GLOBAL RESEARCH TRENDS OF NON-PERFORMING LOANS: A BIBLIOMETRIC ANALYSIS

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ABSTRACT

Non-performing loans (NPLs) remain a significant challenge in financial sectors worldwide. This study aims to explore the scholarly landscape of NPL research from a global perspective between 1970 and 2024 based on publication records retrieved from the Web of Science Core Collection (WoSCC). Using descriptive and bibliometric analyses, this study explores key publication trends, the most productive countries and authors, top-cited articles, and research clusters within NPLs research. The results suggest that the number of publications and citations has risen significantly over the years with the highest number of publications recorded in 2022. The USA dominates the ranking with the highest number of articles published, followed by China, England, Italy, and India. Moreover, the findings from the co-occurrence analysis reveal that previous studies mainly focused on the impacts of macroeconomic and bank-specific determinants on NPLs, with special attention given to the period of financial crisis, credit risk, commercial banks and Islamic banks. Similarly, bank efficiency, stability, and performance are of great interest to researchers and data envelop analysis is employed to obtain efficiency estimates. Lastly, previous studies do not differentiate the NPLs at disaggregated levels. Future researchers can fill this gap by focusing on NPLs at sector or purpose levels. The impacts on NPLs are quantitatively diverse across sectors and purposes.

1.0 INTRODUCTION

Financial institutions either conventional or Islamic banks, play a critical role in ensuring the country's macroeconomic stability in all economic sectors. Generally, financial institutions are one of the catalysts for economic development as they act as a mediator by channelling funds between surplus units and deficit units (Mohd Isa et al., 2018). One of the key sources of income for financial firms is loan creation; yet, this activity exposes the institutions to credit risk. The Basel Committee on Banking Supervision defines credit risk as the potential loss of the outstanding loan, either partially or whole, as a result of credit events (Young, 2011). Financial institutions are more likely to experience financial crises as their vulnerability to credit risk increases, and vice versa. Like any other business, banks prioritize competitive strategies, efficiency levels, and risk assessment to increase their revenues (Shafai et al., 2022). However, when debtors fail to make payments, financial institutions often experience high

levels of impaired credit. Non-performing loans (NPLs) are especially important indicators of credit risk because higher credit risk increases the likelihood of default (Akhter, 2023).

This credit risk will lead to a rising amount of the where the borrowers are unable to make their repayment within the given period. NPLs, or bad debt, are the percentage of loan values that are not serviced for three months or more (Ahmad & Ariff, 2008). According to Erdas and Ezanoglu (2022), loans that are not able to be collected when they are due and for which legal proceedings are initiated at the end of the legal process are classified as NPLs.According to statistics from the World Data Bank (2023), Ukraine had the highest non-performing loan (NPL) rate in the world at 31.72% in 2021, while Korea had the lowest rate at 0.23%. The COVID-19 epidemic and related diseases have put a strain on many corporate borrowers (Surin, 2022).

The decline in the quality of banks' loan portfolios was the primary cause of problems in the banking system and financial crises in industrialized economies. High levels of NPLs can hinder the credit flow to businesses and households, which can in turn constrain economic growth. Indeed, the increase in loan defaults highlights the link between macroeconomic and financial shocks. For instance, Goldstein and Turner (1996) discovered that Spain lost 17% of its GDP because of the country's banking crisis, which occurred between 1977 and 1985. This is because NPLs are likely to limit economic growth and undermine economic efficiency (Hou, 2007). Previous studies by Hernando et al. (2020) and Prasetyo (2020) further support this, finding a negative and significant relationship between economic growth and the NPL ratio.

Studying NPLs allows us to better understand their influence on economic activity and employment, as well as develop policies to mitigate those effects. It also can signal weaknesses in the banking system, thereby threatening financial stability. Moreover, understanding the causes of NPLs allows policymakers, regulators, and financial institutions to develop strategies to address them and prevent systemic risks. Although there has been an increased interest in studying the causes of NPLs, there is a lack of bibliometric research on this topic.

Specifically, this study seeks to address the following research questions:
i.   What are the global research trends on NPLs from 1970 to 2024?
ii.   Which country has contributed the most publications over the past 54 years?
iii.   Who are the authors of the most cited articles in the field of NPLs?
iv.   What are the research clusters in NPLs using keywords co-occurrence analysis?

Drawing on the existing literature on NPLs, the objective of this study is to evaluate global research trends in this area using bibliometric analysis. Specifically, the study examines the publication trends of NPLs from 1970 to 2024, identifies the country that has made the greatest contribution in publishing articles, highlights the prolific authors, and analyzes the top cited articles in the field of NPLs. Lastly, the study aims to discover research clusters in NPLs through the analysis of co-occurring author keywords and keywords plus.

2.0 LITERATURE REVIEW

The production of articles related to non-performing loans (NPLs) has evolved significantly over the years. Numerous empirical studies have investigated the factors contributing to NPL using regression and time series analysis. These studies have focused on individual countries or compared groups of countries. In a recent study, Yilmaz (2022) examined the factors affecting NPLs in Turkey using the ARDL-bound testing approach. This study considered both internal factors specific to banks and macroeconomic factors. Similarly,

Bayar (2019) explored the macroeconomic, bank-specific, and institutional factors in emerging market economies using the system GMM dynamic panel data estimator. The findings showed that economic growth, inflation, economic freedom, return on assets and equity, regulatory capital to risk-weighted assets, and noninterest income to total income have a negative relationship with NPLs. On the other hand, Louzis et al. (2012) found that economic growth hurt NPLs in Greece from 2003 to 2009, while unemployment, real lending interest rate, public debt, and bad management had a positive impact. Previous studies have also discussed disaggregated NPLs. For example, Akca (2023) examined which sectors in Turkey have the highest difficulties in repaying loans. The findings showed significant increases in almost all selected sectors during the pre-crisis, crisis, and post-crisis periods.

On the other hand, bibliometric analysis has been widely used in finance to quantitatively assess research trends and outputs. For example, Biancone et al. (2020) conducted a bibliometric analysis of all publications on Scopus between 1980 and 2020 to examine the areas of Islamic banking and finance. Mohamad Shafi and Tan (2023) discussed the evolution of the Islamic capital market using bibliometric analysis on selected publications from the WoSCC database from 2000 to 2021. Tijjani et al. (2020) used bibliometric analysis to provide insight into the growth of Islamic finance literature, extracting data from the WoSCC database covering the period from 1939 to 2019. Khan (2022) employed bibliometric analysis and meta-analysis to examine the link between environmental, social, and governance (ESG) factors and firm performance. The aim was to propose research trends and a future research framework to address gaps identified in the analysis.

