GAU Journal of Social Science
ISSN: 3062-0333 | Volume: 01 Issue: 03

Machine Learning for Financial Statement Analysis and Forecast: A Case Study of Guaranty Trust Holding Company PLC (GTCO).

Ayomide Oluwadamilola Sobowale[1], Joshua Sopuru[2]
Faculty of Business and Economics, Girne American University, Cyprus [1,2]

**Corresponding Email: joshuasopuru@gau.edu.tr*

DOI: https://doi.org/10.64192/925glxn

Received: 16.02.25 *Accepted: 03.03.25* *Published: 18.03.25*

Abstract: *This thesis explores the integration of machine learning techniques into financial statement analysis and forecasting within the context of the Nigerian Banking Industry. The primary objectives are to predict the financial health and profitability of companies, enhance data-driven investment decisions, reduce the risk of financial losses for investors, and advance the application of machine learning in finance by substituting traditional analysis methods. The study focuses on GTCO, a prominent entity listed on the Nigerian Stock Exchange. Initially, traditional annual report analysis serves as a foundation for understanding the company's financial performance. Subsequently, a predictive model is developed using four machine learning algorithms: Random Forest, K-Nearest Neighbour, Logistic Regression, and Naïve Bayes. The outcomes of this research contribute to a nuanced understanding of machine learning's efficacy in financial analysis, offering a potential paradigm shift from conventional methodologies. The proposed model not only aids in predicting financial health and profitability but also empowers investors with valuable insights, mitigating financial risks in the dynamic Nigerian Banking Industry. This study thus marks a pivotal step towards fostering a data-driven investment landscape and embracing machine learning applications in financial decision-making.*

Keyword:
Financial Statement,
Annual Report,
Machine Learning Algorithms,
Machine Learning Models,
Random Forest,
K-Nearest Neighbour,
Logistics Regression,
Naïve Bayes

INTRODUCTION

Every individual has a quest for financial freedom, and our desire to have several investment portfolios is increasing due to the longing for financial liberty. We often admire investors like Warren Buffett, Benjamin Graham, who have become successful in investment with a proper understanding of the market and by even setting investment rules

to guide their decisions. Sadly, many investors today do not have adequate financial acumen, thereby leading them to make bad decisions, which leads to losses. In order to limit investment losses, investors should fully understand and be able to analyze a company's annual report. The analysis of financial statements is used to evaluate the financial performance of an organization. It entails analyzing historical financial reports to identify patterns and predict future performance. This evaluation is conducted through an examination of the organization's balance sheet, cash flows, and income statement. Financial statement analysis is employed by both internal and external stakeholders of a company to effectively run the company, make prudent investments, and compare it with other companies. It is used by external stakeholders to have an idea of the business value and the general well-being and performance of an organization, while internal users utilize it as a management tool. In the past few decades, financial constituents have carried out this analysis manually, following the accounting procedures they are acquainted with. However, the evolution of technology has revolutionized the financial sector. Financial statement analysis can now be done with the use of Machine Learning (ML); however, Nigeria's financial sector has not fully integrated this technology into some areas of the industry.

Machine learning is a branch of artificial intelligence (AI) that allows computers to acquire knowledge and improve their performance by analyzing and interpreting data and discovering patterns that are not evident to humans. It has been used for many applications, such as stock market prediction, fraud detection, and financial statement analysis. The process of machine learning for financial statement analysis is done by developing models that learn from available data and apply the acquired knowledge to make decisions and predictions. ML algorithms have become increasingly popular in financial statement analysis and forecasting due to their ability to automate the process and provide more accurate predictions. ML algorithms can identify patterns in data that are not easily detected by humans. This has reduced the amount of time and effort required for financial statement analysis and forecasting. This AI has been of great benefit to so many sectors, most especially the Nigerian Stock Exchange Market, which is the focus of this research (Obadiaru et al., 2020).

With the largest economy in Africa, Nigeria is home to the primary stock exchange, the Nigerian Stock Exchange (NSE). This exchange has experienced significant growth in the past two decades, and its market capitalization has grown from US$15 billion in 2007 to US$3.4 trillion in 2022. With the increasing complexity of financial markets, investors and financial analysts are increasingly relying on machine learning techniques to analyze and forecast the stock prices of companies that are listed on the NSE. Furthermore, machine learning algorithms can be employed to create predictive models for forecasting stock values.

Investors use financial statement analysis as a key tool to assess a company's profitability, financial health, and potential for future growth. However, there are certain errors investors make that result in poor investment decisions. Numerous investors possess an inadequate comprehension of financial statement analysis, leading them to make decisions based on their limited understanding of financial analysis or their inability to effectively evaluate a company's financial status or forecast its future performance. When assessing financial accounts, investors usually concentrate on certain ratios like Earnings per Share (EPS), Return on Assets (ROA), Return on Equity (ROE), and Dividend Yield. However, it is crucial to note that these metrics are significant but not the only factors to consider when making investment decisions. An investor may invest in a company that appears profitable based on its recent financial results but fails to consider long-term trends or underlying issues that could impact its future performance. Alternatively, an investor may overlook a company with strong long-term potential because they do not understand how to interpret its financial statements. These errors can lead to financial losses for investors.

Moreover, investment decisions in the Nigerian Stock Exchange Market play a pivotal role in its growth and development. However, traditional approaches to analyzing financial statements are complex and prone to human fallibility, thereby compromising the precision of financial forecasts and investment choices. To make informed investment decisions, investors must possess precise and dependable information regarding the financial performance and durable competitive advantages of

listed companies. The primary goal of this study is to develop machine learning models that can accurately forecast the financial performance of firms and identify companies with sustainable competitive advantages in the Nigerian Stock Exchange Market. This

will be done by analyzing the financial report of GTBank Plc, one of the leading firms in the Nigerian banking sector, listed on the stock exchange market.

Research Questions

This study seeks to address the following research questions:

1. To what extent will the use of machine learning for financial analysis impact the role of financial sector internal stakeholders?

2. Can machine learning algorithms be used to identify patterns in financial statement data and provide insights on making decisions about investments in GTCO?

3. To what extent does the choice of machine learning algorithm affect the accuracy of financial statement analysis and forecasting of GTCO?

4. What is the most effective feature selection technique for financial statement analysis using machine learning algorithms?

5. What are the most important financial ratios and variables that contribute to the accuracy of the machine learning models in forecasting the financial health of Guaranty Trust Holding Plc?

Objectives of Study

This study aims to develop machine learning models that can forecast the financial performance of firms and identify companies with sustainable competitive advantages in the Nigerian Stock Exchange Market, in order to help investors make well-informed and data-driven decisions.

Specific Objective

1. To examine the financial report methods and machine learning techniques used on the Nigerian Stock Exchange Market.

2. To collect financial data of a sample company listed on the Nigerian Stock Exchange over a period of 12 years.

3. To review the impact of economic variables that determine the financial performance of a company that is listed on the Nigerian Stock Exchange.

4. To identify the key elements that contribute to sustainable competitive advantages in the Nigerian Stock Exchange Market by conducting a systematic review of existing literature.

5. To develop machine learning models that can accurately analyze a company's financial statement and identify companies with sustainable competitive advantage, which will help investors make informed decisions.

6. To compare the forecasting accuracy of the developed machine learning models with the traditional financial statement analysis methods currently used in the Nigerian Stock Exchange Market.

7. To provide practical recommendations for the use of machine learning in financial statement analysis and forecasting in the Nigerian Stock Exchange Market.

Literature Review & Hypothesis Development

Economic Indicators

The Nigerian stock exchange (NSE) ranks as one of the biggest stock exchanges in Africa, serving as a barometer for the Nigerian economy. It's said to have a market capitalization of N22 trillion as of March 2023, and its stock market direction is strongly influenced by economic indicators. Investopedia defines economic indicators as a statistical measure of economic performance that is often referred to as macroeconomic indicators, which are used by analysts to interpret economic conditions and opportunities in the future. These indicators provide information on various economic factors such as inflation, employment, and production, which are critical to policymakers, businesses, and investors in making informed decisions. Some researchers have conducted studies on the importance of economic indicators in macroeconomic analysis and forecasting. For example, Fama and French (1988) examined the relationship between stock returns and some economic indices such as inflation, dividend yield, and earnings yield. The authors

discovered that a sizable portion of the variation in stock returns could be explained by these indicators.

Concerning financial statement analysis, some research gaps need to be addressed. One of the main gaps in the past study is the limited focus on the effectiveness of economic

indicators in predicting financial distress. The ability of economic indicators to forecast stock prices and company performance has been the subject of numerous studies, but little is known about how well these indicators can predict financial distress. A study by Altman and Sabato (2005) developed the Z-score model, which uses economic indicators to predict the likelihood of a company going bankrupt. More study is still required, though, to determine how well economic indicators foretell financial distress.

Finally, it is necessary to conduct research on the impact of new technologies such as artificial intelligence and big data on financial statement analysis. These technologies can provide new insights into economic indicators and allow for more accurate predictions of future performance. A study by Liang et al. (2019) studied the application of machine learning algorithms to the prediction of future stock prices, however, the influence of new technology on economic indicators has to be the main focus of future studies.

Gross Domestic Product (GDP)

The Gross Domestic Product (GDP) is a crucial indicator of economic activity in a country. It refers to the whole amount of products and services produced over some time. Notably, GDP gives a comprehensive summary of a country's economic well-being, making it an essential economic indicator. Research studies have demonstrated a direct and positive relationship between GDP growth and stock market performance. (Siddiqui, Ahmad, & Ahmad, 2019; Oladipo, Oyewunmi, & Oyinloye, 2021). In Nigeria, GDP growth rates have been unstable in recent years, with a significant decline in 2020 primarily due to the impact of the COVID-19 pandemic. However, experts predict that the GDP will recover shortly Oyinloye et al, 2021). Several research papers have examined the relationship between the Nigerian stock exchange market and GDP, and the majority have demonstrated a positive relationship. (Olaoye, 2016; Lawal & Yusuf, 2018; Amadi, 2021). This reinforces the importance of paying attention to GDP growth while analyzing the Nigerian stock exchange market, particularly for investors and financial analysts.

