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MASTER THESIS

ON

KLIMATO KAICIU POVEIKIO BANKININKAVIMO SEKTORIUI VERTINIMAS	**VALUATION OF CLIMATE CHANGE IMPACT ON BANKING SECTOR**

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KLIMATO KAIČIŲ POVEIKIO BANKININKAVIMO SEKTORIUI VERTINIMAS

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SANTRAUKA

Baigiamąjį darbą sudaro 93 puslapiai, 18 lentelių, 7 paveikslai, 2 formulės ir 39 literatūros šaltiniai.

Pagrindinis šio magistro darbo tikslas – pateikti teorinių įrodymų, kaip klimato rizika veikia bankų sektorių ir kokius metodus bankai taiko, kad sumažintų jos poveikį.

Darbą sudaro trys pagrindinės dalys; literatūros analizė, atliktas tyrimas ir jo rezultatai, išvados ir rekomendacijos.

Literatūros analizėje apžvelgiami teoriniai klimato kaitos aspektai, pateikiamos pagrindinės klimato kaitos ir su ja susijusių rizikų sampratos, klimato kaitos priežastys, klimato kaitos įtaka bankų sektoriui bei klimato kaitos įtaka bankų finansiniam stabilumui.

Atlikęs literatūros analizę, autorius atliko empirinio tyrimo metodologiją tarp įvairių pasaulio įmonių. Pagrindinis klausimyno ir antrinių duomenų, ty Nigerijos centrinio banko metinių stabilumo ataskaitų ir finansinių sąskaitų ataskaitų, apimančių 2010–2020 m. laikotarpį, tikslas buvo išsiaiškinti, kodėl klimato rizika veikia bankų sektorių ir kokius metodus bankai taiko, kad sumažintų šią riziką. poveikis. Be to, tyrimo rezultatai buvo lyginami su panašiais tyrimais, atliktais kitose Europos šalyse. Tyrimo rezultatai statistiškai apdoroti SPSS 26 versija ir E-views 10. Klimato kaitos poveikiui bankų sektoriui nustatyti buvo panaudota vienpusė dispersinė analizė (ANOVA) ir daugkartinės regresijos metodai.

Tyrimas atskleidė, kad finansinė rizika, fizinė rizika, likvidumo rizika ir veiklos rizika dėl klimato kaitos reikšmingai įtakoja bankų sektoriaus veiklą, o klimato rizikos valdymo metodai – bankų sektorių.

Išvadose ir rekomendacijose apibendrinamos pagrindinės literatūros analizės sąvokos bei tyrimo rezultatai. Tyrėjas tvirtina, kad tyrimo rezultatai galėtų duoti naudingų gairių bankų sektoriui, o „Apex bank“ turėtų labiau stengtis užtikrinti, kad bankai efektyviai valdytų klimato kaitos rizikas savo turtui, kad būtų užtikrintas finansinis stabilumas šalyje.

VALUATION OF CLIMATE CHANGE IMPACT ON BANKING SECTOR

Harry Ndukwu Nwachukwu

Master's Thesis

Finance and Banking Master's Programme

Faculty of Economics and Business Administration, Vilnius University

Supervisor Assoc. Prof. Diemante Teresiene, Vilnius, 2023

SUMMARY

Master thesis consists of 93 pages, 18 tables, 7 figures, 2 formulas and 39 references.

The major purpose of this master thesis is to provide theoretical evidence on how climate risks affect the banking sector, and the method banks adopt to mitigate its effect.

The thesis consists of three main parts; the analysis of literature, the research and its results, a conclusion and recommendations.

Literature analysis reviews the theoretical aspects of climate change, presents the main concepts of climate change and its related risks, causes of climate change, the impact of climate change on banking sector as well as climate change impact on banks' financial stability.

Following the literature analysis, the author carried out the empirical research methodology among different companies of the world. The main aim of the both questionnaire and secondary data i.e Central bank of Nigeria's annual stability reports and financial statements of accounts cover the period from 2010 to 2020 were to find out why climate risks affect the banking sector, and the method banks adopt to mitigate its effect. Moreover, the results of the research were compared to the similar studies performed in other European countries. The results of the research were statistically processed with the SPSS version 26 and E-views 10. In order to establish the impact of climate change on banking sector one-way analysis of variance (ANOVA) and multiple regression techniques were used.

The research revealed that the financial risk, physical risk, liquidity risk and operational risks due to climate change significantly impacts banking sector performance and the methods for managing climate risk significantly impact banking sector.

The conclusions and recommendations summarise the main concepts of literature analysis as well as the results of the research. The researcher affirms that the results of the study could give useful guidelines to the banking sector and Apex bank should do more to ensure that banks effectively manage the risks of climate change on their assets to ensure financial stability in the country.

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INTRODUCTION

Relevancy of the topic: Climate risk is becoming a greater focus for bank regulators worldwide. The physical risks of climate change, such as extreme weather, and the threats to businesses from transitioning to a net-zero economy should be placed in order by regulators. Central banks are also increasing their supervision. Many have begun to tell commercial banks and other regulated financial institutions that climate-related risks must never be neglected and should have considered in their strategies, governance, and risk management. Until recently, prudential rules were less specific about how banks should manage and disclose material risks. Some central banks are also brought into line their loaning with universal decarbonization objectives. Financial institutions and international organizations have also researched central banks' and regulators' roles. Intergovernmental Panel on Climate Change (IPCC) (2021); Batten, Sowerbutts, and Tanaka (2016) of the Bank of England and Krogstrup and Oman (2019) of the International Monetary Fund (IMF), among others, survey the vast science and economics literature on climate change and its economic impacts. These studies also examine how climate change impacts the financial system and how bank regulators address the issue within their mandates.

The level of Exploration of the Research Work: The climate change impact on the banking sector has been a subject of debate due to different views in the literature; while some researchers find adverse effects between the two, others report positive associations. Most of the empirical studies conducted on the impact of climate change impact on the banking sector were inconclusive (Fabris, 2020; Chukwuemeka & Daniel, 2021; Ozili, 2020; Fatoki & Sasona, 2015; Ogbuabor & Egwuchukwu, 2017; Krogstrup & Oman, 2019; Bolton, Després, Da Silva, Samama & Svartzman, 2020; Krogstrup & Oman, 2019), In Nigeria, most research works are limited on climate change impact on the Nigerian economy. However, a preliminary and limited study has investigated the valuation of climate change's impact on the banking sector in Nigeria in particular.

Ozili (2020) states that since the 19th century, natural disasters have hampered the supply of financial services throughout history. The banking industry has dealt with floods, typhoons, mudslides, earthquakes, droughts, and storms. As mentioned

earlier, climate change will continue to do so in the future because many financial institutions, often known as banks, have contractual cross-border financial responsibilities and claims with banks in many countries worldwide. Many financial institutions have at least one branch in countries vulnerable to climate change disasters. Second, as the number of banking sector branch networks continues to grow in tropical locations with harsh weather, the risk of physical damage to financial institutions' fixed assets also grows.

Campiglio et al. (2018) believe that the risk of severe climate change is increasing and is a physical threat to many businesses and financial institutions. It is crucial to start worrying about climate change now. Climate change is a short-term and long-term risk to businesses and affects all industries in some way. Moreover, it may differ in almost every industry and has different impacts in different industries. Climate change can have severe consequences for financial institutions, so it is crucial to get everyone's attention. Severe climate change could wreak havoc on the financial system due to the negative impacts of climate change on the banking sector.

Research Problem

Climate change threatens financial stability because of financial, physical, operational, liquidity, and transition concerns. The actual or predicted economic impacts of further climate change (physical hazards) or a shift to a low-carbon economy might affect the value of financial assets/liabilities (transition risks). Climate-related concerns may have an impact on how banks respond to shocks. They may cause risk premia to rise sharply across various assets (Vladimir, Amado & Connell, 2011). Furthermore, it might change asset price (co-)movement across sectors and jurisdictions, amplifying credit, liquidity, and counterparty risks and posing unpredictable challenges to financial risk management. Some present risk diversification and management techniques may become less successful due to these developments. Climate change might negatively influence banking sector resilience, leading to a self-reinforcing decrease in bank lending. The problem is therefore how climate change's impact on the banking sector.

The Goal of the Research

The main goal of this thesis is to provide theoretical evidence on how climate risks affect the banking sector, and the method banks adopt to mitigate its effect.

Research Objectives

i. Reveal how climate change impact on bank financial system

ii. Evaluate the risk of physical damage to financial institutions' fixed assets growth.

iii. Evaluate the methodological approach adopted by bank regulators in addressing the issue within their mandates.

iv. Create a methodology for managing the impact of climate risk in the banking sector

v. Evaluate the impact of liquidity risks due to climate change on banking sector performance.

vi. Determine the impact of operational risks due to climate change on banking sector performance.

Research Methods (methodology)

A quantitative research method will be employed. Quantitative is the process of collecting and analyzing numerical data. It can find patterns and averages, make predictions, causal test relationships, and generalize results to broader populations. However, the participants will be employed to seek their opinion on managing climate change risk in banks and the Nigerian banking sector. The target population will be bank employees in the commercial city of Lagos, Nigeria. Data extraction will be through both primary and secondary sources. Primary data extraction is by administering survey questionnaires (using Google form) on 500 bank employees through a purposive sampling technique. A secondary source of data will extraction is the Central bank of Nigeria's annual stability reports and financial statements of accounts. The time series data cover the period from 2010 to 2020. Data will be analyzed using descriptive and inferential statistics (one-way analysis of variance (ANOVA) with the aid of Package for Social Sciences (SPSS) version 26.

Structure of the research study

The thesis is into three sections.

The first section is the theoretical part which briefly describes the following structures: the concept of climate change and its related risks, the causes of climate change, the impact of climate change on the financial system, the impact of climate change on the banking sector and climate change impact on banks' financial stability; the second section is the methodology which concentrates on the key variables, thesis hypothesis, sampling, research strategy, the method of data collection and extraction, the construction of the model, the third section is the research which deals with the analysis of the empirical results. It elaborates on the results from the survey feedback received during the research work.

1. THEORETICAL ASPECT OF CLIMATE CHANGE ON FINANCIAL SYSTEM

This thesis debates the possible consequences of climate risks on bank financial structure. It explores medium that climate-related risks might impact the banks' financial system. It also ascertains likely instruments within the financial system that might strengthen the effects of climate-related risk and the cross-border transmission of risks.

1.1. Theoretical aspects of climate change

This part of the thesis deals with the basic structure of climate change, its related risks, the cause of climate change, climate change's impact on the financial system, banking sector and banks' financial stability.