It is evident that NPLs are becoming increasingly popular and tend to increase during and after economic downturns. For example, online databases contain numerous published articles on NPLs, with most researchers focusing on examining the factors or determinants that affect NPLs. Additionally, there are also bibliometric analyses from a financial perspective, such as those conducted by Biancone et al. (2020), Mohamad Shafi and Tan (2023), Tijjani et al. (2020), and Khan (2022), who used bibliometric analysis to identify research trends in their respective areas of study. However, the field of NPLs has received relatively little attention in terms of bibliometric analysis, with fewer published articles compared to other areas of financial research. This indicates a gap in the literature when it comes to systematically assessing the research output, trends, and impact of studies related to NPLs. The limited availability of bibliometric analysis in this field presents an opportunity for researchers to fill this gap and contribute to a more comprehensive understanding of the NPLs research landscape.

3.0 DATA AND METHODS

3.1 Data Source and Search Strategy

The search process begins with the identification step. All the data were retrieved from the Web of Science Core Collection (WoSCC) on May 22, 2024. The WoSCC database was selected because it provides researchers with a wide variety of esteemed, global scientific and social science publications. Additionally, it allows researchers to explore long-term developments as it offers data from the mid-1900s, making it a key source for those investigating historical trends (Birkle et al., 2020).

The search terms are "non-performing loan*" OR "non-performing loan*" OR "bad debt*" OR "uncollectible debt*" OR "uncollectable debt" OR "uncollectible loan*" OR "uncollectable loan*" OR "impaired loan*" OR "default loan*" OR "loan default*" OR "delinquent loan*" can be traced in the title, abstract, and keywords (TS). This study focuses on a topic that offers a

broader perspective and greater flexibility to researchers (Bannah, 2023). Moreover, topics are generally more informative and effective for search engine optimization (SEO) purposes, allowing for exploration and adaptation within a subject area (Victor, 2023). Titles certainly play a crucial role in grabbing attention and providing a concise summary of the content (Bannah, 2023). Subsequently, a total of 2,378 publications have been published in the WoSCC over the past 54 years which is from 1970 to May 2024.

The next step is the screening process. The data was further refined considering the type of documents and languages. The analysis was conducted solely on articles written in English, resulting in the removal of 505 publications. Lastly, a total of 1,873 publications were included for bibliometric analysis.

3.2 Methods

The data was analyzed using Microsoft Excel 2019 to construct the descriptive analysis, showing the percentage and frequencies of the publications. Additionally, relevant graphs and charts were constructed using Microsoft Excel. Further, VOSviewer was employed to conduct bibliometric analysis to visualize and analyze citation networks on these publication records. VOSviewer is a powerful tool for handling large datasets with thousands or even millions of records, allowing researchers to efficiently analyze comprehensive bibliometric datasets (Budianto& Dewi, 2023). This can be particularly useful for identifying research trends, interdisciplinary collaborations, and emerging fields.

3.3 Bibliometric Analysis

Bibliometric analysis is a quantitative tool for assessing and analyzing scholarly publications (Wallin, 2005). It involves examining patterns of publication, citation, and co-citation within a specific field of study or across multiple disciplines (Donthu et al., 2021). Bibliometric analysis relies on data from academic databases, citation indexes, and other sources to assess various aspects of scholarly communication (Wallin, 2005).

Furthermore, the use of bibliometric analysis as a technique for assessing research performance is growing and has gained immense popularity in exploring and analyzing large volumes of data (Donthu et al, 2021). Scholars and researchers employ bibliometric analysis for various purposes, including uncovering emerging trends in article and journal performance, collaboration patterns, and research constituents, as well as exploring the intellectual structure of a specific domain in the extant literature (Donthu, et al 2021; Verma & Gustafsson, 2020). Through this analysis, it becomes possible to evaluate unlimited amounts of published articles from numerous numbers of institutions or countries.

3.4 Keywords Co-occurrence Analysis

Co-occurrence analysis examines the counts of co-occurring elements within a collection of units. The approaches for co-occurrence analysis in bibliometrics have matured during the preceding two decades (Zhou et al., 2022). This is because co-occurrence analysis gives important data for mapping and evaluating the potential relationship between two bibliographic items in the same dissertation (Leydesdorff& Vaughan, 2006). Additionally, this analysis allows for the extraction and identification of various components essential to research objectives. These components include theories, methods, contributions, samples, contexts, trending themes, frequently cited topics, and concepts (Klarin, 2024). The effectiveness of co-occurrence analysis can be influenced by the size and quality of the text data used. Generally, larger datasets yield more reliable results. This data has been subjected

to a variety of analyses, and a substantial body of research has been compiled, making it an important topic in information science (White & McCain, 1998; Klarin, 2024).

Author keywords for scientific literature are terms chosen and provided by the authors. These keywords are intended to highlight the main themes or subjects of the research, making it easier for readers and researchers to find relevant articles when searching databases (Lu et al,2020). These keywords can include terms from the title, abstract, or specific keywords assigned by the authors themselves to describe their research. Previous studies have extensively used author keywords for indexing, information retrieval, bibliometrics, and knowledge organization as many academic databases allow users to search for articles or papers using keywords.

Keywords plus terms are generated using an artificial computer system by WoSCC to identify terms that are closely related to the content of the article but may not have been explicitly mentioned by the authors (Garfield, 1990; Garfield & Sher, 1993). Garfield (1990) claimed that keywords plus phrases can capture an article's substance in greater depth and variety. Similar to author keywords, keyword plus can also be used in bibliometric studies to identify emerging trends, research clusters, or thematic relationships across a body of literature (Zhang et al., 2016). Additionally, keywords plus phrases are derived from the names of articles mentioned by the author of the article being indexed, hence publications with no references or references that are not connected to source items will not have keywords plus. Furthermore, keywords plus may appear in articles with no author keywords, or it may simply include relevant terms that are not specified among the author's keywords.

