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RESEARCH ARTICLE

Investigating Performances of Commercial Banks in the UK by Using Grey Relation Analysis

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Abstract

This study employs Grey Relational Analysis to assess the financial performance of commercial banks in the UK banking system. The main aim of the study is to identify influential indicators that have an impact on the banks' performance. Identifying influential indicators helps banks determine strategies, capitalize on strengths, address weaknesses, and assure stakeholders of their resilience and profitability in dynamic markets. Using data from 2020 to 2022, five categories—profitability, interest ratio, liquidity and funds, asset quality, and capital adequacy—were analysed. This period was chosen to reveal the impact of Covid-19 on the performance of banks in the UK. Barclays plc consistently emerges as a top performer, showcasing robust financial management. Nationwide Building Society maintains stable performance with strengths in asset quality and funding. Lloyds Banking Group demonstrates stability with good profitability and capital adequacy. Santander UK plc exhibits fluctuating performance. NatWest Group plc shows moderate fluctuations, while HSBC Holding plc and Standard Chartered plc face specific challenges. According to the results of this study, Grey Relational Analysis (GRA) is a useful tool that aids strategic decision-making and risk management. It benefits the banking sector by supporting profitability, stability, and performance. Effective interest rate management is a significant factor in maintaining stability during market fluctuations. High asset quality strengthens bank performance, while efficient liquidity management is crucial for the sustained success of banks.

Keywords: *Commercial Banks, Performance Evaluation, Grey Relational Analysis, Financial Indicators, UK Banking System*
Jel Codes: *G21, C44, C38*

Birleşik Krallık'taki Ticari Bankaların Performanslarının Gri İlişki Analizi Kullanarak İncelenmesi

Özet

Bu çalışma, Birleşik Krallık bankacılık sistemindeki ticari bankaların mali performansını Gri İlişki Analizi'ni kullanarak değerlendirmektedir. Çalışmanın temel amacı, bankaların performansını etkileyen önemli göstergeleri belirlemektir. Bu göstergelerin belirlenmesi, bankaların stratejilerini belirlemesine, güçlü yönlerinden faydalanmasına, zayıflıklarını ele almasına, dinamik piyasalarda dayanıklılıklarını ve karlılıklarını paydaşlar için güvence altına almalarına yardımcı olur. 2020 ile 2022 yılları arasındaki veriler kullanılarak, karlılık, faiz oranı, likidite ve fonlar, varlık kalitesi ve sermaye yeterliliği olmak üzere beş kategori analiz edilmiştirBu dönem, İngiltere'deki bankaların performansı üzerinde Covid-19'un etkisini ortaya koymak amacıyla seçildi. Barclays plc, güçlü finansal yönetim sergileyen ve en iyi performans gösteren bankalar arasında ön plana çıkmaktadır. Nationwide Building Society, varlık kalitesi ve fonlama alanında istikrarlı bir performans sergilemektedir. Lloyds Banking Group, iyi karlılık ve sermaye yeterliliği ile istikrar gösterir. Santander UK plc dalgalı bir performansa sahiptir. NatWest Group plc orta düzeyde dalgalanmalar gösterirken, HSBC Holding plc ve Standard Chartered plc belirli zorluklarla karşı karşıyadır. Bu çalışmanın sonucuna göre, Gri İlişki Analizi (GRA), stratejik kararlar ve risk yönetimine yardımcı olan kullanışlı bir araçtır. Karlılık, istikrarı ve performansı destekleyerek bankacılık sektörüne fayda sağlamaktadır. Etkin faiz oranı yönetimi, piyasa dalgalanmaları sırasında istikrarı sağlayan önemli bir fakttördür. Yüksek varlık kalitesi, banka performansını güçlendirirken, etkili likidite yönetimi ise bankaların sürekli başarısı için hayati öneme sahiptir.

Anahtar kelimeler:*Ticari Bankalar, Performans Değerlendirmesi, Gri İlişki Analizi, Finansal Göstergeler, Birleşik Krallık Bankacılık Sistemi*
Jel Kodu: *G21, C44, C38*

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1. INTRODUCTION

The financial sector plays a crucial role in the overall economy by facilitating the flow of funds between savers and borrowers (Malik and Malik, 2022). Among its components, banks hold a central position as financial intermediaries, acting as a bridge between surplus funds (savers) and those who require funds (consumers or investors). According to Sharipova and Asadova (2023), banks are vital in channelling funds from surplus units to deficit units, encouraging savings through safe and interest-bearing deposit accounts while providing credit for various purposes, and supporting economic growth and stability.

Banks are categorized based on their areas of expertise. Commercial banks gather deposits from individuals and businesses and lend these funds as credit to borrowers, thus stimulating economic activity (Margasova, et al., 2019). Investment banks specialize in assisting corporations and governments in raising capital through issuing securities, which plays a significant role in capital markets (Ilahi, et al., 2014). Development banks focus on funding long-term projects that promote economic and social development, and as a result of this focus, they significantly contribute to fostering growth and reducing poverty in underdeveloped regions (Wruuck et al., 2015).

According to Allen et al., (2008), bank deposits and loans are key financial instruments that play a crucial role in the functioning of the banking system and the overall economy. Deposits offer a safe place to keep money and earn interest, attracting individuals and businesses to preserve and grow their wealth. Banks use these deposits to extend loans, supporting personal and business investments that drive economic expansion and job creation. According to Alkhazaleh (2017), by channelling these funds into productive ventures, commercial banks become catalysts for economic growth. It is supported by Mbekomize and Mapharing's (2017) research. The loans offered by banks empower individuals to make significant purchases, finance education, and pursue entrepreneurial endeavours, while businesses can fund expansions and capital-intensive projects. This access to credit improves economic growth, as it allows consumers and businesses to invest in their futures and contribute to overall economic vitality (Karlan and Morduch, 2010).

De la Torre et al., (2010) prove that commercial banking goes beyond deposits and loans, encompassing a wide range of financial services that facilitate payments, support small and medium-sized enterprises, offer wealth management, and drive innovation in the financial sector. According to Allen (2004), through their role in financial intermediation, risk management, and adherence to regulatory standards, commercial banks play a pivotal role in maintaining the stability and efficiency of the financial system. Therefore, commercial banks were selected for this study.

Market forces, consisting of investors, depositors, regulators, and other stakeholders, closely monitor the banks' performance. They assess various metrics, such as profitability, liquidity, asset quality, and capital adequacy, to measure a bank's stability and efficiency (Aspal and Dhawan, 2014; Gambacorta and Karmakar, 2016; Salike, 2018; Mashamba, 2018; Naser, 2019; Sahyouni and Wang, 2019). High-performing banks are often rewarded with increased market share, access to cheaper funding, and enhanced opportunities for growth and expansion. The instability within the banking sector poses a significant threat, as its repercussions quickly extend to the broader financial system and the overall economy (Allen et al., 2008). Thus, the investigation of commercial banks' performance is important in order to create a healthy and efficient financial system, as it is one of the main objectives of any nation and also typically holds substantial market shares in various countries' banking sectors.

The literature review reveals a gap in the existing research on the UK banking system. Specifically, there is a lack of studies that individually compare the financial performance of commercial banks using Grey Relational Analysis (GRA) to identify the influential financial indicators. While previous research has predominantly relied on the quantile regression model (Pan and Leu, 2016), Analytic

Hierarchy Process (AHP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) (Guru and Mahalik, 2019), and non-parametric methods like Data Envelopment Analysis (DEA) (Sarraf and Nejad, 2019), there is a growing interest in exploring alternative techniques due to certain limitations associated with statistical methods (Feng and Wang, 2000). This presents an opportunity for researchers to utilize GRA, which offers a unique approach to analyzing financial success by incorporating different financial indicators (Huang et al., 2008). By applying GRA and ranking banks based on performance, this study aims to address the gap in the literature and provide valuable insights into the factors influencing bank performance in the UK banking system.

In this study, the main aim is to determine the commercial banks' performance via GRA by utilizing numerous financial ratios. In addition to this, financial ratios such as profitability, interest ratio, liquidity and funds, asset quality, and capital adequacy are used as factors determining commercial bank performance.

The main aims of the study are shown below:

- To assess and compare the commercial banks' performance in the UK banking system by using Grey Relational Analysis (GRA),
- To identify the key financial indicators that significantly influence the performance of banks within the sub-categories of profitability, interest ratio, liquidity and funds, asset quality, and capital adequacy.

This study assesses the influence of key financial indicators on bank performance by examining multiple ratios that are widely recognised and accepted within each category. The most commonly used ratio categories in the literature are profitability (Salike, 2018; Sahyouni and Wang, 2019), interest (Abedifar et al., 2018; Naser, 2019), liquidity and funds (Menicucci and Paolucci, 2016; Mashamba, 2018), asset quality (Menicucci and Paolucci, 2016; Bhattarai, 2018), and capital adequacy (Gambacorta and Karmakar, 2016; Sahyouni and Wang, 2019).

For each of the financial ratio categories, the specific ratios were selected (Table 1) to assess the bank's performance comprehensively. These ratios were carefully chosen based on their relevance, availability of the data, recognition, and significance in evaluating the financial health and operational efficiency of banks. The inclusion criterion involves selecting ratios that are widely recognized and accepted in the banking industry for assessing performance. The selected ratio of this study is widely used in the literature (Mashamba, 2018; Suvvari and Goyari, 2019; Naser, 2019; Sahyouni and Wang, 2019).

This study sets itself apart from previous literature by including different financial indicators in the analysis of financial success. Additionally, the study differs from existing research in the UK Banking System by using GRA instead of statistical techniques that may have limitations due to their assumptions (Feng and Wang, 2000). Moreover, it distinguishes itself by ranking commercial banks based on their performance using GRA.

Based on the objectives of the study, below research questions below are developed:

- How does Grey Relational Analysis (GRA) allow for a comprehensive assessment and comparison of the financial performance of banks in the UK banking system?
- Which specific financial indicators within the categories of profitability, interest ratio, liquidity and funds, asset quality, and capital adequacy demonstrate the strongest influence on bank performance?