1.1.1. Concept of climate change and its related risks

Emielu, quoted in IPCC (2021), opines that climate is derived from the Greek word klinein, which means slope, and describes how the angle at which the sun strikes the earth varies in different places and regions. As a result, each region of the world has its climate. Weather is another crucial concept to grasp when studying climate. Climate refers to an area's weather conditions over some time. It is the regular pattern of weather conditions in a specific location. According to the Intergovernmental Panel on Climate Change (IPCC, 2021), the defined climate is the average weather over a given period. It is the statistical description of relevant quantities in terms of mean and variability over a period ranging from months to thousands or millions of years. The classical period is usually 30 years, and the quantities are surface variables like temperature, precipitation, and wind.

Blast, quoted in IPCC (2021), views weather and climate concerned with the angle at which the sun strikes the earth. However, weather and climate are temperatures, pressure, air movement (wind), precipitation (rainfall, snowfall, Etc.), humidity, and sunlight. When these conditions are evaluated or measured in hours, days, or weeks, they are called weather; however, when measured over a more extended period, such as years or millions of years, they are called climate.

IPCC & UN, quoted in Ojutiku, Kolo and Egesie (2017), opine that climate change, irrespective of its cause, is a significant and persistent change in the

statistical properties of the average weather system over a long period. Climate change can be attributed to changes in average weather that are directly or indirectly related to human activity—added Natural Phenomenon, which added Atmosphere, Composition, and Atmosphere over a comparable period. The term may sometimes refer to climate change caused by human activity, human activity and natural processes on earth. Climate change is the long-term change in weather conditions in a particular place, region, or planet. Migration is measured as changes in average weather-related characteristics such as temperature, wind patterns, and precipitation. This could be a change in mean weather conditions or distribution around mean weather conditions. In the context of Environmental Policy, climate change has become synonymous with anthropogenic global warming, i.e. an increase in mean surface temperature. Global warming is heating the earth's surface when the atmosphere traps heat released into space.

Blast, quoted in IPCC (2021), says that climate change entails changes in various meteorological factors known to occur over time and from place to location worldwide. As a result, *climate change* is defined as a significant and long-term shift in the statistical distribution of weather patterns spanning timescales ranging from decades to millions of years, involving meteorological variables such as temperature, pressure, humidity, and precipitation. Climate change, in simple terms, is a long-term change in temperature, pressure, wind, precipitation, and humidity measurements over places and the entire globe, which can manifest in extreme temperatures as global warming or cooling, heavy or minor or no rainfall (drought), extreme wind and thunderstorms, and earth movements of various magnitudes. Climate variability, as said, is the primary source of biospheric or atmospheric catastrophes currently occurring around the world. The lethal heat waves and wildfires currently wreaking havoc in some parts of the world increased glaciation in others, heavy rainfall, snowfall, and flooding wreaking havoc in others, drought and desertification, landslides and gulley erosion, earthquakes, volcanic eruptions, and tsunamis, among other disasters, are among the catastrophes.

IPCC, quoted in Akuwudike, Mac-Ozigbo & Igbokwe-Ibeto (2020), says that climate change is a complex interplay between the earth's atmosphere- stratosphere

and troposphere on the one hand, and the land biosphere on the other. Climate change is thought to be caused by the environmental impacts of global warming. Many people consider global warming the most serious environmental threat in rural and urban areas. *Climate change* is defined as the change in the state of the climate that can be recognized by changes in the mean or variability of its attributes and that lasts for a long time - often decades or longer. Although the length of time it takes for changes to materialize is essential, the degree of deviation from the norm and its consequences for the environment are the most critical factors.

United Nations, as quoted in Akuwudike et al. (2020), defined climate change as a change in climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable periods. According to Fatile (2013), climate change's main characteristics include conditions. In the context of Environmental Policy, climate change has become synonymous with anthropogenic global warming, i.e. an increase in mean surface temperature. Global warming is heating the earth's surface when the atmosphere traps heat released into space.

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United Nations, as quoted in Akuwudike et al. (2020), defined climate change as a change in climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable periods. According to Fatile (2013), climate change's main characteristics include a rise in average global temperature, ice cap melting, changes in precipitation, and an increase in ocean temperature, and all contribute to sea level rise.

Ozor (2019), *climate change* is defined as a change in the climate over time, whether caused by natural variability or human action. It is widely acknowledged as the most severe environmental danger confronting our communities today. This description elicits the gravity of the threat posed by climate change and the haste with which countries must respond to this urgent clarion call to counteract climate change's detrimental impacts.

Table 1

Views of climate change and its impact

View of climate change	Methodology	Findings	Gaps
Fatoki & Sasona (2015) view climate change as irreversible, and no future effort can reverse its impact.	Descriptive approach	The study found that Nigeria still needs to implement a financing platform to tackle mitigation and adaptation options to climatic changes.	The research is only limited to financing Nigerian climate change
Blast (2010) views and referred climate change as the variation in average weather, which is attributed directly or indirectly to human activities in addition to natural events that alter the composition of the atmosphere over the comparable period.	The descriptive survey research design will be adopted for the study. The population of the study was 73,603 respondents made up of 73,513 registered farmers in 10 selected local government regions and 90 extension workers.	The study revealed that climate change has resulted in a high occurrence of floods in the region and increased poverty level and the cost of production (input and labour cost), as indicated by the farmers in the Niger Delta region.	The research is only limited to financing Nigerian climate change.
Akuwudike, Mac-Ozigbo & Igbokwe-Ibeto (2020) opine that climate change is a complex interplay between the Earth's atmosphere- stratosphere and troposphere on the one hand and the land biosphere on the other.	This study adopted the descriptive research design in which 500 respondents were interviewed online.	The study revealed that climate change impact response influenced the creation of new businesses, especially in the SMEs subsector	The present research is only limited to the informal sector. Other sectors of the economy should be considered in future research.
The (UNFCC) United Nations Framework Convention on Climate Change, quoted in Ebele & Emodi (2016), attest that climate change is climate change contributes to and impacts human endeavors directly or indirectly, which alters the composition of the global atmosphere and adds to natural climate variability over the comparable period.	Descriptive approach	The vulnerability to the impacts of climate change, like banks, agricultural sector, health, energy, Etc. indicates that many sectors of the Nigerian economy appear to be directed according to the finding of this study. agricultural sector, health, energy, etc.	The present research is only limited to the Nigerian economy. The banking sector of the economy can be considered in future research.

Continuation of Table 1

Oguntuase (2017) view climate change as a significant and persistent change in the statistical properties of the average weather system over a long period. Climate change can cause changes in average weather that are directly or indirectly related to human activity.	Spearman's rank-order test of the hypotheses was used for data collected by administering survey questionnaires to 100 bank employees.	The study's results demonstrated a strong correlation between knowledge of climate change and perception of climate change as a financial risk.	This study focused only on deposit money banks in Nigeria. The non-financial sector of the economy should be validated based on the study's findings.
Ozili (2020) believes that climate change is also seen as a change in the climate over time, whether caused by natural variability or human action and is widely acknowledged as the most severe environmental danger confronting our communities today.	Descriptive approach	Showed that climate change has severe consequences on the stability of financial institutions through its effect on the counterparties and clients of financial institutions.	This study focused only on financial institutions in the United Kingdom (UK). The non-financial sector of the economy ought and should be validated based on the study's findings.
Fabris's (2020) views on climate change, global warming and continuous greenhouse gas emissions will cause further global warming. It leads to irreversible consequences such as heat waves, hurricanes, floods, droughts, rising sea levels, fires, epidemics.	Descriptive approach	This result indicated that climate change could adversely affect the balance sheets of financial institutions.	This thesis is limited to the financial strength of financial institutions in Montenegro. Instead, Montenegro's economy.
Altamimi & Nobanee (2021) state that *climate change* is the change in the state of the climate that can be recognized by changes in the mean or variability of its attributes and that lasts for a long time - often decades or longer.	Descriptive approach	The study found that establishes that Climate change is responsible for various forms environmental unsustainability negatively affect the environmental jurisdiction, the banks therein also suffer from the negative impacts of climate change.	The study was restricted to banking sectors in the UK..

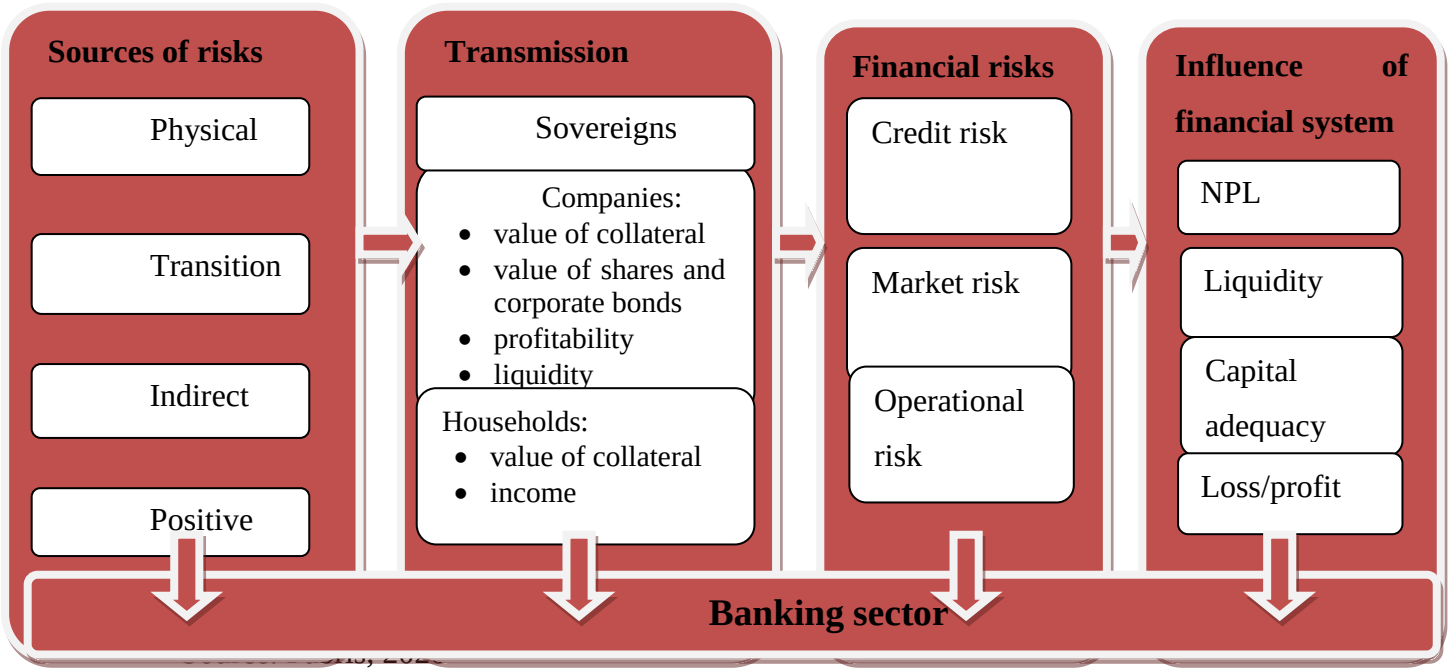
Continuation of Table 1

Liu, Huang, Zou, Chen and Chu (2020) say that climate change refers to any significant long-term change in the average weather experienced in a given region.	This study employed regression analysis and selected 11 small- and medium-sized listed banks.	There is a positive correlation between climate change and systemic risk in banks within the confidence interval. Climate warming increases the non-performing loan ratio and banks' systemic risk.	The present research is only limited to the informal sector. The economy can depend on other sectors of future research.
Khan (2012) states that climate change occurs when the Earth's average temperature changes dramatically over time. As little as one or two degrees can dramatically change because the Earth's ecosystem depends on a delicate balance, and even small shifts can have a far-reaching impact.	No methodology	It was deduced that the present situation is not sustainable; too much CO_2 is being released, which calls for immediate action.	The present research is limited to Ethiopia.