4.0 RESULTS AND DISCUSSION

4.1 Publications Trends

Figure 1 illustrates the publication trends. Upon examining the figure, it is evident that the number of publications has consistently risen over the years, accompanied by an increase in the number of citations. The earliest record dates back to 1970, with 4 publications and no citations. Subsequently, the number of publications began to rise in the 1990s. The number of publications started to increase in the 1990s. This could be attributed to banking crises, such as the Savings and Loan Crisis in the United States during the late 1980s and early 1990s, as well as the Asian Financial Crisis in the late 1990s. These crises typically resulted in significant increases in non-performing loans (NPLs) as banks faced widespread loan defaults and financial distress (Alnabulsi et al., 2022).

The highest number of published articles was recorded in 2022, with 209 publications. This year also saw the highest number of citations, with 4,477 citations. The COVID-19 pandemic, which began in 2020, had a severe impact on economies worldwide. Lockdowns, supply chain disruptions, and reduced consumer spending led to financial difficulties for businesses and individuals, increasing the risk of loan defaults and NPLs. According to the World Bank (2021), the pandemic was estimated to increase the region's public debt to about 54% of GDP in 2020, accelerating the rise in public debt during the past decade. As the pandemic continued into 2022, there was a greater focus on NPLs as banks and policymakers sought ways to mitigate the economic damage. NPLs can hinder credit availability and economic growth (Alnabulsi et al., 2022). By studying NPLs, economists also seek to understand their impact on economic activity and develop effective strategies to address them. This issue has created opportunities for researchers to analyze NPLs across countries and regions in that year. Consequently, there is a significant demand for comprehensive research and investigation into this matter, particularly in light of the global impact of the pandemic.
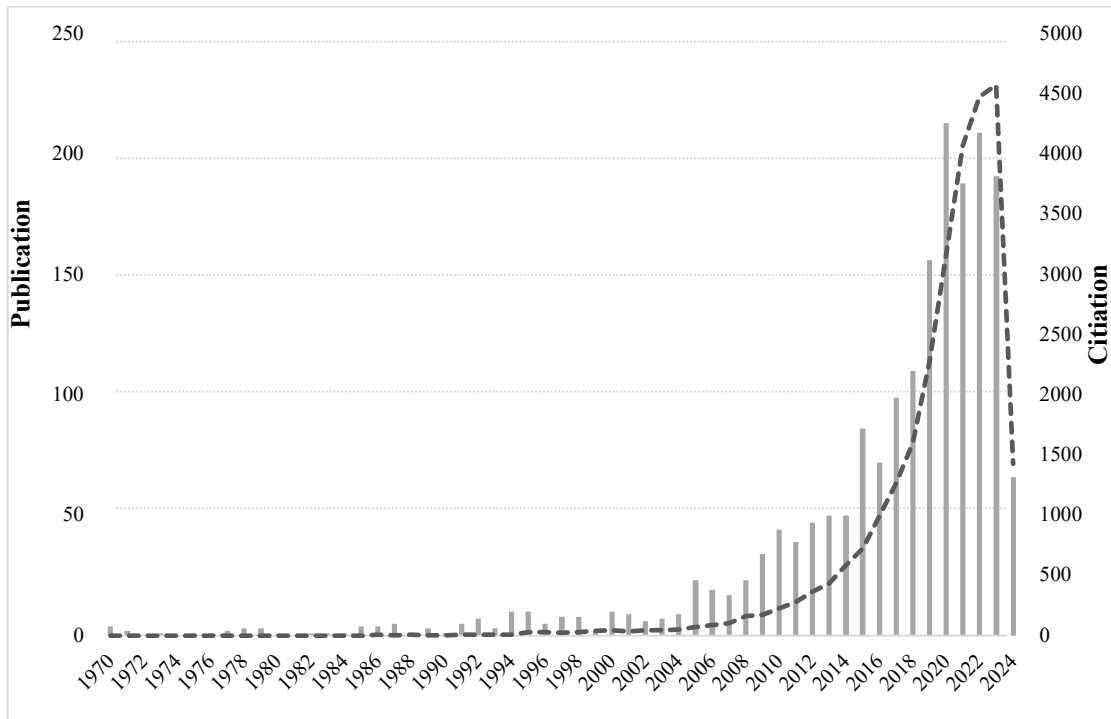
Fig. 1*Publication trends*

4.2 Geographical Distribution of Publications

Researchers from 114 countries worldwide contributed to the publication of retrieved documents and articles. Table 1 presents the top 10 countries that made the largest contributions to the total output. According to the table, the United States of America (USA) released the highest number of articles, with 402 (21.46%) articles. This was followed by the People's Republic of China and England, with 245 (13.08%) and 186 (9.93%) articles respectively. The USA dominated the number of articles published primarily due to its global financial influence. Being a global financial hub, developments in the US financial sector have implications worldwide (Kose et al., 2017). Thus, analysts, policymakers, and investors around the globe closely follow US financial news and trends, including issues related to NPLs. This further amplifies the interest and coverage of such topics in media and academic circles globally.

Table 1. Top 10 countries contributed to the publications

Rank	Countries	Records	%
1	USA	402	21.46
2	People's Republic of China	245	13.08
3	England	186	9.93
4	Italy	102	5.45
5	India	86	4.59
6	Malaysia	72	3.84
7	Australia	68	3.63
8	Taiwan	63	3.36
9	Germany	59	3.15
10	Vietnam	58	3.10