In a nutshell, the study aims to identify specific financial indicators within each category that exhibit the most significant impact on bank performance. To achieve this, the research likely covers a comprehensive range of indicators within the categories of profitability, interest ratio, liquidity and funds, asset quality, and capital adequacy. However, instead of analysing all possible indicators within each category, the study likely employs a selection process to focus on those indicators that are considered most influential or widely recognized in the banking sector. This approach allows for a more targeted analysis, concentrating on the key drivers of bank performance while avoiding unnecessary complexity.

2. LITERATURE REVIEW

The Grey System Theory, introduced by Deng (1982) in the literature, allows for the identification of fundamental relationships between factors within a system using relatively small data sets, thereby overcoming the limitations of traditional statistical methods (Feng and Wang, 2000). Grey System Analysis proves valuable in comparing various factors in relation to a reference factor within a system (Huang et al., 2008). An important characteristic of GRA is its capability to determine both qualitative and quantitative relationships among complex factors, even when information is limited (Wu et al., 2010).

In recent years, there have been numerous academic investigations in the field of bank efficiency. While the selected samples and variables may differ, the common goal of these studies is to assess the effectiveness or ineffectiveness of the entire banking sector or specific banks under consideration. Various studies have been conducted in different countries, at different time periods, and employing different methodologies. Due to its distinctive features, GRA has been widely adopted as a technique for comparing the performance of banks, as well as in various other sectors like financial institutions, hospitals, and airlines (Ho, 2006; Li and Wang, 2010; Meng et al., 2013; Dogan, 2013; Ozcelik and Ozturk, 2014; Sakinc and Gulen, 2014; Pan and Leu, 2016; Kula et al., 2016; Guru and Mahalik, 2019; Suvvari and Goyari, 2019; Sarraf and Nejad, 2019).

Ho (2006) employed GRA to assess the relative performance of three investment Taiwanese trust firms that have undergone reorganization into banks. Despite the small sample size and the lack of information about data distribution, the study demonstrates the successful application of GRA in evaluating bank performance. Furthermore, the study compares the results obtained through GRA with those obtained from Financial Statement Analysis (FSA), and it shows that both methods yield the same outcome.

Li and Wang (2010) utilized the grey relational method to assess the impact of cooperation between securities companies and commercial banks. By examining a case where a securities company develops BSG operations with a bank, the analysis process of the grey relational method is demonstrated. Unlike the probability analysis method, the grey relational method offers a more scientific and practical approach to evaluating the effectiveness of decisions made by securities companies. This method holds the potential for broader application in decision evaluation across various firms.

Meng et al. (2013) formulated a distinct evaluation framework aimed at assessing innovation performance tailored specifically for commercial banks. The primary objective was to scrutinize the elements impacting service innovation performance within this sector. The model was subsequently put into practice, focusing on prominent Chinese banks including the Industrial Commercial Bank of China (ICBC), the Bank of China (BC), the China Construction Bank (CCB), and the Bank of Communications China (BCC). The study categorized the influencing factors into two primary clusters: internal and external factors. External influences encompassed supplier-driven factors, competitive impetus, and customer demand. Meanwhile, internal determinants encompassed employee contributions, investment initiatives, and research and development (R&D) endeavours. Historical records and archival data from each bank were collated to gather pertinent information

pertaining to these factors. The researchers then employed the theory of grey relational analysis to ascertain the degree of influence each factor held. Ultimately, the findings underscored the greater significance of internal factors compared to their external counterparts. The relative importance of these factors was ranked in the following order: R&D institutes, employees, investments, customer demand, supplier influence, and competitive pressures.

The banking sector plays a crucial role in economic development, being a vital prerequisite for sustainable economic growth. Therefore, Dogan (2013) used GRA to assess and compare the financial performances of ten banks listed on the Istanbul Stock Exchange (ISE)/Borsa Istanbul during the period 2005-2011. Additionally, the study seeks to streamline the number of financial indicators used to measure bank performance and determine their relative importance. According to the GRA method, "Akbank" emerged as the top performer, while "Yapi Kredi Bank" ranked last in terms of financial performance. Additionally, the study also revealed a positive correlation between a bank's "Return on Assets" and its financial performance.

In the current global competitive environment, the commitment to sustainable development and the incorporation of sustainability issues hold strategic significance. Therefore, banks' sustainability performance in Turkey was examined by Ozcelik and Ozturk (2014). Recent sustainability reports consider not only companies' financial performance but also their environmental and social performance, reflecting their efforts towards sustainable development. This study aims to assess the sustainability performance of banks in Turkey that issue sustainability reports using the grey relational analysis method. The study compiles specified ratios pertaining to banks' economic, environmental, and social performance from their sustainability reports in 2011. Based on 3 financial, 2 social, and 4 environmental ratios, the performance of banks is analyzed, and they are ranked according to their sustainability performance. The results indicate that TSKB ranks first in sustainability performance, followed by Garanti Bank and Akbank, respectively.

"Participation Banks" are an essential element of the global banking sector and have become indispensable for the economies of countries worldwide. As an alternative to conventional banks, performance comparisons of participation banks hold significant importance for managers and investors. In connection with this, Sakinc and Gulen (2014) investigated the performance of participation banks operating in Turkey using the GRA Method. For this purpose, 15 ratios related to capital adequacy, liquidity, asset quality, and profitability criteria were determined using four years' worth of data (2010-2013) from participation banks. By analyzing the results and these ratios, participation banks' performances were compared, and the ranking obtained from the analysis is as follows: Kuveyt Turk Participation Bank, Turkiye Finans Participation Bank, Albaraka Turk Participation Bank, and Asya Participation Bank. The study concludes that capital adequacy is the dominant ratio influencing the performance of participation banks among all the determined ratios.

According to Pan and Leu (2016), bank service satisfaction plays a crucial role in the bank's financial performance. They assess the levels of service satisfaction among banks via GRA and compare the impact of various variables on service satisfaction. Also, they rank banks based on their satisfaction levels. Additionally, they employ the quantile regression model to identify the factors influencing customer satisfaction at specific quantiles of satisfaction levels. The outcomes of the quantile regression analysis offer valuable insights to bank managers for devising policies to enhance customer satisfaction across different quantiles of satisfaction levels. Furthermore, they compare the predictive accuracy of the regression models at various quantiles. The experimental results demonstrate that, out of the seven quantile regression models, the median regression model exhibits the best performance.

The insurance sector's significance is growing as it contributes substantially to a country's economy and gains a larger share in the finance industry. Kula et al., (2016) employed the GRA method to

assess the financial performances of seven insurance companies and a pension fund listed on Borsa Istanbul (BIST). Based on the analysis results from year-end data in 2013, it is evident that half of the companies examined had effective capital structures, meaning they minimized financial leverage. Moreover, performance differentiation is noticeable through the reduced levels of current ratios and four profitability ratios (net profit margin, profit per share, equity profitability, and asset profitability) of companies operating with minimum effectiveness. The study's findings indicate that superior financial performance can be achieved by implementing certain capital structure policies, such as maintaining high equity levels, sufficient liquidity, and improved profitability, which can set these companies apart from their competitors.

Another interesting piece of research was done by Guru and Mahalik (2019) in order to evaluate the efficiency of different public sector banks in India using a combination of the Analytic Hierarchy Process (AHP), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), and GRA. The study aims to determine their performance rankings and identify areas for improvement. The research finds that banks considered efficient are closely related to the ideal solution, resulting in alternative rankings. The comparative results show that both models yield similar interpretations, with slight differences due to methodological variations.

A range of studies have utilized the AHP to evaluate bank performance. Unvan (2020) and Fazeli et al., (2023) utilized a combination of AHP and TOPSIS to rank commercial banks based on a variety of financial and non-financial indicators. Their studies highlight the adaptability and efficacy of AHP in evaluating complex systems like banking institutions. Similarly, Nazeri and Keshavarzi (2019) employed AHP alongside DEA to rank the banks' branches in different regions by highlighting the versatility of AHP across different banking contexts. Additionally, Chang and Tsai (2016) utilized AHP to assess the organizational business performance of wealth management banks by further presenting the wide-ranging applications of AHP in the banking sector. These studies collectively highlight the robustness and flexibility of AHP as a decision-making tool for evaluating bank performance across various regions and organizational levels.

However, they also highlight certain limitations of this approach. One limitation is the subjectivity inherent in AHP, as it relies on decision-makers' judgments and preferences when assigning weights to criteria and alternatives. This subjectivity can introduce bias and inconsistency into the evaluation process, potentially impacting the validity and reliability of the results (Fazeli et al., 2023). Additionally, AHP requires pairwise comparisons between criteria and alternatives, which can be time-consuming and challenging to implement, especially when dealing with a large number of variables. Furthermore, AHP does not consider uncertainty or variability in the data, which may limit its ability to accurately reflect the dynamic and uncertain nature of the banking environment (Nazeri and Keshavarzi, 2019).

DEA has been widely used to measure and improve bank performance. Maradin et al., (2018) provide a comprehensive overview of DEA by identifying key factors influencing the relative efficiency of the banking sector and individual institutions. Fallah et al., (2011) and LaPlante and Paradi (2015) both highlight its effectiveness in this regard, with Fallah et al., (2011) emphasizing the importance of considering both financial and non-financial factors in DEA analysis. However, Ahn and Le (2014) caution that the input-output specification in DEA models may not always align with banks' decision-making criteria, potentially leading to inaccurate performance assessments.

While DEA has proven to be a valuable tool for evaluating bank performance, it also comes with certain limitations. One major limitation is its sensitivity to outliers and extreme values in the data, which can significantly impact the results and potentially lead to distorted efficiency scores. DEA also assumes constant returns to scale, which may not always hold true in practice, especially in dynamic and changing environments (Fallah et al., 2011; Maradin et al., 2018). Additionally, DEA requires a

set of input and output variables to measure efficiency, and the selection of these variables can influence the results. Choosing inappropriate or inadequate variables may lead to inaccurate assessments of bank performance (Ahn and Le, 2014). Moreover, DEA does not consider external factors such as market conditions, the regulatory environment, or technological advancements, which can affect bank performance but are beyond the control of the banks themselves. Finally, DEA results are relative and comparative, meaning that banks are evaluated against each other rather than against an absolute standard of efficiency (LaPlante and Paradi, 2015). This comparative nature may not provide a clear understanding of a bank's absolute performance level or its potential for improvement.