Inflation Rate

The stock exchange market's performance is significantly influenced by the inflation rate, a crucial economic indicator. Inflation rate denotes a continuous increase in the price of goods and services over a period of time. It is a significant factor as high inflation can lead to a decline in the purchasing power of a currency, ultimately resulting in an adverse effect on the stock exchange market. This has been the case in Nigeria, where the inflation rate was 17.33% in February 2021 (National Bureau of Statistics, 2021), indicating a significant decline in consumer confidence and investment. The Nigerian stock exchange market has been negatively affected by the high inflation rate, as shown in various studies that have found a negative correlation between the two (Akpan & Udoma, 2016; Yusuf & Oladipo, 2017; Oyinloye et al., 2021). This implies that while examining the Nigerian stock exchange market, investors and financial experts have to consider the inflation rate.

Industry Trends

An essential component of financial statement analysis is industry trends, particularly in the context of the Nigerian stock exchange market. Industry trends offer useful insights into the economic climate, market dynamics, and competitive environment that impact the financial performance of organizations within a specific industry.

Multiple studies have investigated the correlation between industry trends and financial statement analysis in the Nigerian stock exchange market. A study conducted by Alao and Okunlola (2020) examined the influence of industry changes on the financial performance of specific companies in the manufacturing sector through the utilization of financial ratios. The study determined that industry dynamics, including shifts in customer preferences, market demand, and competitive factors, exert a substantial influence on the profitability, liquidity, and solvency of manufacturing enterprises.

Similarly, a study by Adeyemi et al. (2020) examined the correlation between industry changes and the financial performance of certain firms in the Nigerian stock exchange market. They employed machine learning techniques to assess the data. The study discovered that industry trends, including shifts in macroeconomic circumstances, regulatory policies, and technological advancements, exert a substantial influence on companies' financial performance. Furthermore, machine learning algorithms such as

Random Forest and Support Vector Machine proved to be successful in forecasting companies' financial performance using industry trend data.

Company Sıze

In analyzing financial statements, the size of the firm must be considered as it offers valuable information about the company's ability to create profits, handle risks, and

maintain development in the long term. Several studies have been conducted to examine how company size is a significant factor in analyzing a firm's financial statement. For example, a study by Fasan and Gbadebo (2017) examined the influence of firm size on financial performance using financial ratios of selected firms in the Nigerian stock exchange market. The study found that larger companies tend to have higher profitability, liquidity, and solvency ratios than smaller companies. Furthermore, the study identified a direct relationship between the size of a firm and its financial performance. This implies that larger companies have a greater ability to handle risks, take advantage of economies of scale, and maintain long-term growth.

Market Capitalization

Market capitalization is a widely employed measure for evaluating the financial well-being of companies listed on the Nigerian Stock Exchange (NSE). A business's market capitalization, which represents the total value of its outstanding shares, is calculated by dividing the share price of the company by the total number of outstanding shares. When analyzing financial statements, market capitalization is a crucial component because it shows the size, liquidity, and growth potential of the business.

The relationship between market capitalization and financial statement analysis in the Nigerian stock exchange market has been the subject of several studies. Market capitalization and the performance of companies listed on the NSE between 2012 and 2016 were analyzed by Olaoye and Eriki (2019). According to the study, there is a significant link between market capitalization and performance, which suggests that larger companies with higher market capitalizations typically perform financially better than smaller ones with lower market capitalizations.

Revenue

The company's capacity to earn income from its fundamental business operations is seen in its revenues, which are an important consideration in financial statement analysis. This metric is used by analysts and investors to assess the profitability and financial health of a firm. The revenue figure is usually the top-line number on a company's income statement and is one of the most important factors in assessing a company's potential for profits. When revenues are increasing, it generally suggests that a company's business is growing and expanding, which can result in increased profit and stock prices. Conversely, a decrease in revenues may suggest that a company is facing difficulties in upholding its market position or encountering operational obstacles. Multiple research projects have examined the correlation between revenues and financial statement analysis in relation to the Nigerian stock market.

Adegbaju and Adaramola (2018) conducted a study to investigate the connection between financial ratios and corporate performance in the Nigerian banking industry. According to the study, there is a substantial and positive relationship between the performance of a company and its revenues, meaning that higher revenues are associated with better financial performance. Comparably, a study conducted by Adegbite and Adebola (2015) looked at how corporate governance affected the performance of the Nigerian banking industry. The research discovered a positive correlation between revenues and financial performance, indicating that businesses with higher revenues typically had better financial performance.

Profit Margin

Profit margin is a key financial parameter that investors use to evaluate a company's financial health. It stands for the percentage of sales income that a company retains following the payment of all expenses. Investors are typically more interested in companies that regularly maintain high profit margins compared to those with low profit margins.

Okpala and Obi (2018) discovered a positive correlation between the profit margin, returns on equity, assets, and earnings per share of publicly traded companies in Nigeria. Additionally, they recommended that when choosing an investment, investors should take profit margin into account. Oladejo and Oluwole (2020) looked at the impact of internal

variables on the profit margin of firms listed on the Nigerian stock exchange market, including firm size, liquidity, and leverage. They discovered that while leverage has a negative impact on profit margin, firm size and liquidity have a positive and substantial influence.

Earnings per Share (EPS)

EPS, as highlighted by Ogundipe and Idowu (2017), is a crucial factor influencing stock prices in the Nigerian market. It holds significance for investors as it offers valuable

information about a firm's financial performance and its prospects for expansion. A high earnings per share (EPS) is a positive indicator for investors since it indicates that the firm is making more money for each share. When assessing the financial performance of businesses in the same sector or industry, EPS is frequently used as a benchmark.

Return on Equity (ROE)

Return on Equity (ROE) is a financial metric that is used to evaluate the profitability of a business. It is computed by dividing net income by equity held by shareholders in the firm. It quantifies the profitability of a corporation by calculating the ratio of its profit to its shareholder equity. Several studies have been done on how ROE is related to other metrics on the financial statement and its determinants. However, despite the extensive research on ROE, there are still research gaps in this area. For example, further research is required to investigate the variables that impact Return on Equity (ROE) in various sectors.

Return on Asset (ROA)

Return on assets (ROA) is a vital metric that quantifies a firm's profitability in relation to its overall assets. Despite the importance of ROA for financial statement analysis, several studies indicate that investors may have a limited comprehension of this indicator and its importance in making investment choices. For example, in a study conducted by Jokhio and Memon (2018), it was discovered that investors in Pakistan lacked a complete understanding of the importance of Return on Assets (ROA) in financial statement analysis. Instead, they preferred to prioritize metrics such as earnings per share and price-

to-earnings ratios. This lack of understanding of ROA and other financial metrics can lead to suboptimal investment decisions and potentially negative outcomes for investors.

Stock Price

The stock price is the present market price of a firm's stock, indicating the price at which investors are willing to purchase or sell shares. The stock price is a vital indicator for analyzing financial statements and is utilized to evaluate the financial well-being and prospective growth of banks listed on the NSE. Several studies have been carried out to examine the relationship between stock price with other variables and what influences it. Fama and French (1988) looked at the relationship between stock prices and variables that are specific to a company, like earnings, dividends, and book value. The study discovered that these variables highly influenced stock prices, with earnings being the most important factor. Similarly, the relationship between stock prices and macroeconomic factors like inflation and interest rates was examined in another study by Shiller (1989). According to the study, inflation was the most significant factor that had a significant impact on stock prices among macroeconomic variables.

Dividend Yield

Dividend yield is a financial metric that quantifies the proportion of dividends distributed by a firm in relation to its stock price. Dividend yield is a crucial indicator employed in the assessment of the financial well-being and profitability of a company, specifically in the study of financial statements of banks listed on the Nigerian stock exchange market. As banks in Nigeria are required by law to pay out a minimum of 30% of their net profit as dividends to shareholders, dividend yield serves as a significant indicator of a bank's ability to create returns for its investors.

So many studies have been conducted to examine how important this metric is in making investment decisions. In a study by Elshandidy, Hassanein, and Gaber (2017), they analyzed how dividend yield affected stock returns on the UK stock market. According to the study, investors valued companies that paid higher dividends because dividend yield was a significant predictor of stock returns. Dividend yield was also found to be more important for small-cap stocks than large-cap stocks by the study's findings. Similarly, Majeed, Azam, and Amjad (2017) examined the influence of dividend yield on stock prices in Pakistan. In the research study, companies that paid higher dividends were valued

by investors because they had a significant positive impact on stock prices through dividend yield. The study also discovered that companies in the consumer goods and financial sectors were more interested in dividend yield.

METHODOLOGY

The mixed methodology was employed to achieve a full understanding of this investigation. This approach comprises both quantitative and qualitative research methods. This method facilitates a comprehensive analysis of the issue by taking into account both subjective and objective perspectives.

The quantitative method involves the collection and analysis of numeric data from one of the companies listed on the Nigerian Stock Exchange market (NSE), GTBank Plc. An in-depth analysis of the company's financial statement for a period of 12 years was carried out using the traditional financial statement analysis method. The qualitative method was used in this thesis mainly for the literature review.

Previous studies on financial statement analysis and Machine Learning were thoroughly examined, finding gaps in the literature and posing questions for further studies. This method was also used to critically examine previous research on the independent and dependent variables of this subject. It also assessed what researchers have studied with respect to identifying the sustainable competitive advantage of companies listed on the NSE, thereby addressing one of the objectives of this study. Finally, this method allowed me to evaluate the machine learning techniques and models performed in previous studies.

Sampling Method

A non-probability sampling method will be used to sample the thesis topic. The study utilizes a purposive probability sampling technique to collect data from the financial statements of Guarantee Trust Bank Limited (GTBank Plc.), which is one of the firms listed on the Nigerian Stock Exchange Market (NSE). This sampling technique was chosen because the data does not involve a random selection.