Source: complies by different authors, 2022

Based on the review of climate change and its impact on the banking sector, the study indicated that climate change has resulted in a high occurrence of floods and an increased poverty level in the country; climate change has severe consequences on the stability of financial institutions. This result also indicated that the balance sheets of financial institutions could be adversely affected by climate change. The study established that climate change is responsible for various forms of environmental unsustainability, negatively affects the environmental jurisdiction and financial institutions, and also suffers from the negative impacts of climate change.

Figure 1:
Types of Climate change-related risks



All these risks can affect lower lending activity, leading to slower economic growth and lower employment. However, we should recognize that, as already mentioned, climate change could result in the emergence of companies for which this would be a chance to enter the market and develop rapidly.

Fabris (2019) concludes that supervisors and financial institutions need an understanding of the nature of these risks and their impact on business. The situation gained additional importance and implications because financial markets and institutions underwent a radical transformation and a sudden expansion induced by general trends in deregulation, liberalization, globalization, and computer technology advances over the past several decades.

There is no doubt that climate change threatens the banking sector, and financial stability is the objective of central banks, which will become increasingly important in the future.

Climate change-related risks to the banking sector: Financial risks

Basel Committee on Banking Supervision (BCBS, 2020) states that in terms of the traditional risk categories of credit, market, liquidity, and operational risk, the influence of climate risk drivers on banks can be explained through examples from the literature. The following drivers are related to financial risks that affect the banking sector: credit risk, market risk, liquidity risk and operational and reputational risk.

Credit risk**:** Climate risk factors can impact personal, business, and government income and wealth. Physical and transition risk drivers can hurt a borrower's ability to repay and service debt (the income effect) or a bank's recovery ability on the value of a loan in the event of default may be at stake because the value of any pledged collateral or recoverable value has been reduced. They increase a bank's credit risk (the wealth effect). This credit risk impact manifests itself in various ways, as evidenced by the examples selected from the literature.

Market risk: According to BCBS (2020), climate risk factors can significantly impact the value of your investments. Physical and transition risks, in particular, have the potential to change or expose new information about future economic conditions or the value of tangible or financial assets, resulting in price shocks and increased market volatility in traded assets. Climate risk could also cause asset correlations to break down, lowering the efficiency of hedges and making it more difficult for banks to manage their risks actively. However, if there are already considerations of climate risks, the likelihood of price swings is lessened. Banks generally use historical data to manage market risk and limit their exposure to systemic shocks. Asset mispricing and the potential of downward price shocks are significant due to the unprecedented nature of climate risk drivers and the opacity of climate-vulnerable assets. It is currently unknown whether, how, or to what extent markets price in climate risks when establishing a financial asset's market value. It also needs to be clarified and emphasized on the incorporation of the amount to which climate risk of asset value affects banks' market risk. More research would be beneficial and necessary in both circumstances. There is also a need for more knowledge on the extent to which

climate risk drivers may jeopardize banks' market risk management assumptions (Emmanuel & Ekwere, 2022).

For example, a bank makes assumptions about the correlation of asset prices in hedges with similar but unequal positions. It also makes assumptions about the market liquidity of financial assets used to hedge positions. Because information on the impact of climate change on these assumptions is limited, it will be encouraging and recommended that further research is necessary.

Liquidity risk: Climate risk factors can affect a bank's liquidity risk, either directly through its ability to raise funds or securitize its assets or indirectly through its customer liquidity needs. Although few studies have investigated the direct impact of climate risk factors on bank liquidity, there are related studies of the indirect impact of natural disasters. There is evidence that natural disasters can pose liquidity risks for banks. These effects affect the bank's ability to finance its asset growth and enable it to meet its due obligations without incurring unacceptable losses. Available research focuses on liquidity risk associated with physical risk, and analysis of the potential impact of transition risk factors on banks' liquidity risk is limited.

Operational and reputational risk: Migliorelli & Dessertine (2020) state that; operational risk is defined in the Basel Concept of Capital as the risk of loss due to improper or failed internal processes, people and systems or external events. This definition includes legal risks but excludes strategic and reputational risks. When necessary, strategic, and reputational risks should be addressed when managing a bank's operational risk. Physical risks are operational risks that can have a direct impact on the bank. However, there are few general studies of the operational risks that banks face and relate to physical hazards and similarities with other natural disaster identification. For example, a deduction can occur in the bank's ability to operate if physical hazards interfere with its vehicles and communications infrastructure. Businesses and banks may be at increased risk of legal and regulatory compliance, litigation and liability costs associated with climate-sensitive investments and businesses. Climate change litigation may also target businesses and banks for past environmental behavior while attempting to control future behavior. For example, climate change has caused a prolonged drought in California,

increasing the risk of fires from PG&E activities. The company estimated the cost of settlements with the plaintiffs at over $13 billion. Indirect reputational risk can also arise from banks that finance companies or activities believed to be responsible for adverse climate impacts (Drill, Paddam & Wong, 2022).

Physical risk drivers: McKinsey Global Institute, cited in Munich Re (2020), opine that physical hazards are weather and climate changes that impact the economy implement acute risks from extreme weather events and chronic hazards from gradual climate change can be as follows; type-specific time lags, frequency, and severity. Physically, human actions and decisions. Although they affect our exposure to climate hazards, the location, timing, and magnitude of some physical events do not allow us to produce the $5.2 trillion outcome, as roughly 60% of them are meteorological and climatological. Losses have occurred, and the number of losses is increasing.

Acute physical risk drivers: Jones, Smith, Betts, Canadell, Prentice & Le Quéré (2020), acute physical hazards usually include catastrophic heat waves, floods, forest fires, hurricanes, cyclones, typhoons and other storms, and heavy rains. For example, rising global temperatures can lead to dramatic climate change due to heat waves and associated forest fires. Also, spreading forest fires is evidence that this contributes to damage to the fauna and the local economy. The warmer atmosphere absorbs water of high quantity, meanwhile, due to a high level of safety and security. Relatively short-term precipitation and increased precipitation can damage property, infrastructure and agriculture. It may lead to severe climate events such as catastrophic flash floods that cause, in connection with heat waves, concentrated rainfall in specific areas can increase the duration of severe droughts followed by floods. These types of climate impacts can cause significant and, in some cases, recurring economic losses.

Chronic physical risk drivers: According to Atanasova & Schwartz (2019), the following can generally be considered chronic physical risks: rising sea levels, rising average temperatures, and ocean acidification. Long-term high temperatures can lead to the further development of chronic climatic events such as desertification.

Similarly, more extended periods of average temperature rise can affect ecosystems, especially agriculture. These changes can lead to higher levels of migration and increased risk of humanitarian crises. By 2050, the World Bank will allow approximately 140 million people in Latin America, South Asia and sub-Saharan Africa to migrate to their home countries from areas with low water availability and yields.

IPCC, cited in McKinsey Global Institute (2020), predicts that up to 200 million people in India could live in areas at risk of deadly heat waves if temperatures rise sharply and there is no allostasis. The IPCC also warns that higher temperatures will accelerate the melting of ice beds and glaciers and raise sea levels. These may lead to endemic (or permanent) floods and erosion of coastal cities, islands, and lowland areas.

Transition risk drivers: Bos & Gupta (2019) predict the need to meet the Paris Agreement commitments on climate change. A global shift away from fossil fuels may result in the bulk of fossil fuel reserves (about 80%) becoming stranded resources, including as much as 90% of Africa's coal deposits, implying severe losses for many countries. A shift like this might significantly impact government revenues and spending in some of the world's poorest countries that rely on fossil fuel earnings. Climate-related income consequences on sovereigns could make it more difficult for them to service their debts, affecting the value of their bonds, their credit ratings, and those linked with the sovereign. As a result, the credit risk of banks dealing projected with these counterparties can rise. As previously said, transition risk drivers can impact the profitability of banks' counterparties, which could have macroeconomic implications. Carbon emission levies, increased pricing in carbon-intensive supply chains, or changes in consumer preferences, for example, could all have an income effect. Higher manufacturing costs affect profitability, lowering investment and share prices. Firms could raise prices in response to increasing production costs, reducing household disposable income and cutting consumption. GDP also can be reduced as a result of decreasing consumption and investment. Due to structural adjustments in the economy caused by climate change impacts or mitigation initiatives, households may experience decreased income due to slower

GDP growth or more unemployment. The ability of households to fulfil their obligations may deteriorate when their wealth and income decline, raising the credit risk to their banks (Fadun & Diekolola, 2021).

Government policy: UNEP-FI, cited in Seltzer, Starks & Zhu (2020), states that changes in production, sales, and profitability in the transition to a low-carbon economy may impact businesses. Creditworthiness by the current and future profitability forecasts as the probability to be influenced. Firms, for example, may suffer higher operational costs as a result of a higher tax on GHG emissions. The impact of this tax could diminish earnings and, as a result, the company's creditworthiness. Also, as a result, its access to funding may be limited, and the cost of such funding may rise. More data on the relative impact of governments' climate measures on company profitability would help understand this transmission channel further; Increases in credit costs for businesses in some industries may limit their ability to repay bank obligations. According to UNEP-FI, assets in the utilities, transportation, agriculture, mining, and petroleum sectors are the most vulnerable to climate-related losses. In contrast, manufacturing assets should lose less value but offer a greater risk to banks' portfolios due to their higher contribution.

Technological change: efforts to combat climate change and to spur technological advancements that will allow for the transition to a lower-carbon economy. If the implementation of carbon taxes or more rigorous regulations, existing carbon-intensive technology may become more expensive. As a result, businesses that rely on carbon-intensive technologies may retain market share if they adopt the latest technology. Automobile makers, for example, may face lesser profitability in carbon-neutral economies if they cannot build electric automobiles efficiently. Banks exposed to companies that fail to shift to carbon-neutral economies may face increased credit-related losses. To better understand this transmission channel, empirical data on the relationship between technological change and credit risk would be valuable (Dietz, Bowen, Dixon & Gradwell,2021).