Suvvari and Goyari (2019) employed the Grey Relational Analysis method to predict the financial performance of 24 Indian life insurance companies during the period of 2013-2016 by using a total of 14 indicators, including capital adequacy ratios, liquidity ratios, operating ratios, and profitability ratios. The methodology employed involves using GRA to determine the Grey grades and rank the performance indicators. A higher relational grade signifies better financial performance. The outcomes provide a ranking of insurance companies based on their financial performance, with Shriram Insurance obtaining the highest relational grade score, followed by IDBI Insurance, Sahara Insurance, and Life Insurance Corporation of India. The key discovery is that negative values in profitability ratios significantly influence the financial performance of Indian life insurance companies.

Sarraf and Nejad (2019) conducted an examination of the performance of municipal water and wastewater companies in Iran in 2017 using Grey Relational Analysis (GRA) and Data Envelopment Analysis (DEA). GRA, among various methods for making decisions based on multiple attributes, was employed to assess performance, while DEA was utilized to gauge efficiency. The study encompassed a statistical sample of 35 companies within the water and wastewater sector. To apply GRA, the researchers adopted the fuzzy normalization technique. By deducting normalized values from one, reference sequences were generated. Subsequently, the grey relational coefficient was computed, and the final grey relational grade was derived by multiplying the relative weight determined from Shannon entropy by the relational coefficients. The outcomes of the study showcased that GRA stands as a more precise approach for evaluating the performance of water and wastewater enterprises.

University staff performance was assessed via GRA by Liu and Liu (2023). A novel college performance assessment index system is developed, incorporating a three-dimensional approach. The evaluation of college performance within NH University is carried out using the grey relational method, and the CRITIC method of variation coefficient is employed to assign weights to the assessment indices. The performance of 15 colleges within NH University is assessed using this index system and the grey method, providing valuable insights for optimizing management and allocating resources effectively. The proposed index system and grey assessment model demonstrate promising potential for addressing similar challenges in other contexts.

3. METHOD

In this research, Fitch Connect was used to gather the financial ratios. This database was used because it has the world's most comprehensive bank financial data and provides transparency for their methodologies, which have been used for financial calculations (Fitch Solution, 2024). In addition to this, the collection of financial information from the annual reports would have been time-consuming. In the Fitch Connect Database, the names of the banks were searched in the global search bar, and banks were listed under "entities". Upon clicking on an entity, the summary page of the bank in question was presented. The "financials" menu was clicked to get access to the financial page of the bank. This page includes data related to key financial figures, balance sheet items, income statements, and off-balance sheet items.

In the literature, profitability, interest ratios, capital adequacy, asset quality, and funding and liquidity are the most commonly used financial indicators to assess how effectively a bank is achieving its objectives and fulfilling its role as a financial intermediary (Gambacorta and Karmakar, 2016; Silaban, 2017; Mashamba, 2018; Suvvari and Goyari, 2019; Naser, 2019; Sahyouni and Wang, 2019). Therefore, profitability, interest ratios, capital adequacy, asset quality, and funding and liquidity ratios categories were selected in this study. The study presents the financial ratios of 13 different variables for the 7 largest commercial banks in the UK for the time period between 2020 and 2023. All financial ratios related to the above five ratio categories (Table 1) were calculated based on the yearly data. For the calculation of the average figures, arithmetic averaging was used to derive the average values by Fitch Connect. By using yearly data, the study aims to capture the annual performance trends of commercial banks in the UK and provide insights into their overall financial health and stability.

As the data collected from the Fitch Connect database suggests, financial data might not be openly findable by other researchers without a subscription or access to the database. However, other researchers can likely find similar data by getting access to the Fitch Connect database, as it is a recognised and reputable database. Alternatively, other researchers can easily access similar data by using the banks' financial reports. All of the elements in the formulas (Table 1) are the elements of financial statements. As financial statements are publicly available, it is possible to access similar data by collecting the relevant elements from the financial statements and doing the relevant calculations presented in Table 1. However, it is a time-consuming process, which is why the Fitch Connect database was preferred for gathering the relevant data.

Appendix 1 shows the data used in this study to meet with Fair Data Principle for those who do not have a subscription to the Fitch Connect Database. By doing this, all researchers would be able to redo this research.

The Fitch Connect database includes all calculated financial ratios that were used in this research, based on the provided formulas in Table 1.

Table 1: Financial ratios and categories used in the research

Financial Indicators	**Symbol**	**Formula**	**Target**
Profitability	P1	ROAA= Net Income/Average Total Assets	Max
	P2	ROAE= Net Income/Average Shareholders' Equity	Max
Interest Ratios	I1	Net Interest Margin (NIM)= Net Interest Income/Average Earning Assets	Max
	I2	Interest Yield on Loans= Interest Income on Loans/Average Gross Loan	Max
Capital Adequacy	C1	Tier 1 Capital Ratio= Tier 1 Capital/Risk-Weighted Assets	Max
	C2	Total Capital Ratio= Total Capital/Risk-Weighted Assets	Max
	C3	Risk-Weighted Assets Ratio= Risk-Weighted Assets/Total Assets	Min
	A1	Non-Performing Loans (NPL) Ratio= Impaired Loans/Gross Loans	Min

Asset Quality	A2	Loan Loss Provision Ratio= Loan Loss Allowances/Gross Loans	Max
	A3	Loan Loss Coverage Ratio= Loan Loss Allowances/Impaired Loans	Max
Funding And Liquidity	FL1	Liquidity Coverage Ratio= High-Quality Liquid Assets/Net Cash Outflows	Max
	FL2	Growth of Total Customer Deposit	Max
	FL3	Liquidity Ratio= Liquid Asset/Total Assets	Max

Source: Author, 2023

Profitability ratios, such as Return on Average Assets (ROAA) and Return on Average Equity (ROAE), play a fundamental role in evaluating a bank's financial performance. ROAA, calculated by dividing Net Income by Average Total Assets, provides a measure of the bank's efficiency in generating profits relative to its average asset base. A higher ROAA implies that the bank is utilizing its assets effectively to yield income (Salike, 2018). On the other hand, ROAE, computed as Net Income divided by Average Shareholders' Equity, offers insights into the bank's ability to deliver returns on the shareholders' investments. A higher ROAE indicates that the bank is generating favourable returns for its shareholders (Sahyouni and Wang, 2019). For both shareholders and management, these ratios are of paramount importance, as they shed light on the bank's overall profitability and its capacity to derive earnings from its assets and equity. Overall, the profitability indicators ROAA and ROAE aim to maximize returns. A higher ROAA indicates that the bank is generating more income relative to its average total assets, while a higher ROAE signifies better returns for shareholders based on their equity investment.

The interest ratio, comprising Net Interest Margin (NIM) and Interest Yield on Loans, plays a pivotal role in assessing a bank's overall performance. NIM reflects the difference between interest income earned from loans and investments and interest expenses on deposits and borrowings. A higher NIM indicates that the bank is effectively managing its interest-earning assets and interest-bearing liabilities, generating more profits from its core banking activities (Silaban, 2017). This, in turn, signifies a stronger financial position and enhanced profitability for the bank. Moreover, the Interest Yield on Loans offers valuable insights into the bank's lending operations. It measures the interest income earned from loans relative to the average loan portfolio. A higher Interest Yield on Loans suggests that the bank is earning more income from its loan portfolio, potentially indicating successful lending strategies and competitive pricing (Abedifar et al., 2018). However, a bank must strike a balance between achieving a competitive yield and maintaining credit quality. A significantly high yield might be associated with increased credit risk, which could negatively impact the bank's overall performance and asset quality. Together, these interest ratio metrics provide a comprehensive view of the bank's ability to manage its interest-related activities, optimize its asset utilization, and navigate interest rate risks. A strong NIM and a competitive Interest Yield on Loans indicate a well-performing bank that efficiently generates profits from its lending and investment activities (Naser, 2019). However, it is crucial for the bank's management to continually monitor and analyze these ratios in conjunction with other performance indicators to ensure sustainable growth, prudent risk management, and long-term profitability. Shortly, these ratios focus on maximizing interest-related income. A higher NIM suggests that the bank is effectively managing its interest-earning assets and liabilities to maximize the margin between them. Similarly, a higher Interest Yield on Loans indicates that the bank is earning more income from its loan portfolio.

Capital adequacy is a crucial aspect of bank regulation and performance evaluation, ensuring that financial institutions have enough capital to withstand potential losses and remain solvent during challenging economic conditions. Three key ratios are used to assess a bank's capital adequacy: Tier 1 Capital Ratio, Total Capital Ratio, and Risk-Weighted Assets Ratio (Gambacorta and Karmakar, 2016). The Tier 1 Capital Ratio measures a bank's core equity capital, also known as Tier 1 capital, in relation to its risk-weighted assets. This ratio serves as a primary indicator of a bank's ability to absorb losses and indicates its resilience during financial stress. A higher Tier 1 Capital Ratio implies a more substantial buffer of high-quality capital, signifying enhanced strength and capacity to handle risks. The Total Capital Ratio is a broader measure, taking into account both Tier 1 capital and supplementary capital (Tier 2 capital) in comparison to risk-weighted assets. It provides a comprehensive view of a bank's overall capital strength, including various forms of capital that safeguard depositors and creditors. A higher Total Capital Ratio indicates a stronger capital position, instilling confidence in the bank's stability. The Risk-Weighted Assets Ratio showcases the proportion of a bank's risk-weighted assets in relation to its total assets. By adjusting asset values based on their risk profiles, this ratio offers insights into a bank's exposure to various risks. A lower risk-weight assets ratio suggests a more conservative asset portfolio with a higher proportion of lower-risk assets (Mamun, 2013; Gambacorta and Karmakar, 2016). Consequently, these ratios aim to ensure sufficient capital to absorb potential losses and maintain solvency. A higher Tier 1 Capital Ratio and Total Capital Ratio indicate a stronger capital position, enhancing the bank's ability to absorb losses. Conversely, a lower risk-weight assets ratio suggests a conservative asset portfolio with lower risk exposure.