Source of Data

Data will be gathered from GTBank Plc, one of the prominent banks in the Nigerian stock exchange market, using purposive sampling, a non-probability sampling method. In this instance, GTBank was chosen as a data source because it has the largest financial statement of banks listed on the stock exchange market. GTBank's annual reports encompass the metrics and ratios needed to analyze the data. The data accessible from the company enables us to determine the sustainability of the firm.

Data Collection

To collect data for this study, a secondary data collection method was used. The data was collected from Guarantee Trust Bank Limited (GTBank Plc.) financial statement over the period of 12 years.

Using a 12-year sample size of data from the list of GTBank annual reports, this data would be used to develop a model and create a trend that the machine learning can follow in order to forecast the performance of the company.

Data Analysis

The Annual Reports of Guaranty Trust Bank Limited from 2009 to 2022 was analyzed technically using the horizontal financial statement analysis method and some ratios like Return to Equity (ROE), Return on Asset (ROA), Net Interest Income, Non-Interest Income, Debt to equity ratio, Capital Adequacy Ratio, Operating Expenses, Dividend Yield, etc.

Results & Findings

The data we collected for this study encompasses GTBank's annual report from the year 2009 to 2022, excluding 2010 and 2015. The horizontal financial statement analysis method was used to traditionally analyze the bank's financial statement, and the results derived from this analysis are represented in the table below;

Table (1): Traditional analysis of GTBank Annual Report 2009-2022.

Year	Net Interest Income	Non-Interest Income	Debt-to-equity ratio	Capital Adequacy Ratio	Operating Expenses	Return on Equity (ROE)	Return on Asset (ROA)	Dividend Yield	Earnings per share (EPS)	Stock Price
2009	73,468,110	40,808,407	4.4	25.99%	82%	12%	2.34 %	1.5%	128 Kobo	50 kobo
2011	95,522,806	48,378,608	1.0	23.03%	63%	22%	3.34 %	8.97%	164 Kobo	₦12.25
2012	123,098,741	44,199,867	4.6	24%	0,32 or 32%	30%	5.26 %	9.87%	₦2.90	₦15.70
2013	127,857,215	49,285,953	4.8	22.27%	44.47%	25.95 %	4.49 %	7.97%	₦2.91	₦21.31
2014	128,698,830	69,022,777	4.8	21.40%	53.08%	25.28 %	4.39 %	6.80%	₦3.17	₦22.03
2016	171,027,957	139,337,380	4.5	19.79%	40.54%	26.59 %	4.85 %	8.16%	₦4.31	₦24.61
2017	217,649,619	75,794,761	3.8	25.50%	45.10%	27.60 %	5.70 %	10.21 %	₦5.48	₦26.44
2018	188,441,907	98,521,378	4.3	23.4%	46.26%	32.61 %	6.15 %	7.61%	₦5.67	₦36.12
2019	189,318,029	109,749,294	4.1	20.66%	42.42%	28.90 %	5.65 %	9.30%	₦5.95	₦30.08
2020	208,932,503	123,485,182	4.8	19.55%	41.23%	25.36 %	4.38 %	13.16 %	₦6.05	₦22.79
2021	0	8,829,354	4.41	23.83%	6.2%	6.02%	5.76 %	11%	28 Kobo	₦27.83
2022	0	2,092,332	1.89	24.08%	8.17%	64%	54%	13%	₦3.01	₦24.38

When analyzing financial statements, most especially for investment purposes, there are certain metrics that analysts look out for to determine the best investment. Investors who are not well informed of financial analysis have been educated to only look out for metrics or ratios like Earnings per Share, Net Income, Return on Assets (ROA), Return on Equity (ROE), and Dividend Yield, etc. As important as these ratios are, they are not the only factors that determine the bank's general state of health, which will aid in its ability to make wiser investment choices.

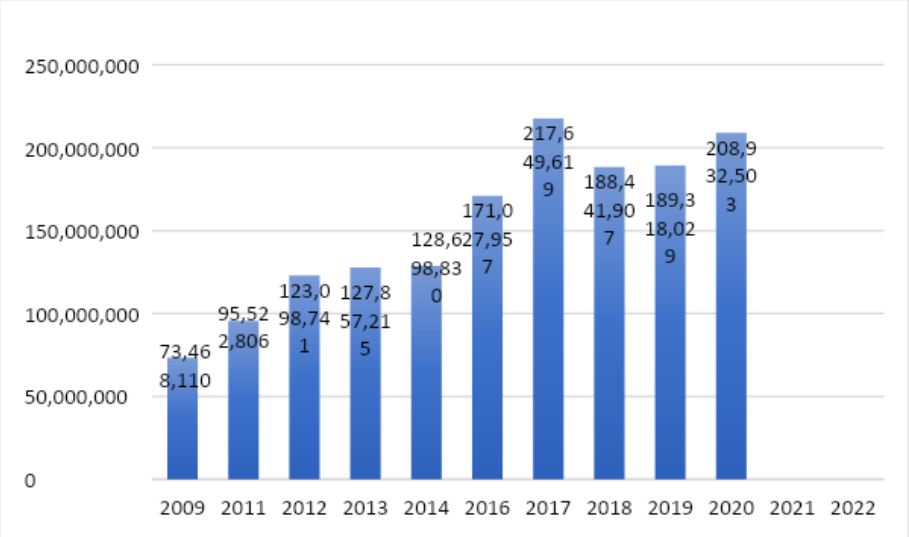
In determining the best investment decision, each of these metrics and ratios is evaluated in accordance with the general guidelines of the industry. The results obtained for each data point are explicitly explained below:

Net Interest Income

In 2009, the net interest income for GTBank was ₦73,468,110 out of a total interest income of ₦110,889,700. This indicates a high interest income, which means the bank is generating more revenue from its interest-earning assets than it is paying out on its interest-bearing liabilities. Of ₦37,421,590, which is indicative of a wise investment. The financial statement in 2011 reported a net income interest of ₦95,522,806, reflecting a 30% increase from the previous year. The net interest rate increased in the following year, 2012, by 28.8%, the annual report recorded ₦123,098,741 as total Net interest income.

However, the net interest income didn't reflect much increase in 2013 and 2014, it grew slightly from ₦127,857,215 to ₦128,698,830, reflecting an increase of 3.9% and 0.66% respectively. This is due to the fact that the bank had little revenue from interest on loans and securities, and it had few expenses to pay on its interest-bearing liabilities, like deposits and borrowings. The net interest income picked up in 2016 by 32.89%, with the total net interest income being ₦171,027,957. In 2017, the net interest income grew from ₦171,027,957 to ₦217,649,619, representing a 27.3% increase and the highest metric in our data set. The results from 2018 to 2022 are represented below in the bar chart. There was a 0.46% increase from 2018 to 2019 and a 10.36% increase from 2019 to 2020. However, the financial statements of the bank in 2021 and 2022 did not reflect any net interest income.

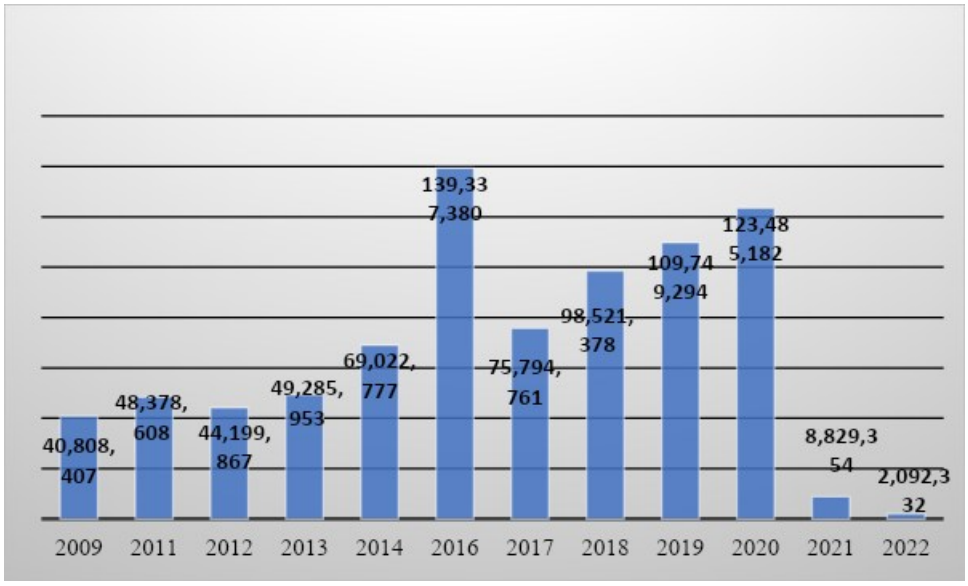
Figure 1: GTBank Plc. Net Income Interest 2009 -2022



Non-Interest Income

As established earlier, Non-interest income is the revenue a financial institution earns from activities other than borrowing and lending money. These other sources of revenue could be generated from fees like commission income, trade gains, insurance income, etc. The Non-Income Interest derived for this study is represented in the figure below.

Figure 2: GTBank Plc. Non-Interest Income 2009-2022



The bank's non-interest income amounted to ₦40,808,407 in 2009, and in 2011, their annual statement reported ₦48,378,608 as Non-interest income, reflecting an 18.6% increase. However, this metric reduced by 3.7% in 2012 and picked up again by 11.5% and 40% in 2013 and 2014, respectively. In 2016, the non-interest income increased from ₦69,022,777 in the previous year (2014) to ₦139,337,380, reflecting more than a 100% increase. This increase might not reveal the accurate picture of the data due to the year gap of 2015 in our data set, this year gap is one of the limitations faced in this study, which will be discussed later on in this study.

This metric decreased in 2017 with a decrease of 45.6%, which means that the bank could not generate as much alternative income as in the previous year. In 2018, the bank generated ₦95,521378 revenues and ₦109,749,294 in 2019. The non-interest income grew by 12.5%, generating an income of ₦123,485,182 in 2020. GTBank Plc. Annual reports in 2021 and 2022 reported a very low non-income statement income of ₦8,829,354 and ₦2,092,332.