Sentiment: According to S&P Global (2018), consumer and market attitudes may move to fewer carbon-intensive products or investments when economies transition to lower-carbon economies. As physical threats materialize, such alterations could

emerge by growing anticipation of harmful future climate events, making people more conscious of climate change. As a result, they may take actions that help mitigate climate change's effects. For example, consumers may increasingly prefer cars with fewer GHG emissions in the automobile sector. As a result, regardless of legal or technical initiatives, traditional automobile manufacturers who continue to create high GHG emission cars may find their brands' futures jeopardized. More research on the income and wealth effects of sentiment on corporations would aid in better understanding the nature of this transmission channel.

1.1.2. Causes of climate change

According to Khan, quoted in Chukwuemeka and Daniel (2021), the earth's climate is dynamic and constantly changing through a natural cycle. What concerns the globe the most is that the current changes have accelerated due to man's activity. Scientists worldwide investigate these shifts, using tree rings, pollen samples, ice cores, and marine sediments as evidence. The majority of experts agree that greenhouse gases created by human activities are the primary cause of climate change. The causes of climate change may be into two categories: those caused by natural factors and those caused by humans.

Human acts that generate large amounts of greenhouse gases into the atmosphere deplete the ozone layer or diminish the amount of carbon absorbed from the atmosphere is referred to as anthropogenic factors, according to the IPCC, as stated in Odjugo (2020). Human activities like fossil fuel combustion, gas flaring, urbanisation, agriculture, and changes in land use such as deforestation release greenhouse gases (GHGs) into the atmosphere, increasing the concentration of these gases already present. Climate change, or global warming, has been proven to be caused by human factors.

According to the South African Confederation of Agriculture Unions, carbon dioxide, methane, and nitrous oxide are the principal greenhouse gases, accounting for 80 per cent, 14 per cent, and 6 per cent of total GHG emissions, respectively. GHGs operate as a blanket over the atmosphere, absorbing heat radiation from the earth's surface. According to some projections, if current trends in anthropogenic

GHG emissions continue through 2030, the world will see a 1.5°C to 4.5°C average temperature rise. While wealthy countries as the main culprits of climate change, developing countries cannot cope due to poverty and lack of technological progress and bear the brunt of the consequences.

Natural causes: Climate change is the result of a variety of natural forces. Continental drift, variations in the earth's orbit, fluctuations in solar output, volcanic emissions, cosmic collisions, ocean currents, the earth's tilt, and comets and meteorites are a few of the more famous ones. Let us take a closer look at them.

Continental Drift: The finding of tropical plant fossils led to the conclusion that this frozen continent was once closer to the equator when the temperature was tropical, with swamps and an abundance of lush vegetation. The continents we know today were created millions of years ago when the landmass began drifting away. The physical characteristics of the mainland, their location, and the position of water bodies all altered due to this drift, which influenced the climate.

The separation of landmasses altered the flow of ocean currents and winds, which impacted the climate. Even now, the continents are drifting; the Himalayan range rises by around 1mm (millimeters) yearly as the Indian landmass slowly but gradually moves towards the Asian mainland.

Solar Output Variation: Many researchers think that the sun's output radiation fluctuated merely by a fraction of a per cent over many years. However, measurements taken by radiometer-equipped satellites in the 1980s and 1990s revealed that the sun's energy output is more variable than previously assumed, with a 0.1 per cent decline in the total quantity of solar energy reaching the planet during just 18 months. If this tendency continues for several decades, it may impact the world climate. Statistical climate models, a 1% shift in solar output every century would vary the earth's average temperature by 0.5° to 1°C. The sunspots change affects the sun's rays' energy fluctuation (22-year cycle).

Volcanoes: Whenever a disaster happens, vast amounts of sulfur dioxide (SO2), water vapor, dust, and ash are released into the atmosphere, influencing climate patterns for years. Volcanic eruptions and their related activity come in various

shapes and sizes. Discharging hazardous gases during volcanic eruptions can occasionally cause much more limited effects. For example, fine ash from the Krakatoa explosion in 1883 was propelled to a height of 27 kilometers by the upsurge of gas and vapors. It was carried over the globe, resulting in unusual sunsets and other climatic changes.

A significant eruption can produce millions of tons of Sulphur Dioxide gas, reaching the higher reaches of the atmosphere. The gases and dust particles partially obscure the sun's beams, which impacts the heat budget. Sulphur dioxide reacts with water to generate tiny droplets of sulphuric acid, which cause acid rain, which is hugely destructive to the environment. Because these droplets are so minute, they can persist in the air for years. They are good reflectors of sunlight and shield the earth from part of the energy that the sun would otherwise provide.

Variation in Earth Orbit & Axis: The elliptical earth's orbit is the distance between the earth and the sun changes over a year (perihelion, 147.1 million km & aphelion, 152.1 million km), affecting solar energy distribution. As a result, the amount of solar energy reaching the earth varies by around 3.5 per cent above or below the solar constant.' Because tropical locations get the most incoming solar radiation (energy) throughout the year, their closeness to the equator impacts their climate. Solar energy reduces as one travels closer to the poles. The earth's axis is typically thought to be fixed. The axis changes at a pace of more than a half-degree every century, so it is not constant. Precession, or the slow change in the direction of the earth's axis, causes climate change.

The tilt of the earth's axis from the normal to the ecliptic fluctuates, oscillating between 24°36′ and 21°59′ during around 40,000 years. The angle is currently 23°27′ and falling. The intensity of the seasons can be affected by changes in the earth's tilt: more tilt implies warmer summers and harsher winters; less tilt means cooler summers and milder winters.

Khan, quoted in Chukwuemeka and Daniel (2021), claims that "distance from the oceans, ocean currents, and El Nino: The oceans have an essential role in the climate system. They cover over 71% of the earth's surface and absorb almost twice as much solar energy than the atmosphere or land surface. The waters influence the

climate of an area. Inland locations are colder and drier than coastal ones. Clouds develop when warm air from the inland meets chilly air from the sea. These clouds act as a heat barrier and impact the climate. The temperature in the core of continents varies greatly. Temperatures may be sweltering and dry in the summer as precipitation from the sea evaporates before reaching the continent's interior.

The Pacific Ocean's El Nio phenomenon has the potential to alter climate conditions all across the world. Droughts and floods in Pacific Rim nations have been blamed on El Nino, which influences wind and rainfall patterns.

The elements mentioned above have a natural effect on the climate. However, we must not overlook the impact of humanity on our environment. As the population grows, more land previously covered in vegetation is destroyed to make room for dwellings and other purposes, negatively impacting the atmosphere's composition in terms of carbon dioxide and oxygen. Natural resources are widely employed in building, industry, transportation, and consumer goods. Because of the enormous population growth, consumerism has exploded, resulting in mountains of trash that harm the environment (Khan in Chukwuemeka & Daniel, 2021).

Industrialization, which began at the end of the nineteenth century, today has significantly impacted the climate. About 3/4 of carbon dioxide, 1/5 of methane, and a significant amount of nitrous oxide is attributed to the energy industry. It also creates nitrogen oxides (NO2) and carbon monoxide (CO), which are not greenhouse gases but impact the chemical processes that produce and remove greenhouse gases in the atmosphere.

1.2. Impact of climate change on the banking sector

Intergovernmental Panel on Climate Change (2021), climate change poses a systemic danger to the financial sector, necessitating increased regulatory monitoring and mitigating actions. Systemic risks in the financial system are those that have the potential to undermine the system's regular functioning and have significant adverse effects on the actual economy. At least two types of climate-related risks cross this line: 1) physical risks connected with more frequent extreme weather events and long-term environmental changes, and 2) transition risks associated with the policy

and technology reforms required to establish a greener economy. Carbon-intensive assets might be stranded, and the value of other financial instruments could be affected. The massive amount of predicted losses owing to physical and transition risks and the potential for such failures to occur quickly impact systemically critical financial institutions and broader financial markets.

Essentially, financial institutions are not only vulnerable to transition and physical risks of climate change but are also impacted actively by amplifying those risks by continuing to fund activities that exacerbate climate change. The six top Wall Street banks in the United States between 2016 and 2018, the commitment was more than $700 billion to fossil fuel finance. According to a 2016 poll, the leading insurers had $528 billion in fossil fuel investments, and the top asset managers boosted their ownership of assets linked to carbon-intensive sectors by 20% in the past three years (Dietz, Bowen, Dixon & Gradwell, 2021).

Rises in the frequency and severity of damaging floods, droughts, fires, hurricanes, and rising sea levels can destabilize, bringing losses to insurance companies, financial institutions, and other financial intermediaries with direct or indirect exposure to various affected industries and assets. Stress at a comprehensive, sophisticated financial institution, a significant firm or correlated stress among smaller enterprises all facing the same risks might spread pressure across the financial system. Between 2016 and 2018, the United States crashed by 45 natural catastrophes costing at least $1 billion (Carbone, Giuzio & Mikkonen, 2019).

Natural catastrophes caused around $150 billion in yearly economic losses over the same period. This shows a significant rise in severity and frequency compared to previous decades. From 1980 to 2019, an average of six natural disasters each year produced more than $1 billion in damage, with yearly natural catastrophe losses of just under $50 billion. Because their primary business line requires them to guarantee losses on physical assets and property, insurance companies (risk bearers) are the financial intermediaries, making them most directly exposed to the physical and other kinds of climate change risks, at least in the short term. In the battle of changing climate and severe weather trends, these companies are attempting to change their loss models and underwriting methods since past statistics are proving to be less

helpful predictors of future underwriting losses. 16 As a result, the sector is affected by a large-scale loss from a combination of natural disasters previously considered unlikely or unthinkable (Carbone et al., 2019).

Furthermore, in the face of potentially massive losses, insurers may be obliged to sell illiquid assets at fire-sale rates to produce enough cash to pay enormous claims or satisfy the cash demands of creditors and counterparties attempting to decrease their exposure to the ailing organization. This fire-sale dynamic could lower asset prices, impacting financial institutions that hold similar assets and raising the cost of capital for companies that rely on such markets (Carbone et al., 2019).

IPCC (2021) opines that the physical concerns of climate change also directly affect the entire financial system. where Mortgage institutes cannot discharge their responsibilities, commercial real estate and businesses are dormant. Agricultural loans, and derivative instruments connected to these markets, are all vulnerable to losses due to severe weather and other environmental changes in different regions of the country. Hurricanes, droughts, floods, fires, and other environmental upheavals, for example, might reduce the value of damaged assets and burden borrowers' capacity to repay lenders, increasing default and losses on these credit portfolios. These physical dangers also affect banks and other financial entities indirectly. Beyond the immediate negative impact on the value of assets that the event affects, severe weather events and environmental changes can cause second-order economic disruptions in local or regional economies. According to studies, catastrophic natural catastrophes cause outmigration, decreased property values, and increased poverty rates in towns impacted. Furthermore, some research suggests that economic production is often higher in more excellent years than in hotter years, with recent years being hotter on average. Increased losses on banks and other financial intermediaries' credit portfolios might result from worsening economic conditions in impacted localities (IPCC, 2021).