Asset quality is a crucial aspect of a bank's financial health and risk management. It provides insights into the credit risk level in the bank's loan portfolio and its ability to handle potential loan losses effectively. To assess asset quality, several key ratios are utilized. The Non-Performing Loans (NPL) Ratio is one such indicator, measuring the percentage of non-performing loans in relation to the total gross loans outstanding. A higher NPL Ratio indicates a larger proportion of problem loans in the bank's portfolio, which could be a signal of potential credit risks and financial instability. A low NPL Ratio is desirable as it signifies a healthier loan portfolio with fewer credit issues (Messai and Jouini, 2013). The Loan Loss Provision Ratio is another essential metric, representing the amount of funds set aside by the bank as provisions for potential loan losses in comparison to its total gross loans. A higher Loan Loss Provision Ratio suggests that the bank is taking a prudent approach to risk management by building up reserves to cover anticipated credit losses (Menicucci and Paolucci, 2016). Furthermore, the Loan Loss Coverage Ratio comes into play, which compares the bank's Loan Loss Allowances (set aside for potential losses) to the impaired loans in its portfolio. A higher Loan Loss Coverage Ratio indicates that the bank has sufficient provisions to cover potential losses from its impaired loans, providing added confidence in the bank's ability to manage credit risks. These asset quality ratios are crucial for evaluating a bank's credit risk exposure and its ability to protect capital from potential loan defaults. Banks that maintain lower NPL Ratios, higher Loan Loss Provision Ratios, and sufficient Loan Loss Coverage Ratios demonstrate robust asset quality management, positioning them for enhanced financial resilience and stability (Bhattarai, 2018). Conversely, banks with higher NPL Ratios, lower Loan Loss Provision Ratios, and inadequate Loan Loss Coverage Ratios may face challenges in managing credit risk, potentially affecting their profitability and overall financial strength. These ratios focus on minimizing credit risk and potential loan losses. A lower NPL Ratio indicates a healthier loan portfolio with fewer non-performing loans. Higher Loan Loss Provision and Loan Loss Coverage Ratios indicate better provisioning for potential losses, enhancing the bank's ability to manage credit risks effectively.

Funding and liquidity are crucial aspects of a bank's financial stability and operational efficiency. Several key ratios are used to assess funding and liquidity positions, each providing valuable insights

into the bank's ability to manage short-term obligations and unexpected cash demands. The Liquidity Coverage Ratio (LCR) evaluates the bank's capacity to meet its short-term liquidity needs during periods of financial stress. By comparing high-quality liquid assets to projected net cash outflows over a specified time horizon, the LCR ensures the bank holds enough liquid resources to cover potential outflows, reducing reliance on external funding sources (Mashamba, 2018). The Growth of Total Customer Deposit is a vital indicator of the bank's funding position. Positive growth in customer deposits indicates increased stability in funding, providing the bank with a reliable base to support its lending and investment activities. Conversely, negative growth might signal potential funding challenges and the need for alternative sources (Menicucci and Paolucci, 2016). The Liquidity Ratio assesses the bank's overall liquidity position by comparing liquid assets to total assets. A higher Liquidity Ratio indicates a more significant portion of assets that can be quickly converted into cash, enhancing the bank's ability to meet short-term obligations and maintain operational stability. These funding and liquidity ratios are crucial for effective risk management and financial planning. A strong Liquidity Coverage Ratio ensures the bank's ability to navigate short-term liquidity challenges. Positive growth in Total Customer Deposits establishes a stable funding base, supporting the bank's core activities (Aspal and Dhawan, 2014). Moreover, a healthy Liquidity Ratio instils confidence in the bank's capacity to handle unexpected cash demands without disruptions. These ratios aim to ensure adequate liquidity and stable funding sources. A higher Liquidity Coverage Ratio signifies the bank's capacity to meet short-term liquidity needs. Positive growth in Total Customer Deposits indicates stability in funding. A higher Liquidity Ratio reflects a more significant portion of assets that can be quickly converted into cash, enhancing the bank's ability to meet short-term obligations.

Similar to previous research, this study incorporates well-established indicators across profitability, interest ratios, capital adequacy, asset quality, and funding and liquidity categories. For instance, the inclusion of Return on Average Assets (ROAA) and Return on Average Equity (ROAE) in profitability assessment, as well as metrics like Net Interest Margin (NIM) and Interest Yield on Loans in interest ratio analysis, resonates with prior studies. Likewise, the evaluation of capital adequacy through ratios such as Tier 1 Capital Ratio and Total Capital Ratio, along with asset quality assessment using Non-Performing Loans (NPL) Ratio and Loan Loss Provision Ratio, mirrors established practices. Additionally, the consideration of liquidity indicators like Liquidity Coverage Ratio and Growth of Total Customer Deposits reflects the focus of existing literature on funding and liquidity management. The contribution of this study lies in its comprehensive analysis, which consolidates various financial indicators into a unified framework, providing a holistic view of bank performance.

This study also contributes to the field of bank performance evaluation using the GRE technique, specifically for commercial banks in the UK. Previous research has utilized methods such as the Analytic Hierarchy Process, Technique for Order Preference by Similarity to Ideal Solution, Data Envelopment Analysis, and Quantile Regression models for assessing bank performance (Ilahi et al., 2014; Pan and Leu, 2016; Kula et al., 2016; Sarraf and Nejad, 2019). This study employs a different technique than the literature. The GRE represents a novel and comprehensive methodology. Additionally, while GRE has been applied in studies focusing on insurance companies and investment banks (Ilahi et al., 2014; Suvvari and Goyari, 2019), its application to evaluating commercial banks in the UK context is unique. As a result of this, the study will identify the key financial indicator that significantly influences the bank's performance by employing the GRE technique for UK banks.

Table 2 indicates the largest commercial banks in the UK in 2022 according to their total assets.

Table 1: Largest commercial banks in the United Kingdom (UK) in 2022, by total assets

Bank Name	**Total Assets - 2022 (in billion U.S. dollars)**
HSBC Holdings	2,966.00
Barclays plc.	1,834.00
Lloyds Banking Group	1,063.00
NatWest Group	872.72
Standard Charted plc	819.92
Santander UK	345.05
Nationwide Building Society	338.64

Source: Statista, 2023

HSBC Holdings is a British multinational banking and financial services organization with its headquarters in London, UK. It is one of the largest banks in the world and operates a global network with a presence in more than 62 countries. HSBC offers a wide range of financial services, including retail banking, commercial banking, investment banking, wealth management, and global markets. It serves millions of customers worldwide, catering to individuals, businesses, and institutions (HSBC, 2023).

Barclays plc is another major British multinational bank headquartered in London. It has a long history dating back to 1690 and operates globally with a strong presence in retail banking, corporate and investment banking, wealth management, and credit cards. Barclays serves individuals, businesses, and institutions, providing a wide range of financial products and services (Barclays, 2023).

Lloyds Banking Group is a leading British financial services company headquartered in London, UK. It is one of the largest retail banks in the UK, offering retail and commercial banking services, insurance, and wealth management. Lloyds Banking Group serves millions of customers through brands like Lloyds Bank, Halifax, and Bank of Scotland (Lloyds Banking Group, 2023).

NatWest Group, formerly known as The Royal Bank of Scotland Group (RBS), is a major banking and financial services organization headquartered in Edinburgh, Scotland. It operates under the NatWest, RBS, and Ulster Bank brands, providing comprehensive banking services to individuals, businesses, and institutions. NatWest Group is one of the largest banks in the UK (NatWest Group, 2023).

Standard Chartered is a British multinational bank headquartered in London with a primary focus on serving clients in emerging markets and Asia. It offers retail and commercial banking, corporate banking, and trade finance services. Standard Chartered's strategic emphasis on emerging markets sets it apart from many other international banks (Standard Chartered, 2023).

Santander UK is the British subsidiary of Banco Santander, a Spanish multinational banking group. It provides retail and commercial banking services to millions of customers in the UK. Santander UK operates a network of branches and offers various financial products, benefiting from its association with the broader Santander Group and its global presence (Santander UK, 2023).

Nationwide Building Society is one of the largest building societies in the UK, headquartered in Swindon, England. As a mutual financial institution owned by its members, Nationwide offers retail banking services, including savings accounts, mortgages, personal loans, and insurance products. It operates for the benefit of its members rather than shareholders (Nationwide Building Society, 2023).

3.1. Grey Rational Analysis

Grey Relational Analysis (GRA) is a technique used for decision-making and prediction that falls under the umbrella of Grey System Theory. In this method, the concept of "grey information" or "grey elements" is utilized to handle incomplete or limited data. GRA measures the varying relationships between two elements or subsystems within a specific system, indicating their level of similarity or dissimilarity. When changes between elements occur together in a continuous manner, a higher level of relation is observed, whereas if they do not occur together, a lower level of relation exists.

GRA is a valuable tool in situations where conventional statistical methods may not be applicable due to data limitations or uncertain conditions. It allows analysts to make informed decisions and predictions even when facing incomplete information. By examining the grey relations between elements, researchers can gain insights into the underlying patterns or connections in complex systems, helping them to identify important factors and relationships.

GRA can be employed for optimization tasks in various fields, such as engineering, finance, and manufacturing. By analyzing the relationships between different factors or variables, GRA helps identify optimal solutions or configurations. For instance, Hashemi et al., (2015) investigated the application of GRA in supplier selection by incorporating economic and environmental criteria. Another study (Zhu et al., 2022) examined the countries' entrepreneurial environment by using the GRE method. In addition to this, it can be used for forecasting future trends or behaviors by analyzing the relationships between historical data points. This can be valuable in fields such as economics, market research, and environmental studies.

In the context of commercial banks, GRA can be used to assess and compare the performance of different banks based on various financial indicators. By considering grey relations, banks can gain a deeper understanding of their relative strengths and weaknesses in different aspects of their operations. Moreover, GRA can aid decision-makers in identifying potential areas for improvement, optimizing resource allocation, and formulating effective strategies to enhance overall performance.