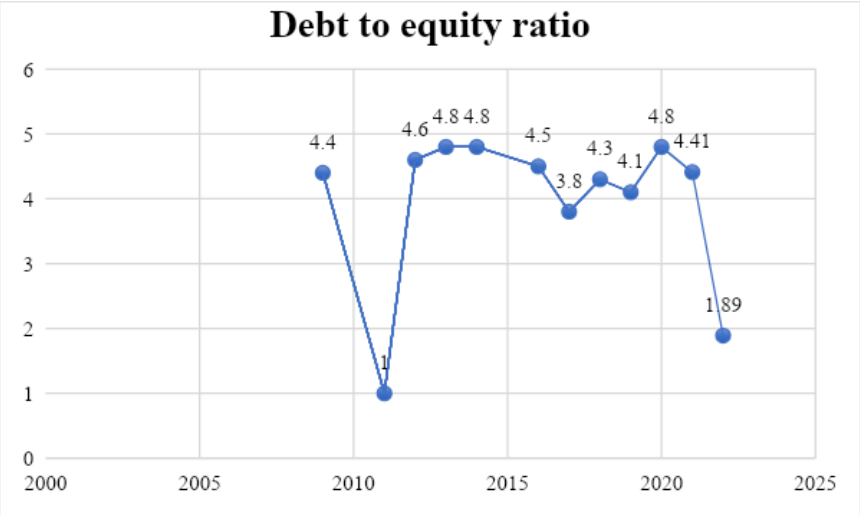
Debt-to-Equity Ratio

A company's debt-to-equity ratio quantifies the extent to which it is using its own resources to finance its operations instead of borrowing from others. Analyzing a debt-to-equity ratio for investment purposes helps us identify companies that are highly leveraged and higher risk. The ideal D/E ratio for a bank should be from 1.5 – 2.0; any ratio higher than this means that the company is highly leveraged.

The graph below represents the D/E Ratio of GTBank Plc from 2009 - 2022. For this analysis, the company started off with a high risk ratio of 4.4. Considering the banking industry's ideal rate of 1.50 - 2.0, the 2009 ratio was a bad indication of the bank's annual report that year. Moreover, since financial institutions borrow money to lend money, they tend to have a higher D/E Ratio, but according to the Central Bank of Nigeria (CBN), the ideal D/E Ratio for the financial sector should be 4%. This ratio measures the firm's financial leverage, i.e., for every amount of equity it shareholders own, the bank owes ₦4.4.

In 2011, the firm's annual report reflected a low D/E Ratio of 1%, i.e., a debt of ₦1 for every amount of equity the bank shareholders own. This ratio is within the scope of the industry's acceptable rate, therefore, the annual report for the year was not highly leveraged. From 2012 to 2021, the company's D/E Ratio was highly leveraged, the ratio fluctuated within 4.1 to 4.8 but with the exception in 2017. In 2017, the rate was 3.8, which is above the ideal ratio for financial institutions but below the set rate from the Central Bank of Nigeria (CBN). In this case, I decided to follow the generally accepted industry ratio to make a decision that the D/E Ratio is high risk. However, the 2022 D/E Ratio was 1.89, which indicated a low risk and was good for making investment decisions.

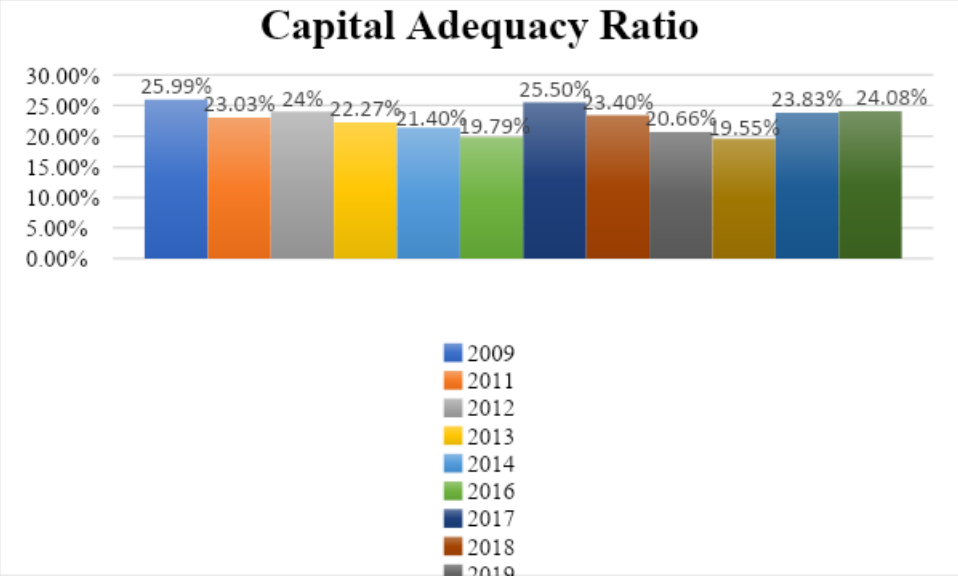
Figure 3: GTBank Plc. Debt to Equity ratio 2009-2022



Capital Adequacy Ratio.

A capital adequacy ratio of 25.99% in 2019 denotes an excellent financial position of the bank. This denotes that GTBank has the ability to absorb losses with its capital if any arise. According to the Central Bank of Nigeria (CBN), all Nigerian banks with an international authorisation, including GTBank, are expected to have at least a 15% capital adequacy ratio. The bank had more than the required rate in all 12 years' data set for this study, which could be attractive to the investors because they are sure their investment would be safe to some extent if any crisis or liquidation arises. The figure below gives a graphical representation of the capital adequacy ratio for 12 years.

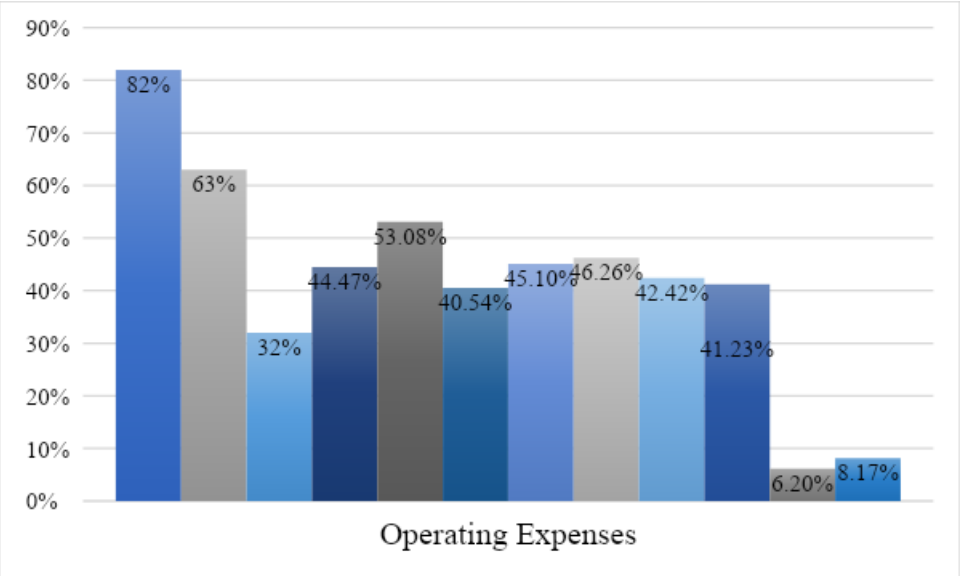
Figure 4: GTBank Plc. Capital Adequacy Ratio 2009-2022



Operating Expenses

Operating expenses are the financial metric that evaluates the ongoing operational activities of an organization. High operating expenses mean that the company may have difficulty generating profits. This can influence the decision of the investors, they will consider the negative effect this will have on the firm's profitability and also its cash flow. A high operating expense can have a negative impact on the firm's cash flow, making it difficult for the firm to pay dividends to shareholders. GTBank's operating expenses from 2009-2022 are represented in the bar chart below:

Figure 5: GTBank Plc. Operating Expenses 2009-2022

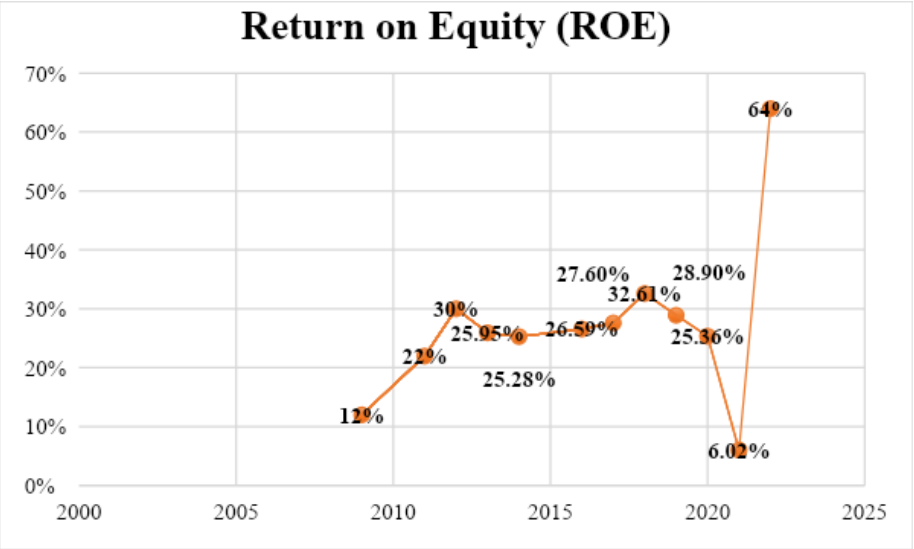


Return on Equity

Return on Equity is a financial metric that calculates the profit made per unit of shareholder stock in order to quantify the profitability of a business. ROE is a measure of a firm's capacity to create returns from the investments made by its stakeholders in an efficient manner. This metric is one of the most important indicators investors look out for while making investment decisions. A high return on equity (ROE) signifies that the company is efficiently producing greater profits from the capital invested by its investors. Although ROE varies from sector to sector, a good return on equity rate should range from 15% - 20% and above.