Aside from these physical threats, the financial system might be destabilized by rapid losses in carbon-intensive assets due to the urgently needed transition to a greener economy. Carbon-sensitive assets in the utilities, energy, transportation, industrial, and other sectors may lose value if policymakers take the necessary steps

to decarbonize the economy or if technical advancements make that move financially advantageous. Such action or innovation might dramatically raise the price of carbon, stranding certain fossil fuel assets and lowering the value of other carbon-sensitive assets (Carbone et al., 2019). One estimate puts the current worth of possible losses at $18 trillion, based on a comprehensive assessment of stranded assets, not only those directly in the fossil fuel sector. The investors and financial intermediaries who own these assets would suffer losses due to the revaluation. Firms and investors may offload assets at fire-sale prices, and creditors may flee firms that are particularly vulnerable to revaluation pressures, and stressed firms may fail to repay creditors or derivatives counterparties, spreading stress through both assets liquidation and exposure transmission channels. Losses might spread across the financial sector, causing instability and severe consequences for the actual economy.

Giuzio, Kruec, Levels, Melo, Mikkonen & Radulova (2019) opine that climate change can significantly impact financial system stability. The financial system is the system that permits lenders, borrowers, and investors to trade monies.

The following are the effect of climate change on the banking sector. Climate change can damage physical collateral. Climate change can disrupt the operations of financial institutions; climate change can disrupt the business of bank customers, and severe climate change will lead to increased insurance claims and liabilities, and also increased insurance premiums and reduction in insurance coverage, harsher working conditions, loss of office branch networks and higher disclosure requirement and costs.

Damage to payment system infrastructure: In order to fulfil financial obligations and collect financial claims from counterparties in commercial transactions, the financial system significantly relies on payment systems. Every country has an interbank settlement system that aids in the resolution of financial claims and obligations arising from transactions that took place in one or more jurisdictions. The interbank settlement infrastructure is frequently housed in a physical warehouse, which might be revealed or kept secret. Damage to this payment infrastructure caused by severe thunderstorms, severe weather, or earthquakes can disrupt the financial

intermediation process since payments will not be processed when they are due, causing severe financial system instability.

Capital flight due to climate change: Cities and countries may become financially unstable as a result of climate change. This is because significant capital holders will withdraw their funds from cities and countries vulnerable to severe climate change catastrophes, leaving them with limited financial resources to recover from such events. Furthermore, high-net-worth individuals when withdraw their funds from banks and investment firms in climate-change-prone areas, leaving these financial institutions with insufficient capital to operate, resulting in undercapitalization and a reduction in financial intermediation, which could make the financial system unstable.

The uncertainty that destabilizes financial markets: Financial markets may be affected by climate issues. The uncertainty about which climate change event will occur, when, and how severe it will be can cause volatility in financial markets in places vulnerable to climate change events. Fear and uncertainty cause investors to hold cash or supply financing at a premium that businesses cannot afford. Furthermore, financial institutions that cannot mitigate climate change risk may withdraw liquidity from money markets by recalling the financial instruments they have issued to the money market, potentially causing a 'liquidity crunch' or a 'run on liquidity' in financial markets, with negative consequences for financial system stability.

Climate change can confuse regulators: Economists-financial economists, business economics, or university economists – frequently serve as financial system regulators. The failure of macroeconomic models to predict the likelihood of climate change can leave regulators perplexed about what to expect from such occurrences and what to do when they occur. Even financial institutions that climate change events have seriously impacted will seek assistance from the regulator. The regulator may be unsure of what to do in some circumstances. Although most regulators facing a climate change concern would turn to the federal government for assistance, there is no guarantee that the government will have a unique solution that will allow the financial sector to return to normalcy.

Intergovernmental Panel on Climate Change (2021), climate change poses a systemic danger to the financial sector, necessitating increased regulatory monitoring and mitigating actions. Systemic risks in the financial system are those that have the potential to undermine the system's regular functioning and have significant adverse effects on the actual economy. At least two types of climate-related risks cross this line: 1) physical risks connected with more frequent extreme weather events and long-term environmental changes, and 2) transition risks associated with the policy and Technology reforms are required to establish a greener economy. Carbon-intensive assets might be stranded, and the value of other financial instruments could be affected. The massive amount of predicted losses due to physical and transition risks and the potential for such failures are the immediate impact of systemically critical financial institutions with broader financial markets.

Damage to physical collateral: Ozili (2020) states that when a bank lends to corporate and individual borrowers of questionable repayment capacity, it needs physical collateral, which is greater than the credit line given to them. Such physical collateral includes residential real estate, commercial real estate, car and plane fleets, equipment and land. Extreme weather events such as floods, landslides, and typhoons can cause severe damage to some or all of the physical (and immovable) collateral designed to mitigate credit risk. Collateral damage from climate change is reflected as a loss on the bank's income statement and negatively impacts the bank's profitability.

Disruption of the operations of financial institutions: Financial institutions mainly rely on communication systems through information technology infrastructure. Any damage to such infrastructure due to severe weather conditions or hurricanes could disrupt the operations of financial institutions for a substantial period before restoration. Climate change events such as hurricanes can damage infrastructure used by financial institutions for corporate communication, such as the Internet, information technology systems, and cell towers. Severe climate change can also disrupt the ability of banks to communicate internally, thereby disrupting their operations.

Disruption of the business of the bank's customers: Hurricanes, landslides, and floods caused by climate change can harm the business of banks' clients and consumers. During hurricanes and floods, bank customers such as manufacturing and agricultural businesses are particularly vulnerable. Although the Impact on banks is indirect, such occurrences would result in low-profit margins for banks with sizeable agricultural exposure because the affected enterprises will be unable to conduct business for an extended time until they recover.

Increase in insurance claims and liabilities: Dlugolecki, quoted in Afolabi, Salahudeen, Kamar and Susan (2021), predicts that insurance firms will face higher costs due to climate change. When climate change events damage the insured item, businesses and people with comprehensive insurance policies with insurance or reinsurance companies are generally the first to file a claim on their policy. When numerous firms and individuals are affected simultaneously, insurance payouts will be larger, which could put insurance companies in financial trouble if they do not have enough money to compensate policyholders. Furthermore, because other financial institutions are the primary lenders to insurance firms, climate change events may indirectly impact these institutions.

Increase in insurance premiums and reduction in insurance coverage: Ozili (2020) says that when numerous firms and individuals are affected simultaneously, insurance payouts will be larger, which could put insurance companies in financial trouble if they do not have enough money to compensate policyholders. Furthermore, because other financial institutions are the primary lenders to insurance firms, climate change events may indirectly impact these institutions. In anticipation of climate change events that the insurance company believes are likely to occur, insurance firms might raise premiums and associated deductibles. When it becomes difficult to measure the likelihood and severity (or frequency) of climate change events, insurance firms may either reduce the availability of insurance coverage for climate change events or refuse to provide any coverage for climate change events.

Harsher working conditions due to climate change: Climate change-related events can make employees of financial institutions less productive, especially as record temperatures make the day unbearable and frustrating. Extreme heat and hydration,

especially when combined with hard work and extended hours, can lead to a mental and physical breakdown in employees of financial institutions. Severe climate change means it will be colder or hotter than ever, and the cold or heat could last much longer than in the past.

Loss of office branch networks due to climate change: Ozili (2020) believes that banks frequently prepare for climate change by installing solar panels and other steps to reduce their carbon footprint at their headquarters. However, more than the same proportional effort is needed to preserve small bank branches across the country and abroad. As a result, a bank will likely lose certain branches when climate change disasters such as flooding and hurricanes occur.

Higher disclosure requirements and costs due to climate change: Ozili (2020) predicts that regulations or laws may emerge that require financial institutions to disclose their exposure to climate change risks. There is also a need to disclose the amount of risk capital secured to mitigate these climate change risks. Financial institutions may also require further disclosures about how climate change will affect a company's strategic and operational performance under regulations. However, such disclosures are expensive for financial institutions. Capital market regulators may impose these disclosure rules to ensure investors understand SOEs' intentions to manage climate change risks better. In the banking sector, banking regulators can make disclosure rules a promising micro-prudential approach to addressing climate change risks. Such disclosures are expensive for financial institutions as they may need to hire experts to quantify their exposure to climate change risks accurately and assess the risk capital they need to set aside to mitigate them.

1.2.1. Climate change impact on banks' financial stability

Network for the Greening Financial System (NGFS, quoted in Chukwuemeka and Daniel (2021), states that climate change is one of the significant structural shifts affecting the financial system. While the precise results, time range, and future cause are unknown, there is a significant probability that a mix of physical and transition risks may manifest. The Bank of England summed up the issue perfectly: "The future would have been pass". *Climate change* is a horizon tragedy that will impose significant expenses on future generations that the current generation has no

immediate motivation to address. Climate change's disastrous effects will be felt well beyond the horizons of most actors. It may already be too late to stabilize the atmosphere once climate change becomes a clear and present hazard to financial stability.

Gelzinis & Steele, quoted in Chukwuemeka and Daniel (2021), state that a rise in the severity and frequency of hurricanes, droughts, floods, fires, and other environmental events might lower the value of damaged assets and put a strain on borrowers' ability to repay lenders, leading to higher levels of default and losses on these credit portfolios," says the report. A quick correction in asset values that do not adequately represent climate-related concerns could result in losses for financial institutions, decreasing financial lending. There will be a need for a climate-resilient financial system.

Sevillano & González (2019), several studies (especially on European banks) have concluded that the banking system is starting to take climate risk into account. However, they have found significant gaps in banks' identification, measurement and risk management, making it more difficult to predict their vulnerability. These risks. The bottom line is that some of these risks, mainly transition risks, will materialize in the long run, whereas the financial system often takes into account short-term risks. The bottom line is that some of these risks, mainly transition risks, will materialize in the long term while the financial system is preoccupied with short-term risks. Bank of England Governor Mark Carney called the phenomenon a "tragedy of the horizon." The "tragedy" here lies in that when these dangers become apparent; it will be too late to prevent them and thus keep global warming below 2°C.

Fabris (2020) predicts that climate risk does not create new risks for financial organizations; instead, it translates to existing risks such as credit risk, market risk, and operational risk. The danger of unfavourable market price movement is known as market risk. Banks are the most vulnerable because of the risk associated with their securities. Climate change, for example, could raise sovereign risk, resulting in a drop in a country's credit rating and, as a result, a drop in the value of government assets held by banks. Operational risk in banks can arise as a result of a financial

institution's business continuity being compromised by extreme occurrences such as flooding, which would prevent the institution or any of its branches from operating.

Credit risk can appear in a variety of ways. Companies that use outdated technology may face higher costs if new technologies result in cheaper costs, compromising their profitability and increasing the risk of default. The imposition of a carbon tax or prohibiting certain CO2-emitting technologies has the same effect. In a flood or hurricane, collateral can be destroyed or have its value significantly reduced. Extreme temperatures reduce agricultural yields and productivity in several industries, particularly those that need outdoor labour, such as construction. Finally, we must recognize the losses that may be incurred by businesses whose operations are not directly affected by climate change but whose essential partners are. All of this limits the ability of the affected enterprises to repay their debts. Banks are affected by climate risk long-term (Afolabi *et al.*, 2021).