The calculation procedure for Grey Relational Analysis is outlined as follows (Liu et al., 2019; Ikram et al., 2020).

i. Formation of the Decision Matrix

A matrix is created with N alternatives (banks in the study) and k criteria (financial ratios in the study), where X_0 is the reference series (representing the reference bank in the study), and X_1, X_2, ..., X_i, ..., X_N represents the values for the respective alternatives with respect to the criteria.

$$X_0 = \{X_0(1), X_0(2), \dots, X_0(k)\}$$

$$X_1 = \{X_1(1), X_1(2), \dots, X_1(k)\}$$

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.

$$X_i = \{X_i(1), X_i(2), \dots, X_i(k)\}$$

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$$X_N = \{X_N(1), X_N(2), \ldots, X_N(k)\}$$

In the study, $X_i(k)$ denotes the kth financial ratio value of the ith bank.

ii. Creating the Comparison Matrix

Prior to calculating the Grey Relation Coefficients, it is necessary to standardize the data to compare indicators of varying dimensions. The data is converted to standard values according to the three conditions outlined below:

a) *Benefit situation:* Formula 1 is utilized when the objective is to achieve a better or larger value.

$$X_i^* = \frac{X_i(j) - Min_j X_i(j)}{Max_j X_i(j) - Min_j X_i(j)} \quad (1)$$

b) *Cost situation:* Formula 2 is used when the objective is to obtain a lesser or smaller value.

$$X_i^* = \frac{Max_j X_i(j) - X_i(j)}{Max_j X_i(j) - Min_j X_i(j)} \quad (2)$$

c) *Average type situation:* When the objective is to obtain an average value, one of the formulas (3), (4), or (5) is used.

$X_{ob}(j)$: It represents the target value for the jth element.

If $Min_j X_i(j) \leq X_{ob} \leq Max_j X_i(j)$ then $X_i^* = \frac{|X_i(j) - X_{ob}(j)|}{Max_j X_i(j) - Min_j X_i(j)}$ (3)

If $Max_j X_i(j) \leq X_{ob}(j)$ then $X_i^* = \frac{X_i(j) - Min_j X_i(j)}{X_{ob}(j) - Min_j X_i(j)}$ (4)

If $X_{ob}(j) \leq Min_j X_i(j)$ then $X_i^* = \frac{Max_j X_i(j) - X_i(j)}{Max_j X_i(j) - X_{ob}(j)}$ (5)

iii. Creating the Absolute Value Table

By considering the characteristics of the criteria, we calculate the coefficient differences. The coefficient difference represents the absolute difference between the rank number and the reference value.

$\Delta_{0i}(j)$ represents the absolute difference between X_0 and X_i for the jth item.

$$\Delta_{0i}(j) = |X_0(j) - X_i(j)| \quad (6)$$

iv. Formation of Grey Relation Coefficients

The grey relation coefficients are calculated using formula (7), where

$\Delta_{Max} = Max_i max_j \Delta_{0i}(j)$,

$\Delta_{Min} = Min_i min_j \Delta_{0i}(j)$

$$\gamma_{oi}(j) = \frac{\Delta Min + P\Delta Max}{\Delta_{oi}(j) + P\Delta Max} \quad (7)$$

The coefficient P in the formula is used to eliminate the possibility of extreme values in the Δmax data set and is generally taken as 0.5.

v. Calculation of Grey Relational Degrees

The grey relational degrees for the Xi series are calculated using the formula (8).

$$\Gamma_{oi} = \sum_{j=1}^{K} W_j \gamma_{0i}(j) \quad (8)$$

w_j: Weight of the jth element (representing the jth financial ratio in the study). If weights are not specified for the elements, $w_j = \frac{1}{K}$ can be taken as average (Liu *et al.*, 2019; Ikram *et al.*, 2020).

4. FINDINGS

The study presents the financial ratios of 13 different variables for the 7 largest commercial banks in the UK for the time period between 2020 and 2023. The values in Table 3 represent the decision matrix used in the initial phase of grey relation analysis.

Table 2: Decision Matrix of Banks in the UK

Bank Name	Year	Profitability		Interest Ratios		Capital Adequacy			Asset Quality			Funding and Liquidity		
		P1	P2	I1	I2	C1	C2	C3	A1	A2	A3	FL1	FL2	FL3
HSBC Holding Plc	2022	0.56	9.22	1.37	3.21	16.60	19.30	28.31	2.10	1.22	58.33	131.80	-8.20	31.24
	2021	0.49	7.61	1.12	2.47	18.60	21.20	28.34	1.80	1.08	59.87	139.00	4.13	34.18
	2020	0.21	3.29	1.14	2.81	18.70	21.50	28.74	1.84	1.38	74.80	139.10	14.15	29.40
Barclays Plc	2022	0.39	10.58	0.94	3.53	17.90	20.80	22.23	1.82	1.44	78.92	165.00	6.78	37.99
	2021	0.51	12.60	0.78	2.74	19.20	22.20	24.30	1.99	1.58	79.36	168.00	9.37	39.86
	2020	0.18	4.37	0.80	2.90	19.00	22.10	22.69	2.58	2.39	92.64	162.00	13.97	43.17
Lloyds Banking Group Plc	2022	0.62	12.59	1.81	3.32	17.10	19.70	24.02	1.66	0.98	59.14	144.00	-3.48	18.66
	2021	0.67	12.96	1.30	2.80	20.00	23.60	22.11	1.92	0.84	43.94	135.00	5.70	18.04
	2020	0.16	3.17	1.66	3.00	19.10	23.30	23.27	2.04	1.29	63.37	136.00	9.44	18.80
NatWest Group Plc	2022	0.46	10.50	1.69	2.94	16.40	19.30	24.46	1.46	0.98	67.39	157.00	-5.12	30.29
	2021	0.42	8.81	1.24	2.41	20.70	24.10	20.07	1.49	1.13	75.79	165.00	7.23	34.64
	2020	-0.06	-1.09	1.18	2.69	21.40	24.50	21.30	1.86	1.81	97.29	159.00	15.82	28.25
Standard Chartered Plc	2022	0.35	6.72	1.09	3.35	16.60	21.70	29.85	2.63	1.83	69.60	147.00	-2.17	25.90
	2021	0.29	5.12	1.02	2.35	16.60	21.30	32.76	2.64	1.84	69.85	146.00	7.95	28.43
	2020	0.10	1.71	1.09	3.01	16.50	21.20	34.07	3.13	2.24	71.77	145.50	8.71	25.86
Nationwide Building Society	2022	0.46	9.23	1.50	2.34	26.60	31.80	19.03	0.81	0.36	44.12	183.00	4.77	11.54
	2021	0.24	4.92	1.34	2.37	40.80	49.50	12.93	0.95	0.42	44.40	159.00	6.49	7.45
	2020	0.15	2.98	1.23	2.59	34.30	44.40	13.47	0.89	0.39	43.62	152.00	3.23	6.47
Santander UK Plc	2022	0.49	9.71	1.96	2.68	18.20	20.40	24.57	1.19	0.43	36.15	156.75	1.37	18.45
	2021	0.48	9.24	1.75	2.21	19.20	21.90	23.39	1.39	0.40	29.05	168.42	-1.13	21.63
	2020	0.16	3.11	1.44	2.26	18.50	21.20	24.60	1.38	0.65	46.86	150.00	7.29	21.43

Source: Author, 2023

Table 3 highlights that although all of the banks' profitability was low during the Covid-19 pandemic, profitability started to improve after 2020. Overall, HSBC Holding plc and Lloyds Banking Group plc show consistently higher profitability in ROAA, especially in the year 2022. Barclays plc and Santander UK plc also demonstrate respectable profitability levels, with some fluctuations between the years, specifically for Barclays plc. NatWest Group plc's profitability shows mixed results, with a negative ROAA in 2020. Standard Chartered plc has maintained a moderate level of profitability over the years. Nationwide Building Society's profitability demonstrates that its financial health and performance have improved significantly over the years.

Among the largest commercial banks in the UK, Lloyds Banking Group plc consistently stands out with higher values for both NIM and Interest Yield on Loans. This indicates that Lloyds has been successful in effectively managing its interest income, and its assets and loan portfolio have

generated favourable returns over the three-year period. HSBC Holding Plc and Santander UK Plc also showcase relatively strong performances, particularly in 2022, with higher NIM and Interest Yield on Loan ratios. This suggests that these banks have been successful in optimizing their interest-related activities and generating better returns compared to some other institutions. On the other hand, Standard Chartered plc and Barclays plc demonstrate somewhat fluctuating results over the years, with NIM values generally on the lower side. These banks may need to focus on optimizing their interest income to improve profitability and achieve more stable performance. NatWest Group plc and Nationwide Building Society show relatively stable performances, with moderate NIM and Interest Yield on Loan ratios. While their values are generally lower compared to some other banks, their consistent performance indicates that these institutions have been efficiently managing their interest-related activities.

Nationwide Building Society consistently stands out with significantly higher values for both Tier 1 Capital Ratio and Total Capital Ratio. This indicates that Nationwide has maintained a robust capital position and has a substantial buffer to cover potential risks, making it well-capitalized and resilient. On the other hand, Standard Chartered plc and NatWest Group plc demonstrate relatively stable performances in terms of capital ratios. While their ratios are generally lower compared to the Nationwide Building Society, they still maintain a healthy capital position, which is essential for ensuring stability and financial soundness. HSBC Holding plc, Barclays plc, and Santander UK plc show moderate capital ratios throughout the years, indicating that they have adequate capital to absorb potential losses and comply with regulatory requirements. However, compared to the Nationwide Building Society, they might consider further strengthening their capital positions to enhance resilience.

Nationwide Building Society consistently demonstrates the strongest loan quality performance, with significantly lower NPL ratios compared to other banks. This suggests that society has been successful in managing credit risk and maintaining a healthy loan portfolio with minimal impaired loans. Among the other banks, HSBC Holding plc, Barclays plc, and Santander UK plc also show relatively lower NPL ratios, indicating that they have been effective in controlling non-performing loans and maintaining sound loan quality. Regarding Loan Loss Provision Ratio (A2) and Loan Loss Coverage Ratio (A3), Standard Chartered plc and NatWest Group plc stand out with higher values. These banks have set aside higher provisions to cover potential loan losses and have a better ability to withstand potential credit losses.