The overlay visualization of international collaboration among countries with a minimum productivity of 13 documents is shown in Figure 2. The majority of articles produced by the USA were published between 2016 and 2017. For instance, "Sector-specific Analysis of the Non-performing Loan in the US Banking System and their macroeconomic impact" written by Amit Ghosh in 2017, "Non-performing Loans, moral hazard and Regulation of the Chinese Commercial Banking System" in February 2016 and "The Drivers of foreign bank lending in Central and Eastern Europe: The roles of parent, subsidiary and host market traits" that was published in December 2017. The USA frequently collaborated with Canada, the People's Republic of China, and Taiwan. China, represented by the largest yellow node, has the highest number of recently published articles.
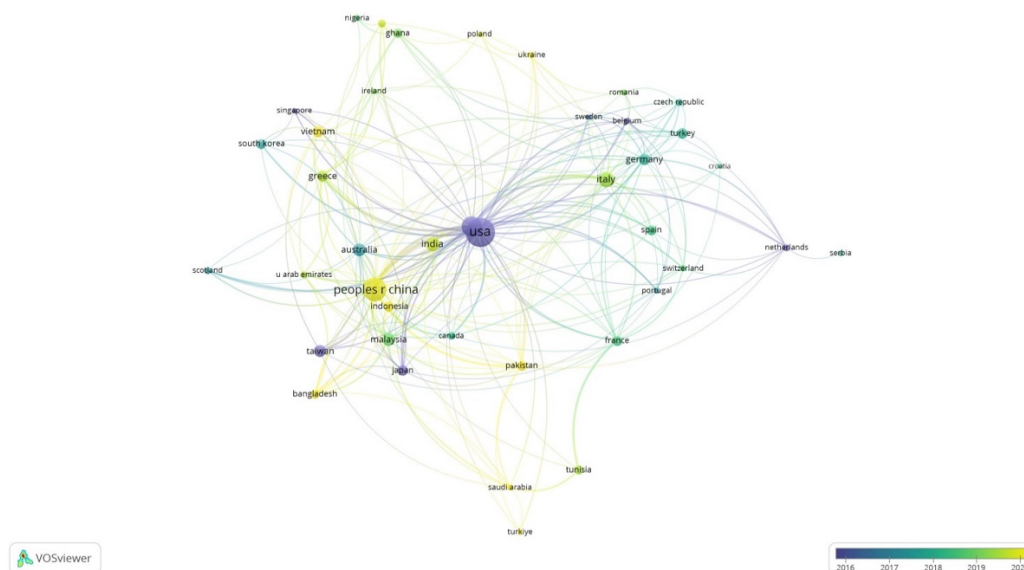
***Fig. 2** Overlay visualization map: International collaboration in producing article*

4.3 Prolific Authors

The top 10 highly productive authors in publishing articles in the field of NPLS are shown in Table 2. Ghosh S has recorded the highest number of publications, with most of the publications focusing on the country of India. Matousek R and Festic M were also among the top 3, with 11 and 8 documents published, respectively.

Table 2. Top 10 authors in publishing articles

Rank	Authors	Records	%
1	Ghosh S	12	0.641
2	Matousek R	11	0.587
3	Festic M	8	0.427
4	Fukuyama H	7	0.374
5	Hakimi A	7	0.374
6	Ozili PK	7	0.374
7	Sohn SY	7	0.374
8	Wang B	7	0.374
9	Wang SY	7	0.374
10	Ghosh A	6	0.320

4.4 Top Cited Articles

Additionally, the top-cited articles are listed in Table 3. The article that recorded the highest number of documents is "Dynamic DEA: A slacks-based measure approach", published by the International Journal of Management Science in January 2014. It received 638 citations, with an average of 43 citations per year. The non-parametric method, Data Envelopment Analysis (DEA), has been a concern for researchers studying NPLs. According to Cooper et al. (2011), DEA can be defined as a data-oriented approach to evaluate the performance of a set of peer entities called Decision-Making Units (DMUs). DEA is widely used in fields such as economics, finance, healthcare, education, and public policy to benchmark performance, identify best practices, and improve decision-making processes. "Efficiency measures of the Chinese commercial banking system using an additive two-stage DEA" by Wang et al. (2014) is an example of a study that utilizes the DEA approach to evaluate efficiencies of the Chinese commercial banks. Other than that, Nhan et al. (2021) also used DEA in their research titled "Evaluating the Efficiency of Vietnam Banks Using Data Envelopment Analysis" to investigate issues related to the technical efficiency, resource analysis, and business efficiency of banks in Vietnam.

Table 3. The most cited articles

Rank	Title	Authors	Year	Average Citations Per Year	Total Citation
1	Dynamic DEA: A slacks-based measure approach.	Tone and Tsutsui	2010	42.53	638
2	Managerial Ability and Earnings Quality.	Demerjian, Peter R., Lev, Lewis and Sarah E.	2013	38.5	462
3	Macroeconomic and bank-specific determinants of non-performing loans in Greece: A comparative study of mortgage, business and consumer loan portfolios.	Louzis, Vouldis, Angelos T. and Metaxas.	2012	35.54	462
4	Corporate social responsibility in the banking industry: Motives and financial performance.	Meng-Wen, Shen and Chung-Hua	2013	33.08	397
5	An experimental comparison of classification algorithms for imbalanced credit scoring data sets.	Brown, Mues and Christophe	2012	30.23	393
6	Evaluating credit risk and loan performance in online Peer-to-Peer (P2P) lending.	Emekter, Riza, Yanbin, Jirasakuldech and Benjamas.	2015	28.4	284
7	The nature of information in commercial bank loan loss disclosures.	Wahlen and JM	1994	8.48	263
8	The technical efficiency of the Japanese banks: Non-radial directional performance measurement with undesirable output.	Barros, Carlos Pestana, Managi, Shunsuke, Matousek and Roman	2012	20.15	262
9	Efficiency measures of the Chinese commercial banking system using an additive two-stage DEA.	Wang, Huang, Jie and Ying-Nan	2014	23.27	256
10	Banking-industry specific and regional economic determinants of non-performing loans: Evidence from US states.	Amit Ghosh	2015	24.5	245

4.5 Co-occurrence Analysis of Keywords

4.5.1 Authors Keywords

Figure 3 displays the co-occurrence of author keywords visualization maps in NPLs research. As shown in figure, the minimum number of author keyword occurrences was set at 15. Out of the 4,077 keywords, 53 keywords met the threshold with the full counting method. The visualization map of Figure 3(a) shows how often specific key terms occur in the published articles collected. Each term is depicted as a node, its size varying according to its frequency. Due to that, larger nodes indicate higher frequency and each node also be coloured differently to represent their clusters (Bukar et al., 2023).

The co-occurrence analysis yielded six clusters, as presented in Figure 3 and Table 4. The first cluster, represented in red colour, consists of 13 items. The largest node in the cluster is banks, where researchers are focusing on studying the NPLs in the banking sector and their impacts on bank profitability and performance. Another critical issue is financial crisis, as it can significantly impact the rate of NPLs worldwide. NPLs in Ghana have also become more appealing. The related studies in Ghana are Aboagye and Ahenkora (2018), Kwashie et al (2022), Alhassan et al. (2014) and Osei-Assibey and Asenso (2015).