In 2009, the Return on Equity for this year was 12%, which does not indicate a good investment; it could mean that the company did not use the shareholders' investment efficiently. ROE from 2011 to 2022 was above 15%, which will be very attractive for potential stakeholders.

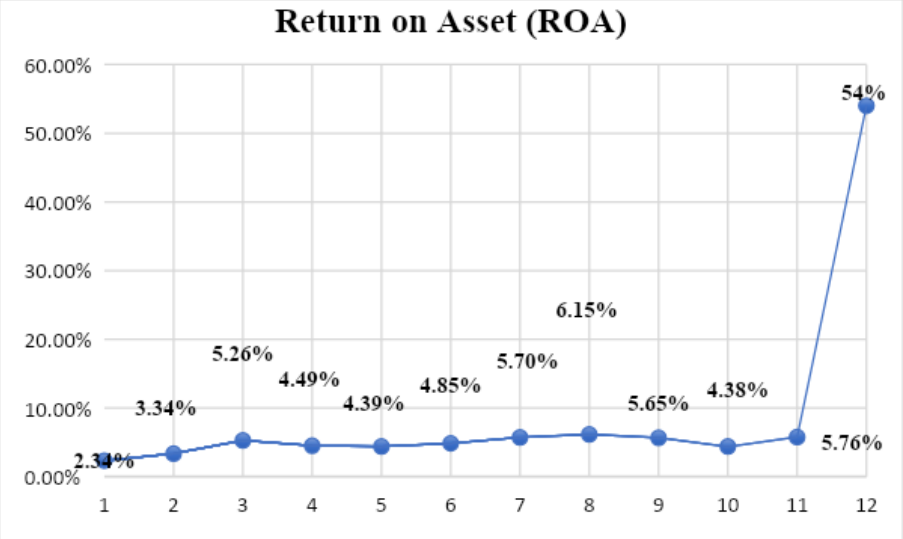
Figure 6: GTBank Plc. Return on Equity 2009-2022



Return on Assets

Return on Assets is an assessment of how well a business uses its earnings to make more profits. A high percentage of this ratio indicates how efficiently the company's management is in handling its balance sheet to make a profit. According to Investopedia, a ROA of more than 5% or more is considered good, while more than 20% is considered excellent. The graph below presents the Return on Equity of GTBank Plc over a 12-year financial period.

Figure 7: GTBank Plc. Return on Asset 2009-2022

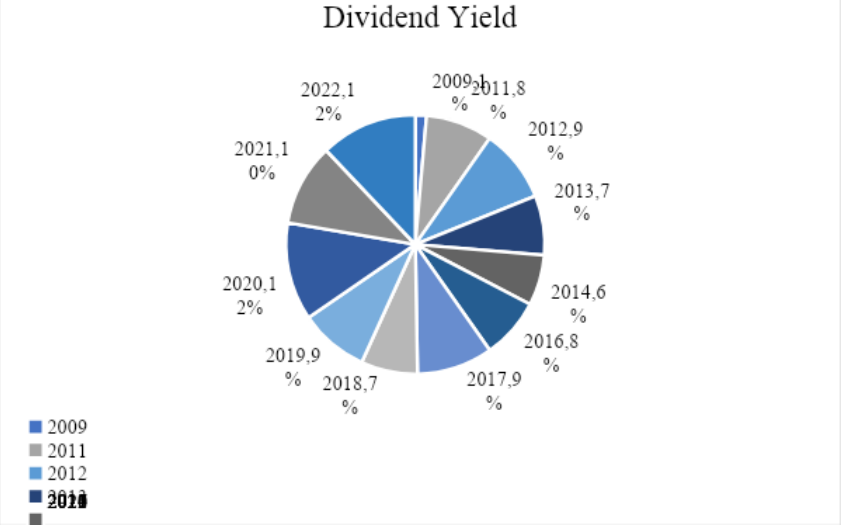


4.1.8 Dividend Yield

Dividend yield is a financial ratio that quantifies how much an investor would earn from an investment based only on the dividend payments from the organization. This metric is one of the most important things an investor looks for when making an investment decision. Investors who do not have adequate financial knowledge are taught to look out for this metric to make their decision when buying a stock. The chairman of an organization will usually declare the year's dividend yield in the annual general meeting, and it will be stated in the annual report.

Some investors evaluate stocks based on only the dividend yield, which is not advisable because a dividend can reduce or even be eliminated if the stock price declines. This proves the importance of this study. Having a trained machine learning program to accurately predict the best investment while carefully evaluating each metric will eliminate bad investment decisions. The linear graph below shows the dividend yield of GTBank Plc from 2009 – 2022.

Figure 8: GTBank Plc. Dividend Yield 2009-2022

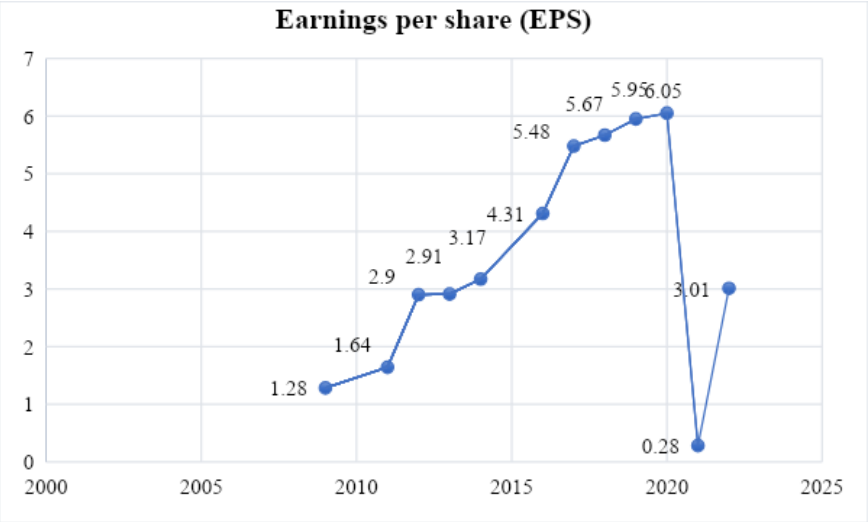


Earnings per Share

The Earnings per Share is a vital indicator for stockholders as it assesses the bank's profitability per share. A higher earnings per share (EPS) signifies that the bank is making more money for every outstanding share of stock. For example, in 2009, on the graph below, the EPS was 128 Kobo, i.e., upon every outstanding share, 128 Kobo profit is earned.

Although this metric is not enough to determine a firm's profitability, Investors are able to make well-informed decisions with the metric when compared with the EPS of other companies in the same industry.

Figure 9: GTBank Plc. Earnings Per Share 2009-2022



Stock Price

The stock price on the Nigerian Stock Exchange (NSE) represents the current market value of the bank's shares. A higher stock price shows that the market has confidence in the bank's prospects and financial performance. GTBank's stock price experienced a steady increase from 2009-2018 and fluctuated from 2019-2022, which could be due to investors' sentiment and market conditions.

Figure 10: GTBank Plc. Stock Price in Naira

DISCUSSIONS

The primary objective of this study is to create a machine-learning model that will transform financial statement analysis from its traditional methods and to predict a company's financial health or profitability to enhance well-informed investment decisions. To create this model, this study used supervised machine learning, which means that our model will have a baseline understanding of what the correct output should be.

In order to get a supervised dataset for our machine learning, it was necessary to first analyze the financial statement traditionally to train the machine to predict on its own. To achieve this, the table below represents my response to each of the metrics analyzed in accordance with the financial industry's overall acceptable rate. The last column title, "Decision," is to give the machine learning algorithms the final decision on a year's financial report, to either invest or not to. The tick sign (✓) indicates a positive sign and to invest, while the cross-out sign (✕) means negative and not to invest. Training the machine with this data has to be done in a language the machine understands, i.e., Binary language, so this data was input to the machine learning algorithms used in 1 and 0, 1 represents the positive (✓) sign while 0 for the negative (✕) sign.

Table 2: Decisions for Traditional Financial Statement Analysis

Year	Net Interest Income	Non-Interest Income	Debt-to-equity ratio	Capital Adequacy Ratio	Operating Expenses	Return on Equity (ROE)	Return on Asset (ROA)	Dividend Yield	Earnings per share (EPS)	Decision
2009	✓	✓	✕	✓	✕	✕	✕	✕	✓	✕
2011	✓	✓	✓	✓	✓	✓	✕	✓	✓	✓
2012	✓	✓	✕	✓	✓	✓	✓	✓	✕	✓
2013	✓	✓	✕	✓	✓	✓	✕	✓	✕	✓
2014	✓	✓	✕	✓	✓	✓	✕	✕	✓	✓
2016	✓	✓	✕	✓	✓	✓	✕	✓	✓	✓
2017	✓	✓	✕	✓	✓	✓	✓	✓	✓	✓
2018	✓	✓	✕	✓	✓	✓	✓	✓	✓	✓
2019	✓	✓	✕	✓	✓	✓	✓	✓	✓	✓
2020	✓	✓	✕	✓	✓	✓	✕	✓	✓	✓
2021	✕	✕	✕	✓	✓	✕	✓	✓	✕	✕
2022	✕	✕	✓	✓	✓	✓	✕	✓	✕	✕

The image below is the representation of the prediction of this study's result from the four ML algorithms used. Each of these algorithms was running on every instance of our data, i.e., trained to predict the result of all the financial metrics used for this study. On the extreme left of this image is the ML algorithms and the accuracy of their readings. As mentioned earlier, binary numbers were used to ascertain the results obtained from the traditional financial analysis performed. The binary number "1" denotes a positive result of "To Invest" and the binary number "0" symbolizes a negative result of "Not to Invest".