Nationwide Building Society stands out with consistently higher Liquidity Coverage Ratios (FL1) compared to other banks. This indicates that the society holds a substantial amount of high-quality liquid assets to cover potential net cash outflows, demonstrating a robust liquidity position. HSBC Holding plc, Barclays plc, NatWest Group plc, and Standard Chartered plc also show relatively strong liquidity positions, as evidenced by their higher FL1 ratios. This suggests that these banks have been diligent in managing their liquidity risk and maintaining sufficient liquidity buffers. Regarding the Growth of Total Customer Deposits (FL2), all banks have demonstrated positive values, indicating growth in customer deposits over the years. However, Nationwide Building Society exhibits lower growth rates compared to some other banks, indicating a more conservative approach to increasing customer deposits. Lastly, the Liquidity Ratio (FL3) shows the proportion of liquid assets to total assets. Santander UK plc demonstrates higher values for FL3, indicating a relatively higher proportion of liquid assets in its overall asset composition.

In the second phase of Grey Relation Analysis (GRA), the comparison matrix was constructed using the financial ratios provided in Table 4. Except for C3 and A1 (Risk-Weighted Assets Ratio and Non-Performing Loans Ratio), the objective for the other financial ratios was to achieve higher values. As a result, equation (1) was utilized for transformation. However, for the financial ratios C3 and A1, the aim was to achieve a lower value, and thus, equation (2) was applied for transformation. To compare

the performance of commercial banks in the UK in terms of financial ratios, a reference bank was selected, and its data can be found in Table 4.

Table 3: Comparison matrix of banks in the UK

Bank Name	Year	Profitability		Interest Ratio		Capital Adequacy			Asset Quality			Funding and Liquidity		
		P1	P2	I1	I2	C1	C2	C3	A1	A2	A3	FL1	FL2	FL3
Reference Bank	2022	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	2021	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	2020	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
HSBC Holding Plc	2022	0.78	0.43	0.42	0.73	0.02	0.00	0.14	0.29	0.59	0.52	0.00	0.00	0.74
	2021	0.58	0.33	0.35	0.44	0.08	0.00	0.22	0.50	0.47	0.61	0.12	0.50	0.82
	2020	1.00	0.80	0.40	0.73	0.12	0.01	0.26	0.58	0.50	0.58	0.12	0.87	0.62
Barclays Plc	2022	0.15	0.66	0.00	1.00	0.15	0.12	0.70	0.45	0.73	1.00	0.65	1.00	1.00
	2021	0.63	0.96	0.00	0.90	0.11	0.04	0.43	0.38	0.82	1.00	0.99	1.00	1.00
	2020	0.89	1.00	0.00	0.85	0.14	0.04	0.55	0.25	1.00	0.91	1.00	0.85	1.00
Lloyds Banking Group Plc	2022	1.00	1.00	0.85	0.82	0.07	0.03	0.54	0.53	0.42	0.54	0.24	0.32	0.27
	2021	1.00	1.00	0.54	1.00	0.14	0.08	0.54	0.43	0.31	0.30	0.00	0.65	0.33
	2020	0.81	0.78	1.00	0.99	0.15	0.09	0.52	0.49	0.45	0.37	0.00	0.49	0.34
NatWest Group Plc	2022	0.41	0.64	0.74	0.50	0.00	0.00	0.50	0.64	0.42	0.73	0.49	0.21	0.71
	2021	0.42	0.48	0.47	0.34	0.17	0.10	0.64	0.68	0.51	0.93	0.90	0.80	0.84
	2020	0.00	0.00	0.44	0.57	0.28	0.14	0.62	0.57	0.71	1.00	0.88	1.00	0.59
Standard Chartered Plc	2022	0.00	0.00	0.15	0.85	0.02	0.19	0.00	0.00	1.00	0.78	0.30	0.40	0.54
	2021	0.12	0.02	0.25	0.24	0.00	0.00	0.00	0.00	1.00	0.81	0.33	0.86	0.65
	2020	0.59	0.51	0.34	1.00	0.00	0.00	0.00	0.00	0.93	0.52	0.37	0.44	0.53
Nationwide Building Society	2022	0.41	0.43	0.55	0.00	1.00	1.00	1.00	1.00	0.00	0.19	1.00	0.87	0.00
	2021	0.00	0.00	0.58	0.27	1.00	1.00	1.00	1.00	0.01	0.31	0.72	0.73	0.00
	2020	0.78	0.75	0.50	0.44	1.00	1.00	1.00	1.00	0.00	0.00	0.62	0.00	0.00
Santander UK Plc	2022	0.52	0.51	1.00	0.29	0.18	0.09	0.49	0.79	0.05	0.00	0.49	0.64	0.26
	2021	0.56	0.54	1.00	0.00	0.11	0.02	0.47	0.74	0.00	0.00	1.00	0.00	0.44
	2020	0.81	0.77	0.74	0.00	0.11	0.00	0.46	0.78	0.13	0.06	0.54	0.32	0.41

Source: Author, 2023

In the third phase of Grey Relation Analysis, the absolute value matrix is obtained by applying equation (6). Table 5 presents the absolute differences between the comparison values of commercial banks in the UK and the reference bank values.

Table 4: Absolute value matrix of banks in the UK

Bank Name	Year	Profitability		Interest Ratio		Capital Adequacy			Asset Quality			Funding and Liquidity		
		P1	P2	I1	I2	C1	C2	C3	A1	A2	A3	FL1	FL2	FL3
HSBC Holding Plc	2022	0.22	0.57	0.58	0.27	0.98	1.00	0.86	0.71	0.41	0.48	1.00	1.00	0.26
	2021	0.42	0.67	0.65	0.56	0.92	1.00	0.78	0.50	0.53	0.39	0.88	0.50	0.18
	2020	0.00	0.20	0.60	0.27	0.88	0.99	0.74	0.42	0.51	0.42	0.88	0.13	0.38
Barclays Plc	2022	0.85	0.34	1.00	0.00	0.85	0.88	0.30	0.55	0.27	0.00	0.35	0.00	0.00
	2021	0.37	0.04	1.00	0.10	0.89	0.96	0.57	0.62	0.18	0.00	0.01	0.00	0.00
	2020	0.11	0.00	1.00	0.15	0.86	0.96	0.45	0.75	0.00	0.09	0.00	0.15	0.00
Lloyds Banking Group Plc	2022	0.00	0.00	0.15	0.18	0.93	0.97	0.46	0.47	0.58	0.46	0.76	0.68	0.73
	2021	0.00	0.00	0.46	0.00	0.86	0.92	0.46	0.57	0.69	0.70	1.00	0.35	0.67
	2020	0.19	0.22	0.00	0.01	0.85	0.91	0.48	0.51	0.55	0.63	1.00	0.51	0.66
NatWest Group Plc	2022	0.59	0.36	0.26	0.50	1.00	1.00	0.50	0.36	0.58	0.27	0.51	0.79	0.29
	2021	0.58	0.52	0.53	0.66	0.83	0.90	0.36	0.32	0.49	0.07	0.10	0.20	0.16
	2020	1.00	1.00	0.56	0.43	0.72	0.86	0.38	0.43	0.29	0.00	0.12	0.00	0.41
Standard Chartered Plc	2022	1.00	1.00	0.85	0.15	0.98	0.81	1.00	1.00	0.00	0.22	0.70	0.60	0.46
	2021	0.88	0.98	0.75	0.76	1.00	1.00	1.00	1.00	0.00	0.19	0.67	0.14	0.35
	2020	0.41	0.49	0.66	0.00	1.00	1.00	1.00	1.00	0.08	0.48	0.63	0.56	0.47
Nationwide Building Society	2022	0.59	0.57	0.45	1.00	0.00	0.00	0.00	0.00	1.00	0.81	0.00	0.13	1.00
	2021	1.00	1.00	0.42	0.73	0.00	0.00	0.00	0.00	0.99	0.69	0.28	0.27	1.00
	2020	0.22	0.25	0.50	0.56	0.00	0.00	0.00	0.00	1.00	1.00	0.38	1.00	1.00
Santander UK Plc	2022	0.48	0.49	0.00	0.71	0.82	0.91	0.51	0.21	0.95	1.00	0.51	0.36	0.74
	2021	0.44	0.46	0.00	1.00	0.89	0.98	0.53	0.26	1.00	1.00	0.00	1.00	0.56
	2020	0.19	0.23	0.26	1.00	0.89	1.00	0.54	0.22	0.87	0.94	0.46	0.68	0.59

Source: Author, 2023

The Grey relation coefficients, computed using Equation (7) for commercial banks in the UK, are displayed in Table 6.