Second cluster (green colour) deals with the banking environment as the largest nodes represent the item of "banking" with 62 occurrences. In this cluster, the research in banking and finance particularly focused in China, is evaluated through Data Envelopment Analysis (DEA) to analyze banking operations and efficiency. Additionally, researchers also consider risk management to provide insights to policymakers on minimizing risks and ensuring financial stability.

Blue cluster as the third cluster focuses on the determinants that influence the fluctuation of the NPLs. Panel data analysis is consistently used in previous studies. Moreover, the use of panel data enables researchers to study how variables change over time within different entities. Instead of focusing on a specific country, the emerging market has been discussed under this cluster.

Next cluster is associated with the yellow colour. The author keywords are related to loan defaults, which will affect individuals' credit scores. The latest issue is linked to the outbreak of Covid-19, during which loans defaults increased due to economic instability. One of the ways to minimize the NPLs is by opting to use peer-to-peer (P2P) lending. P2P lending can be beneficial for borrowers with poor credit scores who want to apply for loans through financial institutions (Milne &Parboteeah, 2016).

Purple cluster indicates the fifth cluster with 6 keywords in the cluster. Under this cluster, the focus is on commercial banks and their association with the bank's profitability and economic growth. Previous studies also highlight the concern of systematic risk, including NPLs, as it can impact financial performance. Dealing with non-performing loans (NPLs) in Vietnam has become increasingly challenging. This is because according to Tran et al., (2022), the research related to Vietnam is unique as the government-owned banks often gained significant influence or control in the country compared to privately-owned banks. This could imply that government-owned banks have a dominant position in terms of market share, influence over interest rates, ability to attract deposits, or other key aspects of banking and finance within Vietnam.

Cluster six (turquoise colour) represents the study in Islamic banking. The recent prominence of G21, G32, G28 likely reflects ongoing research and discussions around financial sector dynamics, regulatory frameworks, and strategies for managing financial risks in a complex and interconnected global economy.

Lastly, Figure 3(b) presents an overlay visualization map based on the annual publications, occurrences, and connections of the author keywords (Rahman et al., 2023). The yellow cluster represents the most recent author keywords used in NPL studies, while the purple cluster represents the author keywords between 2017 and 2018. The overlay clearly shows that the recent author keywords are related to G28 "Covid-19", "G32", and "G21", which occurred in 2022; while "machine learning", "fintech", "NPLs", "Vietnam", and "financial development" occurred in 2021. In the meantime, the author keywords that appeared between 2014 and 2016 are related to "China", "loans", "credit scoring", and "default".
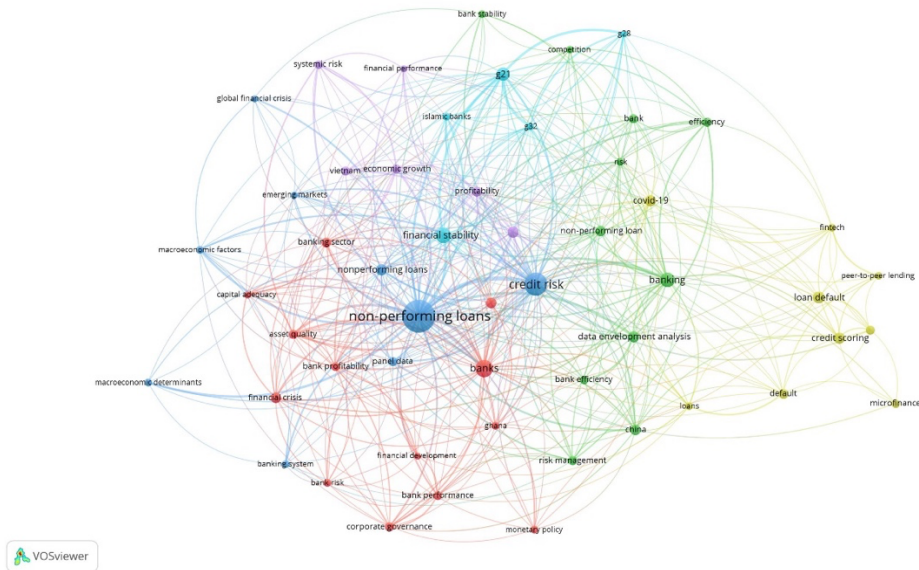
Fig. 3(a)*Network Visualization map: Author keywords co-occurrences in NPLs*
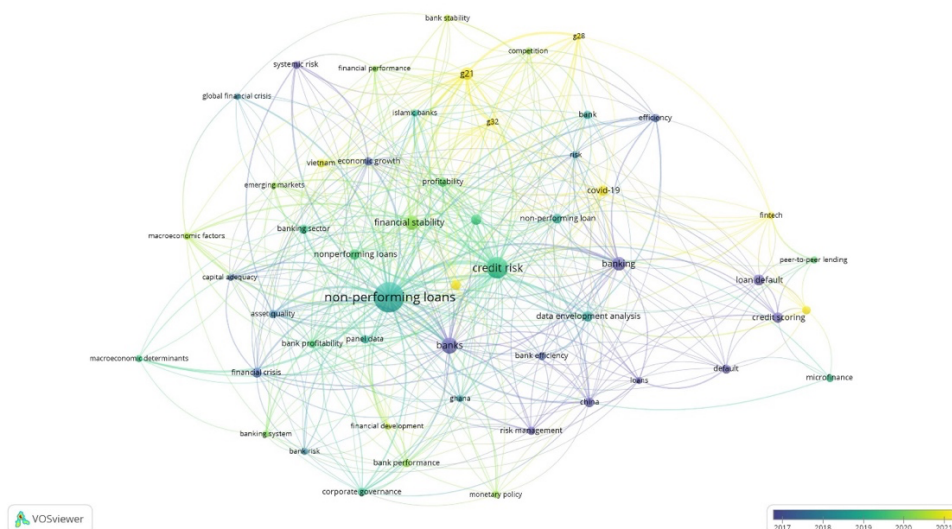
Fig. 3(b)*Overlay Visualization map: Author keywords co-occurrences in NPLs*