The first four columns represent the accuracy of reading of Random Forest, kNN, Logistic Regression, and Naïve Bayes. In 2009, the final decision made on that year's analysis was not to invest, i.e., 0 in binary. Random forest predicted to invest, i.e., "1", with a degree of accuracy of 0.57, K nearest neighbor predicted to invest with 0.80 degree of accuracy. However, Logistic Regression predicted not to invest with a degree of accuracy of 0.58, while Naïve Bayes also predicted not to invest with 0.86 degree of accuracy. This algorithm both got the prediction correctly, but Naïve Bayes has the highest rate of prediction accuracy. For 2011, the investment decision was to invest; all the algorithms predicted correctly for this year. This prediction was carried out through all instances in the dataset of GTBank Plc, the algorithms predicted the result accurately with a few confusion matrices. The result obtained from this experiment proves that the machine learning model was learning well, and it supports the hypothesis that there is a positive relationship between the adoption of the machine learning technique, the level of accuracy of financial statement analysis, and forecasting in the Nigerian stock exchange market.

Additionally, there are five machine learning metrics to examine the level of prediction accuracy of our algorithms.

1. **AUC (Area under the ROC Curve):** AUC is a common indicator used to estimate the discriminatory ability of a classification model. It measures the area under the Receiver Operating Characteristic (ROC) curve. A perfect AUC score is 1.000, which means the model has a perfect ability to differentiate between the classes. An AUC of 1.000 indicates that the model's predictions are completely accurate. As shown in the image below, the AUC outputs for all models in this study were 1, which means all our ML models were able to distinguish between the classes and predict accurately.

2. **CA (Classification Accuracy):** Classification accuracy quantifies the percentage of occurrences properly classified out of all instances. In this case, kNN has a classification accuracy of 0.750, which means it correctly classified approximately 75% of the instances, while Random Forest correctly classified all instances by approximately 91.7%.

3. **F1 Score:** The F1 score is the harmonic mean of precision and recall. It strikes a balance between recall (the number of actual positive cases that were accurately predicted) and accuracy (the number of predicted positive instances that were truly

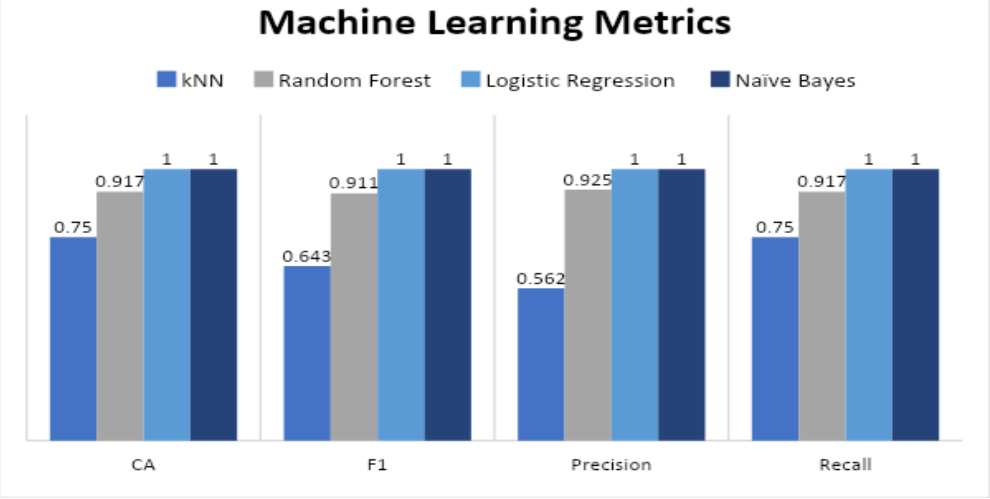
positive). With an F1 score of 0.911, Random Forest exhibits a strong balance between recall and precision.

4. **Precision**: The ratio of accurately predicted positive instances to all expected positive instances is known as precision. It assesses how well the model avoids generating false positive results. A precision of 0.925 means that 92.5% of instances predicted as positive were positive.

5. **Recall:** Recall is a metric that quantifies the proportion of accurately predicted positive cases to all actual positive instances. It is sometimes referred to as sensitivity or true positive rate. With a recall of 0.917, the model was able to accurately identify 91.7 percent of the real positive events.

The figure below represents the rate of accuracy for each metric; each bar on the chart shows how accurately the ML algorithms predicted the result. The major limitation in the study is the limited availability of data; due to this, we could not get a wider range of results for his experiment, however, it does not detract from the purpose of the study. The chart below supports the hypothesis that the accuracy of financial statement analysis and forecasting using machine learning algorithms is influenced by the type of machine learning algorithm used.

Figure 11: ML Metrics Rate of Accuracy.



Model: 4 models

- Random Forest
- kNN
- Logistic Regression
- Naive Bayes

Showing probabilities for all classes that appear in the data

Data & Predictions

	Random Forest	kNN	Logistic Regression	Naive Bayes	Decision	Net Interest Income	Non-Interest Income	Debt to equity ratio	Capital Adequacy Ratio	Operating Expenses	Return on Equity (ROE)	Return on Asset (ROA)	Dividend Yield	Earnings per share (EPS)
1	0.43 : 0.57 → 1	0.20 : 0.80 → 1	0.58 : 0.42 → 0	0.86 : 0.14 → 0	0	1	1	0	1	0	0	0	0	1
2	0.00 : 1.00 → 1	0.00 : 1.00 → 1	0.13 : 0.87 → 1	0.06 : 0.94 → 1	1	1	1	1	1	1	1	0	1	1
3	0.00 : 1.00 → 1	0.00 : 1.00 → 1	0.12 : 0.88 → 1	0.06 : 0.94 → 1	1	1	1	0	1	1	1	1	1	0
4	0.00 : 1.00 → 1	0.00 : 1.00 → 1	0.15 : 0.85 → 1	0.08 : 0.92 → 1	1	1	1	0	1	1	1	0	1	0
5	0.03 : 0.97 → 1	0.00 : 1.00 → 1	0.15 : 0.85 → 1	0.06 : 0.94 → 1	1	1	1	0	1	1	1	0	0	1
6	0.00 : 1.00 → 1	0.00 : 1.00 → 1	0.09 : 0.91 → 1	0.02 : 0.98 → 1	1	1	1	0	1	1	1	0	1	1
7	0.00 : 1.00 → 1	0.00 : 1.00 → 1	0.07 : 0.93 → 1	0.02 : 0.98 → 1	1	1	1	0	1	1	1	1	1	1
8	0.00 : 1.00 → 1	0.00 : 1.00 → 1	0.07 : 0.93 → 1	0.02 : 0.98 → 1	1	1	1	0	1	1	1	1	1	1
9	0.00 : 1.00 → 1	0.00 : 1.00 → 1	0.07 : 0.93 → 1	0.02 : 0.98 → 1	1	1	1	0	1	1	1	1	1	1
10	0.00 : 1.00 → 1	0.00 : 1.00 → 1	0.09 : 0.91 → 1	0.02 : 0.98 → 1	1	1	1	0	1	1	1	0	1	1
11	0.90 : 0.10 → 0	0.40 : 0.60 → 1	0.79 : 0.21 → 0	1.00 : 0.00 → 0	0	0	0	0	1	1	0	1	1	0
12	0.90 : 0.10 → 0	0.40 : 0.60 → 1	0.68 : 0.32 → 0	0.98 : 0.02 → 0	0	0	0	1	1	1	1	0	1	0

Scores

Target class: (Average over classes)

Model	AUC	CA	F1	Precision	Recall
kNN	1.000	0.750	0.643	0.562	0.750
Random Forest	1.000	0.917	0.911	0.925	0.917
Logistic Regression	1.000	1.000	1.000	1.000	1.000
Naive Bayes	1.000	1.000	1.000	1.000	1.000

Confusion Matrix Tue Aug 08 23, 12:47:51

Confusion matrix for Naive Bayes (showing number of instances)

		Predicted 0	1	Σ
Actual	0	3	0	3
	1	0	9	9
	Σ	3	9	12

Confusion Matrix Tue Aug 08 23, 12:48:18

Confusion matrix for Random Forest (showing number of instances)

		Predicted 0	1	Σ
Actual	0	2	1	3
	1	0	9	9
	Σ	2	10	12

Confusion Matrix Tue Aug 08 23, 12:48:22

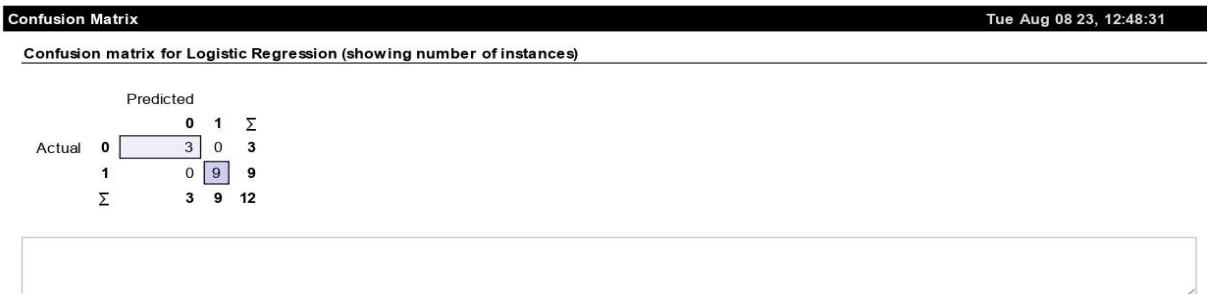
Confusion matrix for Random Forest (showing number of instances)

		Predicted 0	1	Σ
Actual	0	2	1	3
	1	0	9	9
	Σ	2	10	12

Confusion Matrix Tue Aug 08 23, 12:48:27

Confusion matrix for kNN (showing number of instances)

		Predicted 0	1	Σ
Actual	0	0	3	3
	1	0	9	9
	Σ		12	12



Confusion Matrix

The result above represents the confusion matrix, which examines the rate of false-positive (the number of false samples but the ML model categorized as positive) and false-negative (the number of false samples but the ML model categorized as negative) (Kordi Ghasrodashti, Helfroush and Danyali, 2017). For example, Naïve Bayes did not have a confusion matrix, the model predicted all 12 instances accurately, 3 "Not to invest" predictions, and 9 "To invest" predictions. This result corresponds with the financial analysis carried out traditionally.