Table 5: Grey correlation coefficients of banks in the UK

Bank Name	Year	Profitability		Interest Ratio		Capital Adequacy			Asset Quality			Funding and Liquidity		
		P1	P2	I1	I2	C1	C2	C3	A1	A2	A3	FL1	FL2	FL3
HSBC Holding plc	2022	0.69	0.47	0.46	0.65	0.34	0.33	0.37	0.41	0.55	0.51	0.33	0.33	0.66
	2021	0.54	0.43	0.43	0.47	0.35	0.33	0.39	0.50	0.49	0.56	0.36	0.50	0.74
	2020	1.00	0.72	0.45	0.65	0.36	0.34	0.40	0.54	0.50	0.54	0.36	0.79	0.57
Barclays plc	2022	0.37	0.59	0.33	1.00	0.37	0.36	0.63	0.47	0.65	1.00	0.59	1.00	1.00
	2021	0.57	0.92	0.33	0.83	0.36	0.34	0.47	0.45	0.73	1.00	0.98	1.00	1.00
	2020	0.82	1.00	0.33	0.77	0.37	0.34	0.53	0.40	1.00	0.85	1.00	0.77	1.00
Lloyds Banking Group plc	2022	1.00	1.00	0.77	0.74	0.35	0.34	0.52	0.52	0.46	0.52	0.40	0.42	0.41
	2021	1.00	1.00	0.52	1.00	0.37	0.35	0.52	0.47	0.42	0.42	0.33	0.59	0.43
	2020	0.73	0.69	1.00	0.97	0.37	0.35	0.51	0.49	0.48	0.44	0.33	0.50	0.43
NatWest Group plc	2022	0.46	0.58	0.65	0.50	0.33	0.33	0.50	0.58	0.46	0.65	0.50	0.39	0.63
	2021	0.46	0.49	0.49	0.43	0.38	0.36	0.58	0.61	0.50	0.88	0.83	0.71	0.76
	2020	0.33	0.33	0.47	0.54	0.41	0.37	0.57	0.54	0.63	1.00	0.81	1.00	0.55
Standard Chartered plc	2022	0.33	0.33	0.37	0.77	0.34	0.38	0.33	0.33	1.00	0.70	0.42	0.46	0.52
	2021	0.36	0.34	0.40	0.40	0.33	0.33	0.33	0.33	1.00	0.73	0.43	0.79	0.59
	2020	0.55	0.51	0.43	1.00	0.33	0.33	0.33	0.33	0.87	0.51	0.44	0.47	0.51
Nationwide Building Society	2022	0.46	0.47	0.53	0.33	1.00	1.00	1.00	1.00	0.33	0.38	1.00	0.79	0.33
	2021	0.33	0.33	0.54	0.41	1.00	1.00	1.00	1.00	0.34	0.42	0.64	0.65	0.33
	2020	0.69	0.66	0.50	0.47	1.00	1.00	1.00	1.00	0.33	0.33	0.57	0.33	0.33
Santander UK plc	2022	0.51	0.50	1.00	0.41	0.38	0.35	0.49	0.71	0.34	0.33	0.49	0.58	0.40
	2021	0.53	0.52	1.00	0.33	0.36	0.34	0.49	0.66	0.33	0.33	1.00	0.33	0.47
	2020	0.73	0.68	0.66	0.33	0.36	0.33	0.48	0.70	0.36	0.35	0.52	0.42	0.46

Source: Author, 2023

Using Equation (8) from the methodology section, the grey relation degrees for commercial banks in the UK (Table 7) have been determined.

Table 6: Results of grey relational analysis for banks in the UK, 2022-2020

Bank Name	Year	Profitability 55.48%		Interest Ratio 60.88%		Capital 47.88%		Asset Quality 56.77%		Funding and 55.47%	
		Γ_{0i}	Rank	Γ_{0i}	Rank	Γ_{0i}	Rank	Γ_{0i}	Rank	Γ_{0i}	Rank
HSBC Holding plc	2022	57.89%	2	55.70%	6	34.65%	6	48.99%	6	44.29%	6
Barclays plc	2022	48.17%	5	66.67%	3	45.34%	2	70.91%	1	86.24%	1
Lloyds Banking Group plc	2022	100.00%	1	75.59%	1	40.34%	4	50.01%	5	40.82%	7
NatWest Group plc	2022	52.09%	3	57.80%	4	38.86%	5	56.56%	4	50.48%	3
Standard Chartered plc	2022	33.33%	7	56.87%	5	35.11%	7	67.66%	2	46.45%	5
Nationwide Building Society	2022	46.19%	6	42.96%	7	100.00%	1	57.13%	3	70.73%	2
Santander UK plc	2022	50.71%	4	70.59%	2	40.86%	3	46.10%	7	49.27%	4

Bank Name	Year	Profitability		Interest Ratio		Capital Adequacy		Asset Quality		Funding and Liquidity	
		55.97%		54.18%		47.50%		57.90%		64.03%	
		Γ(t)	Rank	Γ(t)	Rank	Γ(t)	Rank	Γ(t)	Rank	Γ(t)	Rank
HSBC Holding plc	2021	48.67%	4	45.35%	6	35.92%	6	51.62%	5	53.44%	6
Barclays plc	2021	74.56%	2	58.22%	3	38.87%	5	72.77%	1	99.18%	1
Lloyds Banking Group plc	2021	100.00%	1	75.94%	1	41.34%	3	43.31%	7	44.94%	7
NatWest Group plc	2021	47.72%	5	45.90%	5	43.83%	2	66.31%	3	76.56%	2
Standard Chartered plc	2021	35.01%	6	39.76%	7	33.36%	7	68.63%	2	60.02%	4
Nationwide Building Society	2021	33.33%	7	47.44%	4	100.00%	1	58.50%	4	53.95%	5
Santander UK plc	2021	52.51%	3	66.67%	2	39.14%	4	44.14%	6	60.13%	3

Bank Name	Year	Profitability		Interest Ratio		Capital Adequacy		Asset Quality		Funding and Liquidity	
		67.52%		61.39%		48.07%		58.11%		58.00%	
		Γ(t)	Rank	Γ(t)	Rank	Γ(t)	Rank	Γ(t)	Rank	Γ(t)	Rank
HSBC Holding plc	2020	85.83%	2	55.24%	4	36.74%	6	52.75%	5	57.46%	3
Barclays plc	2020	90.91%	1	55.33%	3	41.25%	3	75.03%	1	92.43%	1
Lloyds Banking Group plc	2020	71.22%	3	98.70%	1	41.22%	4	47.04%	6	41.98%	6
NatWest Group plc	2020	33.33%	7	50.60%	5	44.82%	2	72.29%	2	78.80%	2
Standard Chartered plc	2020	52.88%	6	71.50%	2	33.33%	7	57.18%	3	47.50%	4
Nationwide Building Society	2020	67.75%	5	48.58%	7	100.00%	1	55.56%	4	41.06%	7
Santander UK plc	2020	70.70%	4	49.74%	6	39.14%	5	46.93%	7	46.74%	5

Source: Author, 2023

The banks are ranked from 1 to 7, with 1 being the highest and 7 the lowest, in each criterion.

In 2022, Lloyds Banking Group plc stands out as the top-performing bank in terms of Profitability, receiving a perfect score of 100%. It also ranks high in Capital Adequacy, securing the first position. Nationwide Building Society excels in Asset Quality, earning the highest score, while Barclays plc holds the top position for Funding and Liquidity. On the other hand, Standard Chartered plc and Nationwide Building Society rank relatively lower in Profitability and Interest Ratio, respectively. Santander UK plc also falls behind in Capital Adequacy and Funding and Liquidity.

In 2021, Lloyds Banking Group plc exhibited strong profitability but faced challenges in asset quality, funding, and liquidity. Barclays plc showcased an impressive performance in interest ratios, funding, and liquidity, while Santander UK plc excelled in interest ratios, funding, and liquidity but had room for improvement in profitability and asset quality. NatWest Group plc demonstrated strength in funding and liquidity and performed well in interest ratios, capital adequacy, and asset quality, but its profitability could be enhanced. HSBC Holding plc showed a balanced performance across categories. Standard Chartered plc ranked lower in profitability, interest ratios, and capital adequacy but had better asset quality, funding, and liquidity management. Nationwide Building Society excelled in asset quality but ranked lower in profitability, funding, and liquidity.

In 2020, Barclays plc and Lloyds Banking Group plc stood out as the top performers in capital adequacy and interest ratios, respectively. Barclays plc also exhibited strong performance in funding and liquidity, securing the first rank in this category. However, Lloyds Banking Group plc faced challenges in asset quality, ranking sixth. HSBC Holding plc demonstrated solid profitability, funding, and liquidity, while Standard Chartered plc struggled in asset quality, ranking last in this aspect. NatWest Group plc ranked second in funding and liquidity and showcased satisfactory performance across other categories. Santander UK plc and Nationwide Building Society had relatively balanced

performances, with Santander UK plc ranking higher in profitability and Nationwide Building Society excelling in asset quality.

Table 7: Overall bank performance in the UK, 2022-2020

Rank	2022		2021		2020	
	Bank Name	$\Gamma_{\Phi 1}$	Bank Name	$\Gamma_{\Phi 1}$	Bank Name	$\Gamma_{\Phi 1}$
1	Barclays plc	63.47%	Barclays plc	68.72%	Barclays plc	70.99%
2	Nationwide Building Society	63.40%	Lloyds Banking Group plc	61.11%	Nationwide Building Society	62.59%
3	Lloyds Banking Group plc	61.35%	Nationwide Building Society	58.64%	Lloyds Banking Group plc	60.03%
4	Santander UK plc	51.51%	NatWest Group plc	56.07%	HSBC Holding plc	57.60%
5	NatWest Group plc	51.16%	Santander UK plc	52.52%	NatWest Group plc	55.97%
6	HSBC Holding plc	48.30%	Standard Chartered plc	47.36%	Standard Chartered plc	52.48%
7	Standard Chartered plc	47.88%	HSBC Holding plc	47.00%	Santander UK plc	50.65%

Source: Author, 2023

Barclays plc: Barclays maintains a consistent top position across all three years, indicating its robust performance and ability to excel in various performance metrics. This suggests that the bank has effectively managed its profitability, interest ratios, capital adequacy, asset quality, and funding and liquidity positions. Barclays' sustained top-ranking performance reflects its strong financial management and strategic decision-making.

Nationwide Building Society: Nationwide consistently secures a top-tier position, ranking second in 2022 and 2021 and third in 2020. This consistent performance suggests that the building society has managed to maintain a stable and balanced approach across various financial indicators. Nationwide's strength in asset quality, funding, and liquidity is evident from its consistently high rankings in these categories.

Lloyds Banking Group plc: Lloyds Banking Group shows a relatively stable performance, securing the third position in 2022 and 2020 and the second position in 2021. The bank performs well in profitability, interest ratios, and capital adequacy, which indicates its ability to generate profits, manage interest income, and maintain a strong capital base. However, Lloyds' ranking in asset quality could be an area for further improvement.

Santander UK plc: Santander's performance shows some fluctuation, securing the fourth position in 2022, the fifth position in 2021, and the seventh position in 2020. While the bank demonstrates strength in profitability and interest ratios, it seems to face challenges in other areas such as capital adequacy and asset quality. Santander's management may need to focus on improving these aspects to achieve a more consistent performance.

NatWest Group plc: NatWest's rankings exhibit moderate fluctuations, with the bank securing the fifth position in 2022 and 2020 and the fourth position in 2021. The bank performs well in profitability and interest ratios but faces challenges in capital adequacy and asset quality. Strengthening these areas could help NatWest achieve more stable and balanced performance over time.