Fabris (2020), physical risks occur in meteorological events such as droughts, floods, storms, rising sea levels and rising temperatures. Financial institutions can be directly impacted by physical risks such as the depreciation of assets and collateral, increased insurance losses, or disruption of a financial institution's business operations. Depending on location, branch diversification, property insurance, Etc., it can be realized directly through operational risk or indirectly through portfolio as credit risk or market risk. Transition risk is the economic risk of adapting to low-carbon production. If the government introduces carbon taxes or carbon emission restrictions, this could increase the cost of enterprises in carbon-intensive industries. This risk can also arise from innovations that create new technologies to reduce greenhouse gas emissions, such as transitioning from traditional gasoline and diesel engines to electric vehicles. A potential risk for these companies is raising consumer awareness towards low-emission companies. Measures by the Green Movement to boycott these producers can also have an impact. Governments can tighten standards as the financial system can become unstable, as carbon-intensive assets can be rapidly lost due to the long-awaited transition to a green economy. This all means that carbon-sensitive assets will be depreciated. This causes significant losses to the shareholders of these companies, the banks that fund them, and the holders of their

securities and bonds, thus significantly reducing their ability to repay their debts (Fadun & Diekolola 2021).

Oh & Reuveny, quoted by Fabris (2020), states that the indirect risk is almost completely ignored in scientific studies. This risk occurs when a company's business is not directly affected by climate change, but the business of one of its key partners can cause disruptions in global supply chains. A catering company, for example, is not directly affected by climate change. However, if it prepares meals for workers in a coal mine that may close in the future, its business is already impacted by climate change. This Impact can also be seen in disrupted trade flows, as evidenced by several studies. These risks can lead to a decrease in lending activity, leading to slower economic growth and lower employment.

In summary/conclusion, this master thesis evaluates climate change in the banking sector and its impact on the financial institution. It shows that climate change can have severe consequences for the stability of financial institutions through its effect on counterparties and clients of financial institutions. It is undoubtedly and can not be debated knowing that climate change is an emerging risk and a cause for increasing uncertainty in the banking sector. In reality, some financial institutions still do not see the need to manage climate change risk because they feel that climate change events have an indirect, not direct, effect on them. Also, many supervisors and central banks still need to issue policy statements to assess the readiness of their financial institutions for climate change events. At least, banking system regulators should give their views regarding climate change events in the banking sector so that financial institutions can understand the role they have to play in managing climate change risks before they occur.

2. METHODOLOGY

This master thesis is based on and related to information gathered from both primary and secondary data. While the primary source is questionnaire administrations, secondary data are gathered from literature, newspapers and journals concerning climate change and its impact on the banking sector's performance. The method is preferred because it helps to describe, record, analyze and interpret the condition, prevailing practices, beliefs, attitudes and an ongoing process in the survey. This aspect of the master thesis is based on and related to research design, the population of the study, sample size and sampling technique, research instrument, validity and reliability of research instrument, administration of instrument/data gathering procedure and method of data analysis. This chapter concerns the methodology suitable for the above situation, the technique and why the approach is adopted.

2.1. The empirical research study

Ozili (2020) examined how climate change affects the financial system and organizations. A descriptive ex-post-facto research approach (DERA) was adopted, and descriptive and inferential statistics (DIS) was assumed to analyze the data for this study. The results demonstrated how the effects of climate change on financial institutions' counterparties and clients have significant ramifications for their stability. Through its impact on financial institutions, climate change also has substantial adverse effects on the strength of the financial system.

In their 2019 study, Tran, Nguyen, Thuy, and Tran found the variables that contributed to the commercial banks' ability to maintain liquidity between 2010 and 2015. The interbank market aids commercial banks in improving their liquidity, the larger the loan size, the higher the liquidity risk, good credit risk management has a positive impact on managing the liquidity risk, and long-term interest rate is negatively correlated with the liquidity of commercial banks, according to analysis using the OLS regression method. The study also advises banks and decision-makers from the government authorities and the State Bank of Vietnam on managing liquidity risk.

Golubeva, Duljic, & Keminen (2019) looked into how liquidity affected bank profitability after implementing Basel III regulations. The analysis used a data collection of 45 European banks, with 180 observations from 2014 to 2017 and 37 observations from 2018. Tools: The paper suggests a quantitative approach based on weighted least squares regression analysis and ordinary least squares techniques. The study discovered that although alternative liquidity risk metrics significantly and positively impact specific profitability proxies, others are just marginally affected. Further research is necessary since the Liquidity Coverage Ratio, a Basel III liquidity indicator, contributed insignificantly to all return proxies. The findings also showed that profitability proxies fall when bank size and net provision for loan losses grow. Additionally, we discovered conflicting conclusions about the effects of gains and losses on securities and deposits on bank profitability and offered potential explanations.

Zou, Chen, Liu, Huang & Chu (2020) evaluated the mechanisms through which climate change affects systemic risk in Chinese small- and medium-sized commercial banks. In this study, the systemic risk of 11 small- and medium-sized listed banks was assessed using the CoVaR model, and the relationship between daily average temperature and climate change was investigated. Furthermore, it examined the impact of climate change on systemic risk in commercial banks using intermediary variables (such as the loan-to-deposit ratio, non-performing loan ratio, and net interest margin of commercial banks). The findings showed a significant positive indirect effect of climate change on bank systemic risk via the NPL ratio, indicating that climate warming increases the NPL ratio and thereby increases the banks' systemic risk. The findings show a positive correlation between systemic risk in banks and climate change within the confidence interval.

Ebele & Emodi (2016) examined the effects of climate change on the Nigerian economy. The study examined some of the available research, data, information, and policy on climate change in Nigeria and its effects on the major economic sectors. The study used a descriptive ex post facto research approach. According to the findings, numerous economic sectors in Nigeria appear to be directly exposed to the effects of climate change, most notably the banking system. The impact of climate

change that this study highlights underscore the need for additional funding for research and education about the effects of climate change in Nigeria. Awareness of the seriousness of the impact of climate change in Nigeria, this paper offers some policy ideas for mitigating and adapting to the problems.

South-eastern Nigeria's commercial potential has been affected by climate change, according to Akuwudike, Mac-Ozigbo & Igbokwe-Ibeto (2020). This study used a descriptive research strategy and conducted online interviews with 500 respondents. The results showed that the response to climate change impacted the development of new businesses, particularly in the small and medium-sized enterprises (SMEs) subsector. Over 90% of respondents agreed that companies had been created in the renewable energy subsector, such as repair projects, tree-planting initiatives, and embankment projects to prevent river overflow. Determinants of the leading forces behind the development of new economic prospects and mitigation against the effects of climate change. It was suggested that the pursuit of mitigation and adaptation activities should be stepped up to lessen the degree of destruction to life and livelihoods since they can reduce carbon dioxide (CO2) emissions and the frequency of occurrence of climate change events, improving the viability and growth of the economy through the creative powers of the process.

Emmanuel and Ekwere determined credit risk and bank performance in Nigeria in 2022. The study used a panel data research approach and examined ten banks between 2006 and 2018. As a proxy for financial risk, the bank's non-performing loans (NPLs), loan loss provisions (LLP), and loans and advances were regressed against their return on assets (ROA) and return on equity (ROE). The analysis findings were discussed using both FEM and REM. None of the explanatory factors for hypothesis one had a significant association with ROA in both FEM and REM. In the second hypothesis, LLP and LAA demonstrated a meaningful link with ROE in FEM, but NPL and LLP showed a significant association with ROE in REM. In both FEM and REM, NPL and ROE had a favorable association. It was advised that regulators keep a close eye on banks' excesses, which tend to improve the link between NPLs and ROE.

Afolabi, Salahudeen, Kamar & Susan (2021) examined financial risk and bank performance in Nigeria using a panel study approach and panel data from 2009 to 2018 acquired from annual bank reports of the sampled banks; econometric panel methods were employed to calculate the impact of credit risk on Nigerian banks' performance. According to the study, a percentage change in equity or shareholder funds increased profitability (ROA) by roughly 19%. It was also discovered that although a percentage change in non-performing loans boosts profitability by 7%, a percentage change in the loan-to-deposit ratio decreases profitability by 3%. And to protect or improve Nigerian banks from a low CAMEL rating and bank failure, the research advised Nigerian banks to keep an eye on their loans and advances and to avoid having their assets and liabilities out of balance. To prevent crises, banks should also keep an eye on their capital base and maintain the required ratio of capital to risk-weighted assets. Future research should look at management variations, regional variables, bank categorization, and whether bank size significantly affects credit risk and performance.

In this study, bank workers in Nigeria were asked to rate their familiarity with climate change and how seriously they saw it as a financial danger (Oguntuase, 2017). Additionally, the study questions their perspective on how banks and the Nigerian financial industry can handle climate change risk. One hundred bank workers were given survey questionnaires, and the results were gathered. Spearman's rank order correlation was applied to ascertain the link between the questionnaire indices. The study's findings showed a significant association between understanding climate change and consider it a financial concern. It is advised that Nigerian banks structure climate change adaptation methods as a risk management process to manage their financial risks efficiently.

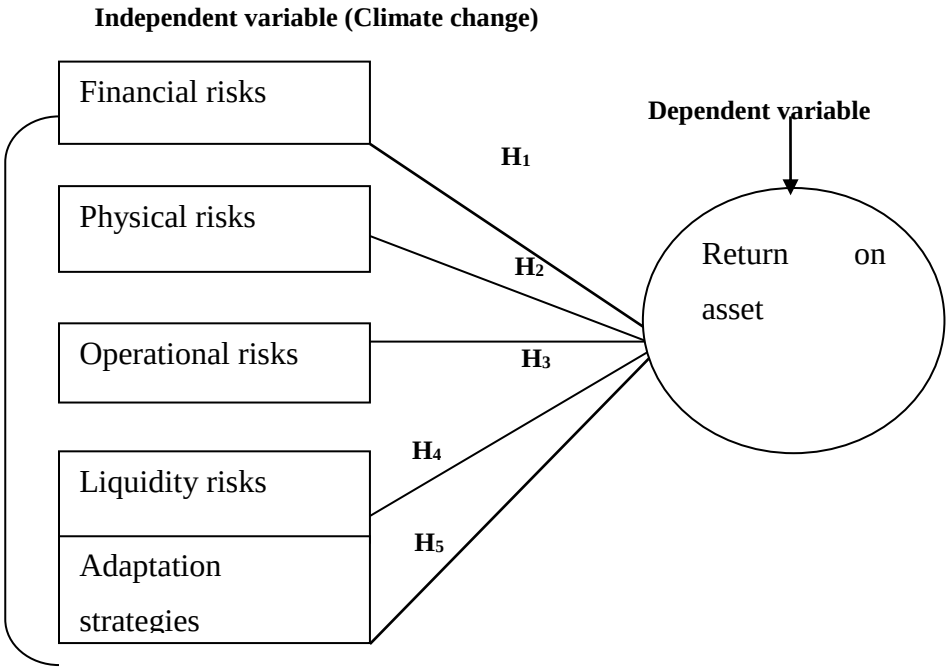
Fadun & Diekolola (2021) analyzed the operational risk drivers in Nigerian commercial banks and the proportions to which each driver contributes. Primary data were gathered from the Operational Risk Management Desks of six (6) sampled commercial banks and analyzed using SPSS and Microsoft Excel to meet the study's goals. The outcome demonstrated that internal processes, IT systems, and risk officers' calibre influence banks' operational losses. However, it was noted that

internal procedure had the most influence. According to the study, operational risk in Nigerian commercial banks is mainly caused by internal processes. To minimize operational risk occurrences and related costs, the researcher advised bank management to establish specified procedures for critical tasks and emphasize frequent assessment of their essential processes.