Random Forest had one false-positive confusion matrix, the model predicted an instance that was "Not invest" as "To invest". kNN had three false-positive confusion matrices; it predicted 3 instances out of 12 inaccurately, which indicates that it is not a good classification model. However, Logistic Regression also had a perfect prediction. It classified and predicted all instances accurately. In this instance, Naïve Bayes and Logistic Regression were the models with the perfect classification; the two other models had very few false positives, and this indicated that all our models could classify accurately. This rejects the second hypothesis of this study, which states that there is a significant difference between the performance of traditional financial statement analysis methods and machine learning algorithms in forecasting stock prices in the Nigerian stock exchange market.

Model	AUC	CA	F1	Precision	Recall
kNN	1.000	0.750	0.643	0.562	0.750
Random Forest	1.000	0.917	0.911	0.925	0.917
Logistic Regression	1.000	1.000	1.000	1.000	1.000
Naive Bayes	1.000	1.000	1.000	1.000	1.000

Rank Tue Aug 08 23, 13:38:14

Input

Features: Net Interest Income, Non-Interest Income, Debt to equity ratio, Capital Adequacy Ratio, Operating Expenses, Return on Equity (ROE), Return on Asset (ROA), Dividend Yield, Earnings per share (EPS)
Target: Decision

Ranks

		#	Info. gain	Gain ratio	Gini	χ^2	ReliefF	FCBF
1	Net Interest Income	2.0	0.4204846313473 18	0.6468214774323336	0.22500000000000006	1.2	0.312	0.0001355402997953 1828
2	Non-Interest Income	2.0	0.4204846313473 18	0.6468214774323336	0.22500000000000006	1.2	0.312	1.3554029979531828
3	Return on Equity (ROE)	2.0	0.4204846313473 18	0.6468214774323336	0.22500000000000006	1.2	0.272	1.3554029979531828
4	Operating Expenses	2.0	0.1842428917900113	0.44522810430465803	0.10227272727272735	0.2727272727272727	0.1	4.301679078078116e-05
5	Earnings per share (EPS)	2.0	0.11556849565940197	0.12585105079823808	0.0625	0.6666666666666666	0.096	1.5425206156753393e-05
6	Debt to equity ratio	2.0	0.04300471205299761	0.0661588133282302	0.025000000000000133	0.6666666666666666		6.253906735093569e-06
7	Dividend Yield	2.0	0.04300471205299761	0.0661588133282302	0.025000000000000133	0.13333333333333333	0.012	6.253906735093569e-06
8	Return on Asset (ROA)	2.0	0.006987753258863694	0.007131315506727024	0.0035714285714286143	0.06666666666666667	-0.108	0.007863904808241394
9	Capital Adequacy Ratio	1.0				nan		

Output

Features: Net Interest Income, Non-Interest Income, Return on Equity (ROE), Operating Expenses, Earnings per share (EPS)
Target: Decision

CONCLUSIONS

This study has delved into the realm of machine learning for financial statement analysis and forecasting within the context of the Nigerian Stock Exchange market, focusing on GTBank Plc. The overarching objective of this thesis was threefold: firstly, to predict the financial health and profitability of the company, thereby facilitating well-informed and data-driven investment decisions; secondly, to lower investors' risk of financial loss on the Nigerian Stock Exchange; and lastly, to progress machine learning's use in finance by creating a model that can replace traditional methods for financial statement analysis.

To achieve these objectives, we began by employing traditional methods of financial statement analysis, relying on the comprehensive annual reports of GTBank Plc. This initial analysis provided valuable insights into the company's financial standing, which served as the foundation for the subsequent development and evaluation of machine learning models.

The four machine learning algorithms chosen for this thesis, Random Forest, K-Nearest Neighbor, Logistic Regression, and Naïve Bayes, were systematically applied and assessed. Each algorithm brought its own strengths and limitations to the table, contributing to a well-rounded understanding of their efficacy in predicting financial outcomes. The results were promising, with the models demonstrating a capacity to offer valuable predictions regarding GTBank Plc's financial health and profitability.

The predictive power of these models is crucial in enhancing investment decision-making processes. Investors can now leverage these machine learning models to make informed choices, thus mitigating the risks associated with financial investments in the dynamic Nigerian Stock Exchange market. The reduction of financial losses is particularly significant in a market as dynamic and complex as Nigeria's, where economic and geopolitical factors can impact stock prices swiftly and unpredictably.

Furthermore, the successful development and adoption of machine learning models in this study enhances the field of financial analysis as a whole. By showcasing the effectiveness of these models in predicting financial outcomes, we advocate for the integration of machine learning techniques into financial analysis practices. This advancement stands to revolutionize traditional methods and bring about a new era of efficiency, accuracy, and adaptability in financial decision-making.

In essence, this thesis serves as a testament to the potential of machine learning in financial statement analysis and forecasting within the Nigerian Stock Exchange market. The application of these models not only benefits investors by providing valuable insights and reducing risks but also contributes to the ongoing evolution of financial analysis methodologies. As technology continues to progress, embracing machine learning in finance becomes imperative for staying ahead in an increasingly competitive and dynamic market environment. The findings of this study, centered on GTBank Plc, provide a foundation for future research and implementation of machine learning in financial markets, clearing the path for a more informed and data-driven method of making investment decisions.

REFERENCES

Adebiyi, O. (2020). Corporate Governance and the Nigerian Stock Exchange Market. African Journal of Corporate Governance, 1(1), 1-14. https://doi.org/10.11648/j.ajcg.20200101.11

Adegbite, O. S., Adebisi, O. F., & Adegbite, E. A. (2019). Exchange rate volatility and financial performance of commercial banks in Nigeria: Evidence from Guaranty Trust Bank Plc. European Journal of Accounting, Auditing and Finance Research, 7(6), 32-42.

Adegbaju, A., & Adaramola, A. (2018). Financial ratios and corporate performance: Evidence from the Nigerian banking sector. Journal of Financial Reporting and Accounting, 16(4), 661-678.

Adegbite, E., & Adebola, S. (2015). Corporate governance and corporate finance in Nigeria. Corporate Governance: The International Journal of Business in Society, 15(3), 369-386.

Adekunle, S. O., Oguntuase, A. M., & Akanbi, A. M. (2020). Empirical Analysis of Earnings per Share and Return on Assets of Firms Listed on the Nigerian Stock Exchange. Journal of Accounting and Financial Management, 6(1), 10-17.

Adesina, O. T., Azeez, O. R., & Adesina, A. O. (2017). The effect of debt to debt-to-equity ratio on a firm's financial performance. International Journal of Management, Accounting and Economics, 4(10), 690-702.

Adesina, K., Abdulrahman, M. D., & Olayemi, J. K. (2018). Predicting sustainable competitive advantage of Nigerian firms: A machine learning approach. Cogent Business & Management, 5(1), 1444094. doi: 10.1080/23311975.2018.1444094

Adeyemi, O. D., Olugbara, O. O., & Oyelade, O. J. (2020). Industry trends and financial performance prediction of selected companies in the Nigerian Stock Exchange using machine learning. Journal of Computational Science, 44, 101175.

Afolabi, R. O., & Adefila, J. O. (2018). Financial statement analysis and investors' decisions in Nigeria. International Journal of Business and Management, 13(8), 99-107.

Ahmadi, M., Kouhizadeh, M., & Khosravi, B. (2020). The impact of firm size on the financial performance prediction using data mining techniques. Journal of Accounting and Management Information Systems, 19(3), 465-484.

Alao, O. R., & Okunlola, J. T. (2020). The impact of industry trends on the financial performance of selected manufacturing firms in Nigeria. International Journal of Management, Innovation & Entrepreneurial Research, 6(1), 21-34.

Al-Kilidar, H. M., Albattah, H. M., Alkhalafat, F. M., Alabdulwahhab, F. M., & Al-Matrouk, M. A. (2019). Employee satisfaction prediction in the banking sector using machine learning techniques. International Journal of Advanced Computer Science and Applications, 10(10), 312-320. doi: 10.14569/IJACSA.2019.0101043

Al-Nabulsi, A. A., Alfaqawi, M. A., Alsmadi, M. K., & Al-Sarayreh, H. A. (2020). Predicting the financial performance of companies listed in Amman Stock Exchange using machine learning techniques. Sustainability, 12(7), 2711. doi: 10.3390/su12072711

Al-Malkawi, H. A., & Masadeh, R. (2021). Predicting the financial performance of companies listed on the Amman Stock Exchange: A machine learning approach. Journal of Finance and Investment Analysis, 10(2), 66-82.

Altman, E. I. (1968). Financial ratios, discriminant analysis, and the prediction of corporate bankruptcy. The Journal of Finance, 23(4), 589-609.

Altman, E. I., & Sabato, G. (2005). Modeling credit risk for SMEs: Evidence from the US market. Abacus, 41(3), 257-268.

Amadi, V. C. (2021). The Impact of GDP on Nigerian Stock Market Returns. Journal of Economics and Sustainable Development, 12(5), 64-71

Akande, O. J., & Olubiyi, O. A. (2019). Predicting stock prices of Nigerian banks: A machine learning approach. Journal of Financial Data Science, 1(1), 106-116. doi: 10.3905/jfds.2019.1.1.106

Akinniyi, O. D., Akinola, O. A., Aluko, O. O., & Oloyede, O. O. (2021). Modeling stock market returns in Nigeria using machine learning algorithms. Journal of Financial Reporting and Accounting, 19(1), 43-62.

Akpan, U. F., & Udoma, J. A. (2016). The relationship between inflation rate and stock prices in Nigeria. Journal of Applied Economics and Business Research, 6(3), 93-106.

Ayinde, T. O., & Oladipo, O. A. (2020). Machine learning approach for financial statement analysis: An application in the Nigerian stock exchange. Journal of Financial Reporting and Accounting.

Baker, M., & Wurgler, J. (2007). Investor sentiment in the stock market. Journal of Economic Perspectives, 21(2), 129-151.

Beaver, W. H. (1968). Market prices, financial ratios, and the prediction of failure. Journal of Accounting Research, 6, 179-192.