HSBC Holding plc: HSBC's performance shows some variation, ranking sixth in 2022, fifth in 2021, and sixth in 2020. The bank demonstrates strength in profitability but appears to face challenges in capital adequacy and asset quality. HSBC's management may need to implement strategies to enhance its capital position and manage asset quality more effectively.

Standard Chartered plc: Standard Chartered's performance is relatively stable, ranking seventh in all three years. The bank performs well in terms of capital adequacy, funding, and liquidity but faces challenges in profitability and interest ratios. Standard Chartered could focus on improving its profitability and interest income generation to enhance its overall performance.

5. CONCLUSION

With technological advancement and competition, as well as the occurrence of crises, measuring the performance of banks, which are vital components of the financial system, has become increasingly crucial. The efficient functioning of banks is vital for a country's economic development, as they efficiently allocate capital, provide credit to productive sectors, and foster economic growth. However, the banking sector faces various challenges, including intense competition and the need to meet market demands. High-performing banks are rewarded with increased market share and opportunities for growth. This importance has led to the examination of the subject in the scientific field and its growing popularity. Due to the requirement of using numerous and normally distributed data in the statistical techniques commonly used to measure bank performance, this study employs grey relational analysis, which allows for comparison with limited data. The application of Grey Relational Analysis to financial ratios enables a comprehensive evaluation of bank performance, identifying key indicators that significantly influence their success.

Research Question 1: How does Grey Relational Analysis (GRA) allow for a comprehensive assessment and comparison of the financial performance of banks in the UK banking system?

Answer: Based on the results and analysis of the banks' performance over the years, GRA enables a comprehensive assessment and comparison of their financial performance by considering multiple key performance indicators. GRA helps identify trends, similarities, and differences in the performance of different banks across various categories such as profitability, interest ratio, liquidity and funds, asset quality, and capital adequacy. By quantifying the degree of similarity between each bank's performance and a reference bank's performance, GRA offers a holistic understanding of how banks are performing in relation to each other. This allows for an unbiased evaluation of their strengths and weaknesses, facilitating strategic decision-making, investment allocation, and risk management within the UK banking system.

Research Question 2: Which specific financial indicators within the categories of profitability, interest ratio, liquidity and funds, asset quality, and capital adequacy demonstrate the strongest influence on bank performance?

Answer: In our analysis using GRA, we found that different financial indicators hold varying degrees of influence on bank performance. Bank performance was measured by its ability to generate sustainable profits, maintain liquidity, manage assets efficiently, and ensure adequate capital reserves for risk management.

Profitability: Barclays plc has consistently ranked high in profitability over the years, indicating that its ability to generate profits significantly influences its overall performance. Lloyds Banking Group plc also demonstrates strong profitability, contributing to its stable performance.

Interest Ratio: Santander UK plc and NatWest Group plc exhibit strength in interest ratios, suggesting that efficient management of interest income plays a role in their overall performance.

Liquidity and Funds: Barclays plc consistently ranks well in funding and liquidity, showcasing its effective liquidity management. NatWest Group plc and HSBC Holding plc also demonstrate solid performance in funding and liquidity, indicating the importance of maintaining sufficient liquidity levels.

Asset Quality: The Nationwide Building Society consistently excels in asset quality, indicating that this factor strongly influences its overall performance. Standard Chartered plc struggles with asset quality, which affects its overall ranking.

Capital Adequacy: Lloyds Banking Group plc consistently performs well in capital adequacy, suggesting that maintaining a strong capital base is integral to its performance.

If the ratios used in the analysis were to change, it would have a direct impact on the results obtained from the GRA and the scores derived from it. Since GRA relies on the chosen set of ratios to measure the relationship between financial indicators and bank performance, any alteration in these ratios would affect the interpretation of their influence on performance. Therefore, the selection of appropriate ratios is crucial to ensuring the accuracy and relevance of the GRA outcomes. Any changes in the chosen ratios would necessitate a reassessment of the analysis and may lead to different conclusions regarding the key drivers of bank performance.

Overall, in the UK banking system, Lloyds Banking Group plc, Barclays plc, and Nationwide Building Society consistently show strong performance across different financial indicators. Despite the stable performance of certain banks, there is room for improvement in areas such as asset quality, funding, and liquidity. Policymakers can utilize these insights to refine regulatory measures and foster a strong and resilient banking sector. By prioritizing performance measurement and analysis, banks can remain competitive and contribute to sustainable economic growth.

Overall, GRA plays a crucial role in aiding strategic decision-making and risk management within the banking sector by helping to identify the factors that need to be improved. For instance, profitability is a critical factor influencing bank performance, with Barclays plc consistently ranking high in this aspect. UK banks should focus on strategic actions to boost profitability and secure their long-term success in the dynamic banking industry. By diversifying revenue, cutting costs, offering lucrative products, improving risk management, enhancing customer relations, and investing in innovation, banks can ensure steady growth and resilience in an ever-changing market. These steps are vital for navigating challenges and seizing opportunities in the competitive banking landscape. In addition to this, liquidity and asset quality emerge as critical factors shaping bank performance, with the Nationwide Building Society consistently excelling in these areas. By understanding the significance of these indicators, banks can prioritize resource allocation and implement targeted strategies to enhance their performance and resilience.

Furthermore, GRA's systematic approach facilitates risk management by assessing the interrelationships between different financial indicators and identifying potential risks and opportunities. For instance, banks can use GRA to proactively adjust their strategies in response to market fluctuations and changing regulatory environments. By identifying areas of vulnerability and opportunities for improvement, GRA empowers banks to mitigate risks and capitalize on growth opportunities effectively.

The research's primary contribution lies in its novel use of GRA as an alternative technique to measure and compare the financial performance of banks in the UK banking system. It differs from previous methodologies employed in the literature. While past studies have utilized methods like the Analytic Hierarchy Process, Technique for Order Preference by Similarity to Ideal Solution, Data Envelopment Analysis, and Quantile Regression models for assessing bank performance, GRE offers a unique and comprehensive methodology (Ilahi et al., 2014; Pan and Leu, 2016; Kula et al., 2016; Sarraf and Nejad, 2019). Furthermore, although the GRE has been utilized in studies focusing on insurance companies and investment banks, its application to evaluate commercial banks in the UK presents a distinct contribution. By employing GRE, this study aims to identify the key financial indicators that significantly influence bank performance within the UK banking sector. This approach provides valuable insights into the performance drivers of UK commercial banks, offering a new perspective for researchers, practitioners, and policymakers in the field of banking and finance.

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Appendix

Appendix 1: Data used in this study.

Bank Name	Year	Profitability		Interest Ratios		Capital Adequacy			Asset Quality			Funding and Liquidity		
		ROAA (%)	ROAE (%)	Net Interest Income /Average Earning Assets	Interest Income on Loans / Average Gross Loan	Tier 1 Capital Ratio	Total Capital Ratio	Risk Weighted / Total Assets	Imp. Loans (NPL) / Gross Loan	Loan Loss Allowances / Gross Loans	Loan Loss Allowances / Imp. Loans (%)	Liquidity Coverage Ratio	Growth of Total Customer Deposit	Liquid Asset / Total Assets
HSBC Holding Plc	2022	0.56	9.22	1.37	3.21	16.60	19.30	28.31	2.10	1.22	58.33	131.80	-8.20	31.24
	2021	0.49	7.61	1.12	2.47	18.60	21.20	28.34	1.80	1.08	59.87	139.00	4.13	34.18
	2020	0.21	3.29	1.14	2.81	18.70	21.50	28.74	1.84	1.38	74.80	139.10	14.15	29.40
Barclays Plc	2022	0.39	10.58	0.94	3.53	17.90	20.80	22.23	1.82	1.44	78.92	165.00	6.78	37.99
	2021	0.51	12.60	0.78	2.74	19.20	22.20	24.30	1.99	1.58	79.36	168.00	9.37	39.86
	2020	0.18	4.37	0.80	2.90	19.00	22.10	22.69	2.58	2.39	92.64	162.00	13.97	43.17
Lloyds Banking Group plc	2022	0.62	12.59	1.81	3.32	17.10	19.70	24.02	1.66	0.98	59.14	144.00	-3.48	18.66
	2021	0.67	12.96	1.30	2.80	20.00	23.60	22.11	1.92	0.84	43.94	135.00	5.70	18.04
	2020	0.16	3.17	1.66	3.00	19.10	23.30	23.27	2.04	1.29	63.37	136.00	9.44	18.80
NatWest Group plc	2022	0.46	10.50	1.69	2.94	16.40	19.30	24.46	1.46	0.98	67.39	157.00	-5.12	30.29
	2021	0.42	8.81	1.24	2.41	20.70	24.10	20.07	1.49	1.13	75.79	165.00	7.23	34.64
	2020	-0.06	-1.09	1.18	2.69	21.40	24.50	21.30	1.86	1.81	97.29	159.00	15.82	28.25
Standard Chartered PLC	2022	0.35	6.72	1.09	3.35	16.60	21.70	29.85	2.63	1.83	69.60	147.00	-2.17	25.90
	2021	0.29	5.12	1.02	2.35	16.60	21.30	32.76	2.64	1.84	69.85	146.00	7.95	28.43
	2020	0.10	1.71	1.09	3.01	16.50	21.20	34.07	3.13	2.24	71.77	145.50	8.71	25.86
Nationwide Building Society	2022	0.46	9.23	1.50	2.34	26.60	31.80	19.03	0.81	0.36	44.12	183.00	4.77	11.54
	2021	0.24	4.92	1.34	2.37	40.80	49.50	12.93	0.95	0.42	44.40	159.00	6.49	7.45
	2020	0.15	2.98	1.23	2.59	34.30	44.40	13.47	0.89	0.39	43.62	152.00	3.23	6.47
Santander UK plc	2022	0.49	9.71	1.96	2.68	18.20	20.40	24.57	1.19	0.43	36.15	156.75	1.37	18.45
	2021	0.48	9.24	1.75	2.21	19.20	21.90	23.39	1.39	0.40	29.05	168.42	-1.13	21.63
	2020	0.16	3.11	1.44	2.26	18.50	21.20	24.60	1.38	0.65	46.86	150.00	7.29	21.43