Table 4. Author Keywords Clustering

	Author Keywords	Occurrences	Average Publication Year
Cluster 1 (Red)	Banks	85	2017
	Financial crisis	33	2017
	NPLs	32	2021
	Banking sector	27	2019
	Corporate governance	26	2019
	Asset quality	23	2018
	Bank profitability	22	2020
	Bank performance	21	2020
	Monetary policy	19	2020
	Ghana	19	2018
	Bank risk	19	2018
	Financial development	15	2021
	Capital adequacy	15	2017
Cluster 2 (Green)	Banking	62	2017
	Data envelopment analysis	39	2019
	China	33	2014
	Non-performing loan	31	2019
	Risk management	26	2016
	Bank	24	2019
	Efficiency	23	2017
	Bank efficiency	21	2017
	Bank stability	17	2020
	Competition	17	2020
	Risk	17	2018
Cluster 3 (Blue)	Non-performing loans	303	2019
	Credit risk	155	2019
	Nonperforming loans	38	2020
	Panel data	23	2019
	Macroeconomic factors	19	2020
	Banking system	19	2020
	Macroeconomic determinants	18	2019
	Emerging markets	16	2020
	Global financial crisis	16	2018
Cluster 4 (Yellow)	Loan default	41	2017
	Credit scoring	39	2016
	Covid-19	35	2022
	Default	29	2016
	Machine learning	24	2021
	Microfinance	20	2019
	Peer-to-peer lending	19	2020
	Loans	19	2015
	Fintech	17	2021
Cluster 5 (Purple)	Commercial banks	37	2019
	Profitability	27	2020
	Economic growth	26	2017
	Vietnam	23	2021
	Systemic risk	22	2017
	Financial performance	16	2020
Cluster 6 (Turquoise)	Financial stability	66	2020
	G21	54	2022
	Islamic banks	19	2019
	G32	17	2022
	G28	16	2022

4.5.2 Keywords Plus

Figure 4 illustrates the keywords plus co-occurrence visualization maps. Specifically, Figure 4(a) displays the keywords plus co-occurrence network visualization map while Figure 4(b) illustrates the overlay visualization map of keywords plus co-occurrence. Similar to the author keywords, keywords plus are generated with a minimum of 15 occurrences using the full counting method. Out of 1,797 keywords, 95 keywords meet the threshold. Keywords plus generate a higher number of keywords compared to author keywords, as it helps optimize content for a wider range of search queries (Zhang et al., 2016).

Table 5 and Figure 4 report the items in the 6 clusters of keywords plus. The first cluster highlighted in red contains the largest occurrences, with a total of 29 keywords. This cluster includes keywords plus such as "impact", "credit", "growth", "information", "crisis", and "market". pose a significant challenge to banks and firms, especially during times of economic stress and crisis. This issue not only strains the balance sheets of banks but also hampers the flow of credit to productive sectors, thereby hindering economic growth. Effective monetary policy is crucial for mitigating the risks associated with NPLs and promoting a resilient financial system.

"Efficiency", "performance", "ownership", "profitability", "industry", and "models" are some examples of keywords plus connected to the second cluster (green colour). The second cluster deals with Data Envelopment Analysis (DEA). DEA has been used by researchers in the previous studies to assess the efficiency of commercial banks across different countries in handling NPLs. This analysis allows for comparisons across countries, highlighting best practices for improving in loan management strategies in order to increase profitability and productivity growth. Profitability ratios represent measures of a firm or company's return and are used to assess their financial health (Manaf et al., 2021).These keywords are related to cluster two of author keywords, with DEA being selected as the research method. Additionally, instead of focusing solely on China as shown in the author keywords, the authors plus have chosen to focus on countries worldwide.

Cluster three (blue colour) related with the competition among institutions in shaping market dynamics and economic growth. However, alongside competition comes risk-taking and this can influence market power and the overall stability of the financial sector. Subsequently, the keywords plus under this cluster are "economic-growth", "institution", "risk-taking", "market power" and diversification". Thus, effective supervision by regulatory bodies is crucial to mitigate these risks as well as ensure financial stability of the financial institutions.

Additionally, cluster four (yellow colour) connects with studies that employed time series analysis to track trends in NPLs over periods. The researchers used the regression test to identify a significant relationship between NPLs and financial ratios such as profitability and liquidity ratios. Keywords plus under this cluster include "risk", "model", "regression", "tests", "prediction", "bankruptcy", and "classification". NPLs pose significant credit risks for bank where high level of NPLs can strain bank's liquidity, potentially leading to financial instability or bankruptcy if not managed effectively.

Purple colour represents cluster five with the highest occurrences of the "determinants" recorded among all the keywords in the six clusters. This is followed by other keywords plus such as "non-performing loans", "panel-data", "credit risk", "business", "stability", and "bank-specific determinants. NPLs in the banking sector can be influenced by a variety of determinants, including bank-specific factors, using panel data analysis. Bank-specific determinants include capital adequacy ratios, asset quality, and management efficiency, which play crucial roles in determining the level of NPLs. Higher levels of NPLs often reflect

increased credit risk stemming from inadequate risk management practices or poor loan underwriting standards (Naili &Lahrichi, 2022). This cluster is associated with cluster three in the author keywords, as it discusses the factors that influence NPLs using panel data analysis. However, the keywords plus outline the bank-specific determinants instead of macroeconomic determinants.

Cluster six (turquoise colour) focuses on "behavior", "corporate governance", "management", "empirical-evidence", "costs", and "firm performance". Cluster six connects to corporate governance where it is significantly influences both behavior and management practices within firms, impacting their handling of NPLs and overall financial performance. The ownership structure of a firm plays a crucial role in determining the governance mechanisms that guide decision-making regarding NPLs. By enhancing transparency and accountability, strong governance not only reduces NPLs but also minimizes associated costs and improves the firm's financial performance. These keywords are related to the cluster six of the authors keywords, as financial institutions relate to G21, risk management to G32, and corporate governance to G28.