In summary/conclusion, this master thesis empirical review denotes that climate change significantly affects the financial system's stability. And the significant positive indirect effect of climate change on bank systemic risk through the NPL ratio, indicating that climate warming increases the NPL ratio and thereby increases the banks' systemic risk, that regulators keep a close eye on banks' excesses, which tend to improve the link between NPLs and ROE. Nigerian banks should structure climate change adaptation methods as a risk management process to manage their financial risks efficiently. Operational risk incidents continue to rise despite the institutionalization of active risk management in banks and the stringent oversight of bank regulators. Banks are starting to realize that recurrence lowers the chance; it is essential to pinpoint the causes of this risk and address them head-on.

2.2. Aim, model and hypotheses of the research

Figure 2:
Relationship between independent and dependent variables



Source: Self-structure model**, 2022**

The following hypotheses are stated:

H_{01}: Financial risks due to climate change has no significant impact on return on asset

H_{02}: Physical risks due to climate change has no significant impact on return on asset

H_{03}: Liquidity risks due to climate change have no significant impact on return on asset

H_{04}: Operational risks due to climate change have no significant impact on return on asset

H_{05}: The methodology created for managing climate risk has no significant impact on the banking sector

Selection of respondents and sample characteristics

The study will adopt a descriptive survey research design. A research design specifies procedures for collecting and analyzing the necessary data to help solve a given research problem. Research design is a detailed outline of how an investigation or research would take place using a systematic research design approach. In gathering data for this study, the researcher used the descriptive design method (Obasi, 2009). A researcher who employs this method goes into the field and selects the samples from the entire population. It involves administering questionnaires personally to gather data and collecting them back from the various respondents to analyze the data for a better result. This design will enable the researcher to describe the variables that exist in the study critically. The survey research method aims to collect a significant and small sample from the population to examine educational and sociological phenomena' distribution, incidence, and interaction. The nature of the study necessitates using a descriptive research design as it is concerned with determining the respondents' attitudes towards climate change's impact on the banking sector. The target population comprises selected bank employees in the commercial city of Lagos, Nigeria. Obasi (2009) defines *sampling* as the process of selecting a part (called a sample) from the whole (called a population or universe) to make inferences about the whole. A sample, then, is that tiny part selected from the whole population. It is a subset of the population.

We will obtain a sample of 500 bank employees from the population through purposive sampling. The technique that will be used to attain a representative sample is purposive sampling, intending to identify and select participants that are exceptionally knowledgeable about or experienced in the subject matter. In addition to knowledge and experience, Bernard in Bougie and Sekaran (2010) opines that the most significant is the readiness and preparedness to participate and the capability to converse experiences and opinions in a transparent, communicative, and thoughtful manner.

Since the population under study is finite, a finite population characteristic formula for sample size determination is preferred. Furthermore, this research's sample size

will be calculated using the Taro Yamane formula with a 95% confidence level. The calculation formula is as follows:

Formula 1:

$$n = \frac{N}{1 + N\,(e)^2}$$

Where;

N= Population

n = Sample size

e =Error Term (5%)

$$n = \frac{500}{1 + 500\,(0.05)^2}$$

n = 399

After calculated the sample size by substituting the numbers using the Yamane formula, the numbers of sample is 399 respondents.

2.3. Organization and instrument of the research

This study's instrument used to gather information is a self-designed questionnaire (using Google Forms). The questionnaire consists of two sections. Section A elicits demographic characteristics such as gender, age, educational background, employment status, Etc. In contrast, Section B contained structured items relating to the research questions that necessitated this research by seeking opinions on managing climate change risk in banks and the Nigerian banking sector. The second section will range from a 5-1 point scale in the following pattern. Strongly agree (5), Agree (4), Neutral (3), Disagree (2), Strongly Disagree (1).

In addition to peer review by researchers, critique by educational management experts will be consulted to ensure the validity of this study. The instrument's

reliability through a test-retest technique to analyze the data collected will be employed.

The quantitative method of data is a piece of information that can be counted and is usually gathered by surveys from large numbers of respondents randomly selected for inclusion. Quantitative approaches are best used to answer what, when, and who questions and are not well suited to how and why questions. Data collected through the survey will be quantitatively analyzed using descriptive and inferential statistics (one-way analysis of variance (ANOVA) with the aid of Package for Social Sciences (SPSS) version 26.

This thesis will also employ data from the secondary source, which will be obtained from the Central bank of Nigeria's annual stability reports and financial statements of accounts. The time series data cover the period from 2010 to 2020. In an attempt to determine climate change's impact on banking sector performance in Nigeria, the following will be used; return on asset (ROA) as a proxy to banking sector performance (dependent variable), while Financial risks (FINRKS), Operational risks (OPRKS) and Liquidity risks (LIQRKS) as a proxy to Climate change risks (Independent variables) in the equation. The thesis seeks to determine a cause-and-effect relationship between climate risks (independent variables) and banking sector performance (dependent variable). Both descriptive and inferential statistics (regression analysis) will be employed in this thesis, allowing for the collection of quantitative data and analyzing of it quantitatively using inferential statistics. Unit root tests will be used to predict the current values of both variables. The statistical package to be employed in this study is the E-views 10.

The data will be analyzed using multiple regression techniques to determine the relationship between dependent and independent variables. A liner regression model which expresses the banking sector performance as a function of climate change is stated in functional form as follows:

Formula 2:

$Y_{it} = \alpha_i + x_{it}\beta + \varepsilon_{it}$

$ROA = \alpha_i + x_{it}\beta_1 FINRKS + x_{it}\beta_2 OPRKS + \beta_3 LIQRKS + \varepsilon_{it}$

Where:

$ROA = \beta_0 + \beta_1 FINRKS + \varepsilon_i$ ……eqn i

$ROA = \beta_0 + \beta_1 OPRKS + \varepsilon_i$ ……eqn ii

$ROA = \beta_0 + \beta_1 LIQRKS + \varepsilon_i$ ……eqn iii

$ROA = \alpha_i + x_{it}\beta_1 FINRKS + x_{it}\beta_2 OPRKS + \beta_3 LIQRKS + \varepsilon_{it}$……..eqn iv

ROA: Return on asset

FINRKS: Financial risks

OPRKS: Operational risks

LIQRKS: Liquidity risks

Where:

The priori expectation is **β_1-β_3, >0**

ROA= Dependent variable (Return on assets proxy by net profit after tax divided by the total assets)

FINRKS = Independent variable (Financial risks are credit risk, market risks, etc. for instant, failing to pay creditor such as bank or a lender, market volatility, hikes in interest rate, fluctuation of foreign currency value which affect debt repayments)

OPRKS: = Independent variable (Operational risks are some of the risks faced by Nigerian financial institutions include ATM frauds, armed robberies, identity theft, fraud and break-down of information technology (IT) systems, employee errors, and so on due to climate change)

LIQRKS = Independent variable (Liquidity risks; Nigerian banks experienced severe liquidity challenges which are caused mainly by the following factors: Huge non-performing loans, particularly margin loans and Oil & Gas relates exposures.)

β_0 = intercept parameter

β = slope of the regression line (it is the rate of change in ROA with respect to FINRKS, OPRKS & LIQRKS**)**

ε_{it} = Error Term (Stochastic Variable)

The research work is divided into four sections. The first section is the introductory part which briefly describes the following structures: the relevance of the topic; novelty of the master thesis, problem; purpose of the master thesis, problem solving methods and theoretical and empirical methods applied and plan of study,

The second section is the methodology which concentrates on the key variables, established hypotheses, sampling, research strategy, the method of data collection and extraction, the construction of the model.

The third section is the analysis of the empirical results. It elaborates the results which will be received during the research work.

The last section is the conclusion and further innovation in the same fields, where future researchers can work upon in the same field.

In summary/conclusion, this master thesis will quantitatively analyze the impact of climate change on banking sector using both primary and secondary sources of data. Hence, it is expected that climate risks factors such as financial risks, physical risks, operational risks and liquidity risks will have significant/insignificant negative or positive impact on banking sector performance in Nigeria.

3. THE EMPIRICAL RESULTS

This section encompasses the most important empirical research results and the most significant information. Secondary data, qualitative research, surveys and observations are analyzed, hypotheses are tested, various calculations are made, and statistical criteria are used to evaluate the relationships between variables. This presents the analysis of both primary (questionnaire) and secondary data gathered from published financial stability data from Central Bank of Nigeria within the period of 2010 to 2020.

Out of 399 copies of questionnaires administered to the chosen bank employees in Lagos, Nigeria, three hundred and five (305) were retrieved and appropriately filled via (Google Forms). The statistical tools used for the analysis was descriptive statistic such as simple frequency table, mean, bar chart and pie chart. Analysis of variance (ANOVA) is used for the research hypotheses with the aid of Statistical Package for Social Sciences (SPSS), version 26. This represents a response rate of 76.4%, and 23.6% represents the questionnaire that has yet to be returned. Below are the details:

Table 2

Analysis of questionnaire distributed

				Percentage
Numbers of respondents	399			
Numbers of questionnaires distributed		399		
Numbers retrieved			305	76.4%
Numbers unreturned			87	23.6%
Total			399	100%

Source: Field Survey Report, 2022

3.1 Data analysis

This section covers the empirical research results of the data analysis on the valuation of climate change's impact on the banking sector among selected bank employees in Lagos, Nigeria. The outcome of statistical analysis of the various statements generated from the research objectives are analyses based on the respondents' responses.