Berger, A. N., & DeYoung, R. (1997). Problem loans and cost efficiency in commercial banks. Journal of Banking & Finance, 21(6), 849-870.

Bhattacharya, U., Graham, J. R., & Harvey, C. R. (2002). The effects of financial statement credibility on judgmental forecasts of future earnings. The Accounting Review, 77(Supplement), 115-142

Economic Indicator: Definition and How to interpret https://www.investopedia.com/terms/e/economic_indicator.asp

Elshandidy, T., Hassanein, A., & Gaber, M. (2017). The relevance of dividend yield in stock return: Evidence from the UK stock market. Research in International Business and Finance, 42, 1312-1327.

Fasan, O. E., & Gbadebo, O. J. (2017). The impact of company size on financial performance: Evidence from selected companies in the Nigerian Stock Exchange. Journal of Accounting and Financial Management, 3(1), 1-13.

Fama, E. F., & French, K. R. (1988). Dividend yields and expected stock returns. Journal of Financial Economics, 22(1), 3-25.

Goudreau, J. (2021). Machine Learning Algorithms in Finance. Investopedia. https://www.investopedia.com/terms/m/machine-learning-algorithms-finance.asp

Hou, Y., Ni, Z., & Xu, X. (2020). Industry trends, regulatory changes, and stock price synchronicity: Evidence from China. Emerging Markets Finance and Trade, 56(1), 1-12.

Inanga, E. L., Ogbulu, O. M., & Ogoun, E. N. (2016). The relationship between earnings per share and market value of firms listed in the Nigerian Stock Exchange. International Journal of Finance and Accounting, 5(6), 354-358.

Investopedia. What is considered a good ROA https://www.investopedia.com/terms/r/returnonassets.asp#:~:text=What%20Is%20Considered%20a%20Good,firms%20in%20the%20same%20sector.

Iyoha, F. O., Adebiyi, A. A., Adebiyi, M. A., & Olugbara, O. O. (2019). Pattern analysis of trading activities in the Nigerian stock exchange. Heliyon, 5(5), e01766.

Jalaludin, N. H., & Ibrahim, M. H. (2014). Predicting bank performance using financial statement analysis: A case of Malaysian commercial banks. Procedia - Social and Behavioral Sciences, 145, 171-178.

Jiménez, G., Ongena, S., Peydró, J. L., & Saurina, J. (2014). Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking? Econometrica, 82(2), 463-505.

Jokhio, S. H., & Memon, M. A. (2018). Understanding financial ratios and performance indicators: A case of investors in Pakistan. Journal of Business and Economics Review, 3(1), 24-35.

Karimi, M., & Rahmani, M. (2017). Financial statement analysis of Iranian companies using ratio analysis. International Journal of Accounting and Financial Reporting, 7(1), 305-318.

Khalid, H., Abbas, Z., & Sadiq, M. (2016). Comparative financial statement analysis of selected companies in Pakistan. Research Journal of Finance and Accounting, 7(1), 103-110.

Kieso, D. E., Weygandt, J. J., & Warfield, T. D. (2016). Intermediate accounting (16th ed.). Hoboken, NJ: John Wiley & Sons.

Kumar, A., & Rastogi, P. (2019). Financial statement analysis using machine learning. In Proceedings of the 10th International Conference on Computational Intelligence and Communication Networks (pp. 328-333).

Lawal, A. I., Abdulsalam, D. A., & Abdulrasheed, A. A. (2017). Exchange rate fluctuations and the financial performance of listed firms in Nigeria. Research Journal of Finance and Accounting, 8(17), 26-34.

Lawal, R. A., & Yusuf, S. A. (2018). The impact of Gross Domestic Product (GDP) on stock market performance in Nigeria. Journal of Accounting, Finance and Auditing Studies, 4(2), 85-96.

Liang, Y., Ren, R., & Sun, C. (2020). Earnings quality and stock price crash risk: Evidence from Chinese listed companies. Journal of Business Research, 116, 125-135.

Liang, M., Yang, B., Zhang, X., & Zhang, J. (2019). Stock price prediction using machine learning: A review. International Journal of Financial Studies, 7(3), 38.

Li, Y., & Li, X. (2020). Using machine learning for customer retention analysis in the banking industry. Journal of Big Data, 7(1), 56. doi: 10.1186/s40537-020-00330-6

National Bureau of Statistics (2021). Consumer Price Index and Inflation

Nsehe, M. (2018, June 7). GTBank, Zenith Bank, And Access Bank Are Nigerian Banks of the Year. Forbes. Retrieved from https://www.forbes.com/sites/mfonobongnsehe/2018/06/07/gtbank-zenith-bank-and-access-bank-are-nigerian-banks-of-the-year/?sh=128f1a9a1b11

Nigeria Stock Exchange. (2021). Market Data. https://www.nse.com.ng/market-data/

Majeed, M. T., Azam, M., & Amjad, N. (2017). Impact of dividend yield on stock prices: Evidence from Pakistan. Pakistan Journal of Commerce and Social Sciences, 11(1), 251-270.s

Obadiaru, E.D., Obasaju, B.O., Omankhanlen, A.E. and Eyiolorunshe, D.T. (2020) "Dynamic links between the Nigerian equity market and those of selected regional and developed countries," Heliyon, 6(9), p. e04782. doi:10.1016/j.heliyon.2020.e04782.

Odo, C., Okpara, G. C., Ugwu, S. U., & Onwe, I. O. (2019). Impact of interest rate on stock market performance in Nigeria: A machine learning approach. Journal of Economics and Sustainable Development, 10(16), 222-231.

Olayinka, T. O., & Ogundele, O. J. (2018). The impact of company size on financial performance: Evidence from machine learning algorithms. International Journal of Intelligent Computing and Cybernetics, 11(2), 213-228.

Olugbenga, A. (2012). Exchange Rate Volatility and Stock Market Behaviour: The Nigerian Experience. https://core.ac.uk/download/pdf/234629265.pdf.

Olugbenga, A. S., & Adetunji, O. I. (2019). Machine learning for stock price prediction in Nigerian stock exchange. International Journal of Advanced Computer Science and Applications, 10(2), 157-164.

Ogbebor, P. A., & Okorie, K. C. (2019). An empirical investigation of the capital structure determinants of quoted firms in Nigeria. African Journal of Accounting, Auditing and Finance, 8(4), 296-312.

Ogundipe, S. E., & Idowu, A. (2017). Determinants of stock prices in the Nigerian stock exchange. Research Journal of Finance and Accounting, 8(19), 2222-5697

Ogunjobi, T., & Ogunnaike, O. O. (2021). Predicting the financial performance of selected companies listed in the Nigeria stock exchange using interest rate data: A machine learning approach. Data in Brief, 36, 107023.

Ogundele, O. J., & Olayinka, T. O. (2021). Predicting the future financial performance of companies listed on the Nigeria Stock Exchange using industry trend analysis. International Journal of Business Forecasting and Marketing Intelligence, 7(2), 143-160.

Okpala, K. C., & Obi, C. S. (2018). The impact of profitability ratios on stock prices: Evidence from Nigeria. Journal of Financial Reporting and Accounting, 16(1), 119-139.

Oladejo, M. A., & Oluwole, O. O. (2020). Firm-specific determinants of profitability of Nigerian listed firms. Journal of Financial Reporting and Accounting, 18(4), 543-564.

Oladele, P. O., Adetiloye, K. A., & Oke, M. O. (2020). Market capitalization and financial performance: Evidence from Nigerian listed firms. Journal of Accounting and Management Information Systems, 19(2), 311-332.

Olaoye, O. A., & Eriki, P. O. (2019). Market capitalization and financial performance of quoted companies in Nigeria. Journal of Accounting and Financial Management, 5(1), 16-26.

Olugbenga, A. O., & Adetayo, A. A. (2018). Effect of interest rate on the financial performance of selected deposit money banks in Nigeria. Journal of Finance and Investment Analysis, 7(2), 12-26.

Oyetayo, V. O., Iyiola, O. O., & Oyekunle, R. O. (2015). Dividend policy and financial performance of listed banks in Nigeria. Journal of Applied Accounting Research, 16(2), 221-238.

Oyebanjo, O. J., & Oladipupo, A. O. (2019). Exchange rate fluctuations and financial performance of banks in Nigeria. Journal of Applied Accounting and Taxation, 6(2), 1-10.

Okafor, G. C., & Obute, G. C. (2018). Neural network analysis of Nigerian stock prices. International Journal of Advanced Computer Science and Applications, 9(6), 381-386.

Okoro, O. J., & Akaniro, E. M. (2019). The effect of leverage on the return on equity of listed manufacturing companies in Nigeria. International Journal of Innovative Research and Advanced Studies, 6(8), 32-38.

Raza, S. A., Saqib, N., & Masood, A. (2015). Financial analysis of selected companies in Pakistan using vertical analysis technique. Journal of Finance and Accounting, 3(1), 1-9.

Shiller, R. J. (1989). Market volatility and macroeconomic fluctuations. The American Economic Review, 79(5), 1116-1132.

Sondhi, N., & Kaur, J. (2018). Understanding financial ratios and their significance: An empirical analysis of Indian investors. International Journal of Applied Business and Economic Research, 16(3), 311-320.

Talwar, N., Bhatia, V., & Kalia, N. (2020). Financial statement analysis using machine learning: A review. Journal of Financial Reporting and Accounting, 18(2), 271-289.

Witten, I. H., Frank, E., Hall, M. A., & Pal, C. J. (2016). Data Mining: Practical Machine Learning Tools and Techniques (3rd ed.). Morgan Kaufmann Publishers.

Zairi, M., Ahmed, A. M., & Jabnoun, N. (2005). Trend analysis of financial ratios: A tool for company's performance analysis. Benchmarking: An International Journal, 12(5), 443-454.

Zeng, Y., Liu, Z., & Fang, Y. (2020). The impact of Altman Z-score on stock prices: Evidence from Chinese listed companies. Journal of Risk Research, 23(1), 116-132.