Based on Figure 4(b), the recent keywords plus cover "financial stability" and "bank-specific determinants" in 2022. This is followed by the keywords plus that occurred in 2021. These keywords include "nonperforming loans", "non-performing loans", "empirical-evidence", "Greece", "regression", "stability", "moral hazard", "economic-growth", "diversification", "corporate governance", and "business". On the other hand, the keyword plus of "reform" occurred in 2013 and "choice" and "scale" in 2015.
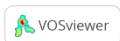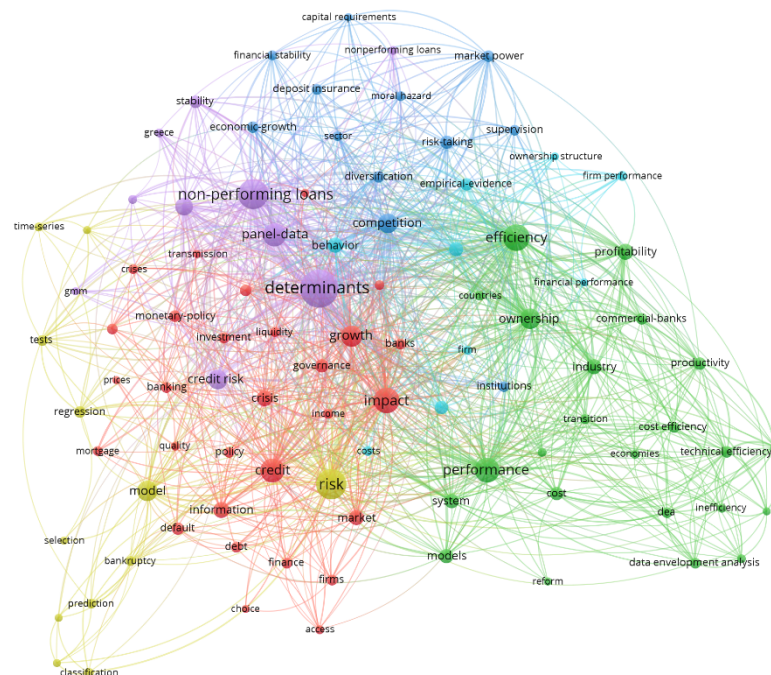
Fig. 4(a)*Network Visualization map: Keywords plus co-occurrences in NPLs*
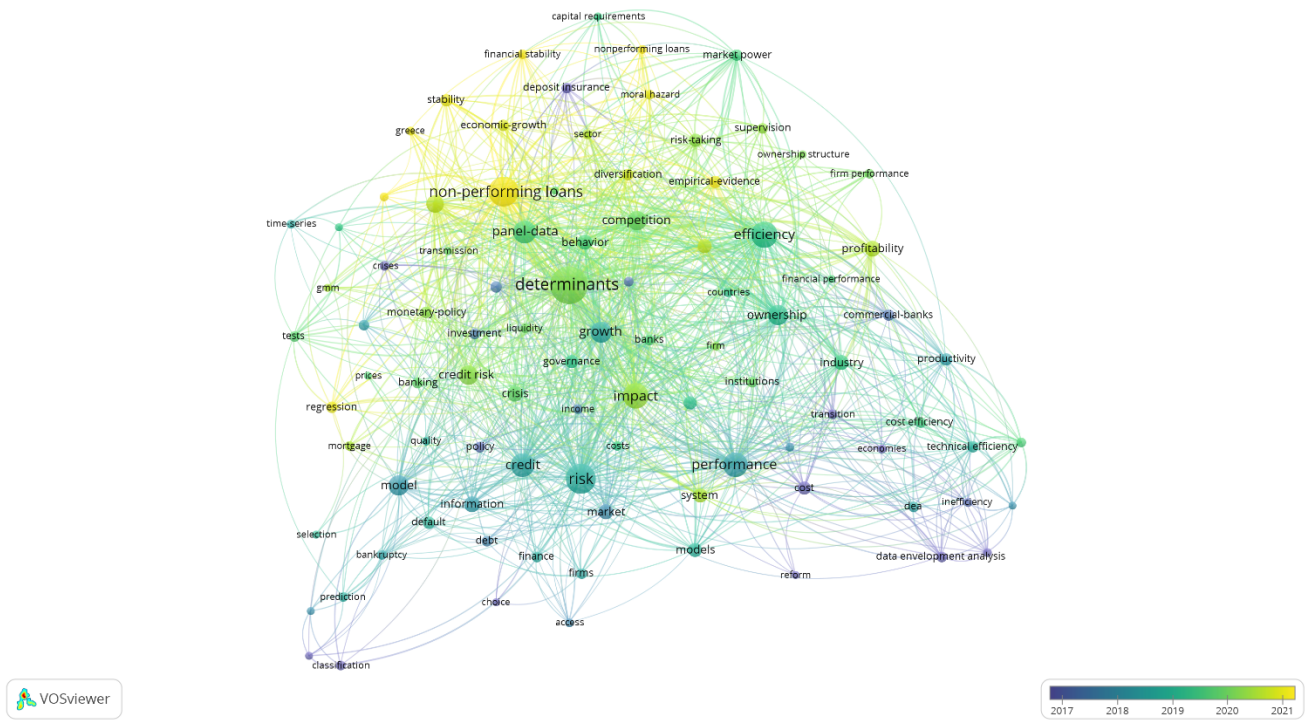
Fig. 4(b) *Overlay Visualization map: Keywords plus co-occurrences in NPLs*

Table 5. Keywords Plus Clustering

	Keywords Plus	Occurrences	Average Publication Year
Cluster 1 (Red)	Impact	153	2020
	Credit	133	2019
	Growth	104	2019
	Information	59	2018
	Crisis	58	2020
	Market	54	2018
	Governance	42	2019
	Default	38	2019
	Markets	34	2018
	Monetary-policy	32	2020
	Debt	30	2018
	Policy	30	2017
	Earnings management	28	2018
	Banking	27	2020
	Firms	27	2019
	Banks	26	2020
	Finance	26	2019
	Investment	26	2018
	Crises	25	2016
	Mortgage	24	2020
	Financial crisis	24	2017
	Liquidity	23	2020
	Income	22	2018
	Quality	20	2019
	Access	18	2018

