Do institutional quality and financial development affect sustainable economic growth? Evidence from South Asian countries. *Borsa Istanbul Review*, *22*(1), 189–196.

Bhattacharyya, R. (2022). Green finance for energy transition, climate action and sustainable development: Overview of concepts, applications, implementation and challenges. *Green Finance*, *4*(1), 1–35.

Bhutta, U. S., Tariq, A., Farrukh, M., Raza, A., & Iqbal, M. K. (2022). Green bonds for sustainable development: Review of literature on development and impact of green bonds. *Technological Forecasting and Social Change*, *175*, 121378.

Brollo, F., Hanedar, E., & Walker, M. S. (2021). *Pakistan: Spending needs for reaching sustainable development goals (SDGs)*. Washington DC: International Monetary Fund.

Choudhury, T., Kamran, M., Djajadikerta, H. G., & Sarker, T. (2021). Can banks sustain the growth in renewable energy supply? An international evidence. *The European Journal of Development Research*, *35*, 20–50.

De Paz, C., Muller, M., Munoz Boudet, A. M., & Gaddis, I. (2020). *Gender dimensions of the COVID-19 pandemic*. Washington DC: World Bank Publications.

Gambetta, N., Azcárate-Llanes, F., Sierra-García, L., & García-Benau, M. A. (2021). Financial institutions' risk profile and contribution to the sustainable development goals. *Sustainability*, *13*(14), 7738.

Gangi, F., Meles, A., D'Angelo, E., & Daniele, L. M. (2019). Sustainable development and corporate governance in the financial system: Are environmentally friendly banks less risky?. *Corporate Social Responsibility and Environmental Management*, *26*(3), 529–547.

Gujarati, D. N., & Porter, D. C. (1999). *Essentials of econometrics*, (*2*). Singapore: Irwin/McGraw-Hill.

Lepetit, L., & Strobel, F. (2015). Bank insolvency risk and Z-score measures: A refinement. *Finance Research Letters*, *13*, 214–224.

Li, G., Zhang, R., Feng, S., & Wang, Y. (2022). Digital finance and sustainable development: Evidence from environmental inequality in China. *Business Strategy and the Environment*, *31*(7), 3574–3594.

Naqvi, B., Mirza, N., Rizvi, S. K. A., Porada-Rochoń, M., & Itani, R. (2021). Is there a green fund premium? Evidence from twenty-seven emerging markets. *Global Finance Journal*, *50*, 100656.

Ozili, P. K. (2019). Non-performing loans and financial development: New evidence. *Journal of Risk Finance*, *20*(1), 59–81.

Ozili, P. K. (2021). Circular economy, banks, and other financial institutions: what's in it for them?. *Circular Economy and Sustainability*, *1*(3), 787–798.

Ozili, P. K. (2022). Economic policy uncertainty, bank nonperforming loans and loan loss provisions: Are they correlated?. *Asian Journal of Economics and Banking*, *6*(2), 221–235.

Ozili, P. K. (2023a). Financial inclusion and environmental sustainability. In *Digital Economy, Energy and Sustainability: Opportunities and Challenges* (pp. 25–39). Cham: Springer International Publishing.

Ozili, P. K. (2023b). Bank loan loss provisioning for sustainable development: The case for a sustainable or green loan loss provisioning system. *Journal of Sustainable Finance and Investment*, 1–13.

Ozili, P. K., & Iorember, P. T. (2023). Financial stability and sustainable development. *International Journal of Finance and Economics*.

Piaw, C. Y. (2013). *Mastering research statistics*. Malaysia, New York: McGraw Hill Education.

Sachs, J. D., Woo, W. T., Yoshino, N., & Taghizadeh-Hesary, F. (2019). Importance of green finance for achieving sustainable development goals and energy security. In *Handbook of Green Finance* (pp. 3–12). Singapore: Springer.

Samour, A., Baskaya, M., & Tursoy, T. (2022). The impact of financial development and FDI on renewable energy in the UAE: A path towards sustainable development. *Sustainability*, *14*(3), 1208.

Scholtens, B., & van't Klooster, S. (2019). Sustainability and bank risk. *Palgrave Communications*, *5*(1), 1–8.

Shahbaz, M., Raghutla, C., Chittedi, K. R., Jiao, Z., & Vo, X. V. (2020). The effect of renewable energy consumption on economic growth: Evidence from the renewable energy country attractive index. *Energy*, *207*, 118162.

Umar, M., Ji, X., Mirza, N., & Naqvi, B. (2021). Carbon neutrality, bank lending, and credit risk: Evidence from the Eurozone. *Journal of Environmental Management*, *296*, 113156.

Vorisek, D. L., & Yu, S. (2020). Understanding the cost of achieving the sustainable development goals. *World Bank Policy Research* Working Paper No. 9164.

Wahab, S., Imran, M., Safi, A., Wahab, Z., & Kirikkaleli, D. (2022). Role of financial stability, technological innovation, and renewable energy in achieving sustainable development goals in BRICS countries. *Environmental Science and Pollution Research*, *29*(32), 48827–48838.

Wang, K. H., Zhao, Y. X., Jiang, C. F., & Li, Z. Z. (2022). Does green finance inspire sustainable development? Evidence from a global perspective. *Economic Analysis and Policy*, *75*, 412–426.

Wu, L., Adebayo, T. S., Yue, X. G., & Umut, A. (2023). The role of renewable energy consumption and financial development in environmental sustainability: Implications for the Nordic countries. *International Journal of Sustainable Development and World Ecology*, *30*(1), 21–36.

Xue, Q., Feng, S., Chen, K., & Li, M. (2022). Impact of digital finance on regional carbon emissions: An empirical study of sustainable development in China. *Sustainability*, *14*(14), 8340.

Zhou, G., Liu, L., & Luo, S. (2022). Sustainable development, ESG performance and company market value: Mediating effect of financial performance. *Business Strategy and the Environment*, *31*(7), 3371–3387.

Corresponding author
Peterson K. Ozili can be contacted at: petersonkitakogelu@yahoo.com