	Transmission	17	2020
	Systemic risk	16	2020
	Choice	16	2015
	Prices	15	2020
Cluster 2 (Green)	Efficiency	163	2019
	Performance	141	2018
	Ownership	101	2019
	Profitability	61	2020
	Industry	54	2019
	Models	50	2019
	System	47	2020
	Cost	45	2016
	Productivity	37	2018
	Technical efficiency	34	2019
	Commercial-banks	33	2017
	Cost efficiency	30	2019
	Data envelopment analysis	27	2017
	DEA	26	2018
	Undesirable outputs	23	2020
	Transition	23	2017
	Countries	22	2019
	Loans	20	2018
	Scale	20	2015
	Inefficiency	19	2017
	Economies	19	2016
	Productivity growth	16	2018
	Reform	15	2013
Cluster 3 (Blue)	Competition	94	2020
	Risk-taking	44	2020
	Market power	34	2020
	Economic-growth	33	2021
	Diversification	32	2021
	Institutions	30	2020
	Supervision	27	2020
	Deposit insurance	27	2017
	Moral hazard	25	2021
	Sector	25	2020
	Financial stability	24	2022
	Capital requirements	16	2019
Cluster 4 (Yellow)	Risk	214	2019
	Model	99	2018
	Regression	31	2021
	Tests	30	2020
	Prediction	25	2019
	Bankruptcy	24	2018
	Classification	24	2017
	Time-series	19	2019
	Neural-networks	17	2016
	Cointegration	16	2019
	Selection	16	2019
	Financial ratios	16	2018
Cluster 5 (Purple)	Determinants	338	2020
	Non-performing loans	218	2021
	Panel-data	123	2020
	Credit risk	87	2020
	Business	75	2021
	Stability	37	2021
	Bank-specific determinants	20	2022
	Nonperforming loans	20	2021
	Greece	20	2021
	GMM	16	2020
Cluster 6 (Tur...)	Behavior	56	2020
	Corporate governance	48	2021

Management	43	2019
Empirical-evidence	36	2021
Costs	23	2019
Firm performance	22	2020
Firm	18	2020
Ownership structure	17	2020
Financial performance	15	2020

4.5.3 Discussion

In sum, four main points emerge from the co-occurrences of the author keywords and keywords plus analysis. First, it is important to note that NPLs has been identified as a critical issue in the current global economy. This is because from the visualization maps, the author keyword and keyword plus with the largest node was NPLs with 303 and 218 occurrences, respectively.

Second, there are numerous studies that focus on the macroeconomic factors that drive NPLs in emerging markets, as evidenced by the high occurrences of "macroeconomic determinants" in the author keywords, and "impact" and "determinants" appearing in the keywords plus. Alternatively, several studies study the bank-specific determinants affecting NPLs, with special attention placed on financial crisis and credit risk. This is shown in the keywords plus of "bank-specific determinants" with 20 occurrences and an average publication year of 2022.

Third, some studies analyse NPLs with a special attention on commercial banks and Islamic banks, exploring their connection to bank efficiency, stability, and performance. The author keywords include "banks" (85 occurrences), "banking" (62 occurrences), "commercial banks" (37 occurrences), and "Islamic banks" (19 occurrences). Moreover, data envelop analysis (DEA) is frequently employed to derive efficiency estimates in the banking sector. This is followed by the author keywords of "data envelopment analysis", "efficiency", and "bank efficiency", while the keyword plus of "efficiency" recorded a relatively higher occurrence of 163 with an average publication year of 2019.

Lastly, although NPLs continue to pose pressing financial risks, there is a lack of studies that explore the different purposes and sectors of NPLs. For instance, future studies should focus on the macroeconomic factors and bank-specific factors on NPLs at disaggregated levels. This is because the impacts on NPLs are quantitatively diverse across sectors and purposes.

5.0 LIMITATIONS OF STUDY

Even though bibliometric analysis is a valuable tool for understanding the trends within scientific literature, it has several limitations that should be aware of. The first limitation arises from the reliance on using the WoSCC database as the sole source of documents. Different databases have varying coverage of journals, conference proceedings, and other scholarly outputs, which means that this database may underrepresent and not reflect the broader research landscape. Furthermore, exclusion criteria were imposed to retrieve the documents, with this study focusing only on the English language and article-type documents. Research published in languages other than English may be excluded, leading to a biased representation of global scholarship. This omission can overlook significant contributions from non-English-speaking countries and researchers. Similarly, bibliometric analyses that are limited to articles overlook other valuable forms of scholarly communication, such as books, book chapters, conference proceedings, patents, and datasets. This can lead to an incomplete picture of research impact and influence within a field.

6.0 CONCLUSION

NPLs has been identified as a critical issue in the current global economy. Although there has been increased interest in examining the causes of NPLs, there is a lack of bibliometric research on NPLs. Therefore, the objective of this study is to examine the global research trends on NPLs through bibliometric analysis. More importantly, this study focuses on the publication trends from 1970 to 2024, the productive countries, the prolific authors, and the top cited articles in the field of NPLs. This study also aims to discover research clusters using co-occurrence analysis of author keywords and keywords plus.

Several findings emerge from this study. First, the bibliometric analysis provides insights into the landscape and evolution of published articles surrounding NPLs. It is evident that the number of publications and the number of citations have consistently risen over the years. Subsequently, NPLs has shown a significant evolution starting in the 1990s.

Second, the USA, China and England emerge as top 3 productive nations in publishing articles on NPLs, reflecting their leadership in researching and addressing critical financial issues. Meanwhile, Ghosh S's prolific record count solidifies his position as a leading author as compared to the authors. The article "Dynamic DEA: A slacks-based measure approach" by Tone and Tsutsui, with its impressive 638 total citations stands as the most cited articles. This article not only informs ongoing discussions but also inspires further exploration and innovation to readers and future researchers.

Third, several main points can be drawn from the co-occurrences analysis of the author keywords and keywords plus. Previous studies primarily focused on the macroeconomic and bank-specific determinants that affect NPLs, with special attention given to the period of financial crisis and credit risk. Moreover, while previous research has focused on NPLs with special attention given to commercial banks and Islamic banks, bank efficiency, researchers are also interested in bank efficiency, stability, and performance. Therefore, data envelop analysis (DEA) is often used to derive efficiency estimates in the banking sector.

Lastly, previous studies do not differentiate NPLs at disaggregated levels. Future researchers should focus on filling this gap by emphasizing NPLs at the sector or purpose levels, instead of looking at aggregated NPLs in a country. This is because the impacts on NPLs are quantitatively diverse across different sectors and purposes.

CO-AUTHOR CONTRIBUTION

The authors affirmed that there is no conflict of interest or personal relationship in this article. All authors contributed equally to the conception and design of the study.

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