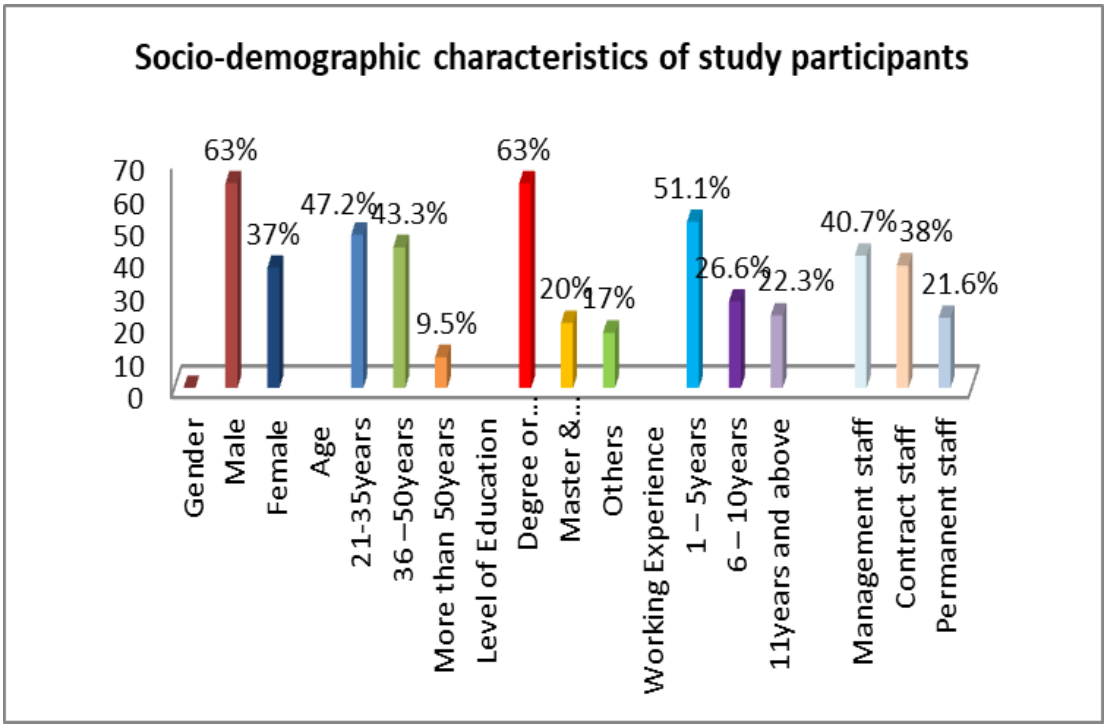
Table 3

Socio-demographic characteristics of study participants

Variables (n=305)	Category	Freq.	Percentage
Gender	Male	192	63.0
	Female	113	37.0
Age group	21-35years	144	47.2
	36-50years	132	43.3
	>50years	29	9.5
Level of Education	Bachelor's degree	192	65.2
	Master	60	20.0
	Others Certificate	53	17.0
How long have you been with the firm?	1 – 5years	156	51.1
	6 – 10 years	81	26.6
	11years &Above	68	22.3
Level of management	Management staff	124	40.7
	Senior staff	115	37.7
	Junior staff	66	21.6

Source: Researcher's field survey, 2022

Figure 3:



The table above presents a summary of the characteristics of the study participants (n = 305). The result showed a higher percentage of males (63.0%) than females (37.0%). The respondents are between the age range of 21 years and above, and many participants (47.0%) were in the age range of 21-35 years. More than half of the respondents (63.0%) reported having Bachelor's degree or equivalent. Concerning working experience in the risk management function, (51.1%) of the respondents have 1–5 years of working experience, indicating that most of the bank employees have good working experience and (40.7%) of the respondents were management staff.

Analysis of responses according to research objectives

This section shows the study of the various statements generated from the research objectives based on the respondents' answers.

Table 4

Reveal the impact of financial risks due to climate change on banking sector performance

	STATEMENTS	SA	A	N	D	SD	Mean
	Financial risks posed by climate change affect banking sector performance	103 (33.8)	112 (36.7)	28 (9.2)	33 (10.8)	29 (9.5)	3.7
	Financial risks resulting from climate change reduced level of financial intermediation which can make the banking system financially unstable	101 (33.1)	94 (30.8)	23 (7.5)	43 (14.1)	44 (14.4)	3.5
	Financial risks resulting from climate change causes direct damage to asset quality in the banking system.	102 (33.4)	110 (36.1)	35 (11.5)	30 (9.8)	28 (9.2)	3.8
	Increase in the NPL ratio, increase the risk exposure of banks, hence adversely impacting the banking system resulting from the financial risk due to climate change	112 (36.7)	120 (39.3)	28 (9.2)	32 (10.5)	13 (4.3)	3.94
	Climate change events such as hurricanes, landslide and floods damage the business of banks' clients and customers which lower bank profit margin	91 (29.8)	105 (34.4)	43 (14.1)	56 (18.4)		3.8

Source: Field Survey, 2022

Interpretation:

From the table above, the majority of the respondents representing 103(33.8%), strongly agree with the statement that "Financial risks posed by climate change affect the banking sector performance". 112(36.7%) picked agreed; 33(10.8%) picked disagreed; 29(9.5%), strongly disagreed; and only 28(9.2%) picked neutral. The implication is that financial risks posed by climate change affect banking sector performance.

The table shows respondents representing 101(33.1%) strongly agreed that "Financial risks resulting from climate change reduced level of financial intermediation which can make the banking system financially unstable". 94(30.8%) agreed; 44(14.4%) strongly disagreed; 43(14.1%) disagreed; and only 23(7.5%) neutral. This implies that financial risks resulting from climate change reduce financial intermediation, which can make the banking system financially unstable.

The table above also shows that 110 respondents representing 36.1%, agreed with the statement," Financial risk resulting from climate change causes direct damage to asset quality in the banking system". 102(33.4%) picked strongly agreed; 35(11.5%) picked neutral; 30(9.8%) picked disagreed; and only 28(9.2%) picked strongly disagreed. This shows that financial risks resulting from climate change cause direct damage to asset quality in the banking system.

From the table above, 120 respondents representing 39.3%, agreed with the statement, "Increase in the NPL ratio, increase the risk exposure of banks, hence adversely impacting the banking system resulting from the financial risk due to climate change". 112(36.7%) picked strongly agreed; 32(10.5%) disagreed; 28(9.2%) neutral; and only 13(4.3%) strongly disagreed. It can be inferred that increase in the NPL ratio increase the risk exposure of banks, hence adversely impacting the banking system resulting from the financial risk due to climate change.

The table shows that 105 respondents representing 34.4%, agreed, and 91(29.9%) strongly agreed with the statement, "Climate change events such as hurricanes, landslides and floods damage the business of banks' clients and customers and lower bank profit margin". 56(18.4%) disagreed; 43(14.1%) neutral; and only 30(9.8%)

strongly disagreed. This shows that climate change events such as hurricanes, landslides and floods damage the business of banks' clients and customers and lower bank profit margins.

Table 5
Evaluate the impact of physical risks due to climate change on banking sector performance

	STATEMENTS	SA	A	N	D	SD	Mean
	Physical damage, materials, physical capital, such as factories and houses due to climate change leads to deterioration in firms' creditworthiness, which in turn affects banks' balance sheets.	113 (37.0)	102 (34.0)	18 (6.0)	40 (13.1)	32 (10.5)	3.73
	Physical risks due to climate change lead to weather-related disasters such as heatwaves, landslides, floods, wildfires and storms hence negatively impact on banking sector performance	102 (33.4)	101 (33.1)	15 (5.0)	42 (13.8)	45 (14.8)	3.57
	Physical destruction lead to reduction in the value of collateral, which in turn limits the ability of firms and individuals to borrow	132 (43.3)	110 (36.1)	15 (4.9)	30 (9.8)	18 (5.9)	00
	The potential occurrence of a natural or human-induced physical event may cause loss of life, injury, as well as damage and loss of property and infrastructure, affect value of financial assets or increase liabilities.	101 (33.1)	75 (25.0)	53 (17.4)	66 (21.6)	10 (3.3)	
	Losses caused by climate-related natural disasters weaken the soundness of banking institutions and the stability of the financial system	135 (44.3)	140 (46.0)	10 (3.3)	6 (2.0)	14 (4.6)	

Source: Field Survey, 2022

Interpretation:

From the table above shows that 113 respondents representing (37.0%) picked strongly agreed on the statement, “Physical damage, materials, physical capital, such as factories and houses due to climate change leads to deterioration in firms' creditworthiness, which in turn affects banks' balance sheets”. 102(34.0%) agreed; 40(13.1%) picked disagreed; 32(10.5%) picked strongly disagreed; and only 18(6.0%) respondents neutral. This implies that physical damage, materials, physical capital, such as factories and houses due to climate change leads to deterioration in firms' creditworthiness, which in turn affects banks' balance sheets.

The table shows that majority of the respondents representing 102(33.4%) strongly agreed that “Physical risks due to climate change lead to weather-related disasters such as heatwaves, landslides, floods, wildfires and storms hence negatively impact on banking sector performance”. 101(33.1%) agreed; 45(14.8%) strongly disagreed; 42(13.8%) disagreed; and only 15(5.0%) neutral. It can be implies that physical risks due to climate change lead to weather-related disasters such as heatwaves, landslides, floods, wildfires and storms hence negatively impact on banking sector performance.

From the table above, 132 respondents representing (43.3%) strongly agreed on the statement, “Physical destruction lead to reduction in the value of collateral, which in turn limits the ability of firms and individuals to borrow”. 110(36.1%) agreed; 30(9.8%) disagreed; 18(5.9%) strongly disagreed; and only 15(4.9%) neutral. The implication is that physical destruction lead to reduction in the value of collateral, which in turn limits the ability of firms and individuals to borrow.

From the table above, 101 respondents representing (33.1%) strongly agreed on the statement, “the potential occurrence of a natural or human-induced physical event may cause loss of life, injury, as well as damage and loss of property and infrastructure, affect value of financial assets or increase liabilities”. 75(25.0%) agreed; 66(21.6%) disagreed; 53(17.4%) neutral; and only 10(3.3%) strongly disagreed. This implies that the potential occurrence of a natural or human-induced physical event may cause loss of life, injury, as well as damage and loss of property and infrastructure, affect value of financial assets or increase liabilities.

From the table above, 140 respondents representing 46.0% respondents strongly agreed on the statement, “Losses caused by climate-related natural disasters weaken the soundness of banking institutions and the stability of the financial system”. 135(44.3 %) agreed; 14(4.6%) strongly disagreed; 10(3.3%) neutral; and only 6(2.0%) disagreed. This implies that losses caused by climate-related natural disasters weaken the soundness of banking institutions and the stability of the financial system.

Summary/conclusion

Based on the result of finding, the researcher deduced that physical risks negatively impact on banking sector performance due to climate risks such as materials, physical capital, such as factories and houses leading to deterioration in firms' creditworthiness, weather-related disasters such as heatwaves, landslides, floods, wildfires and storms, physical destruction leading to reduction in the value of collateral, occurrence of a natural or human-induced physical event causing loss of life, injury, as well as damage and loss of property and infrastructure, which in turn affects value of financial assets or increase bank liabilities.

Table 6

Determine the impact of liquidity risks due to climate change on banking sector performance

	STATEMENTS	SA	A	N	D	SD
	Climate change directly affect bank's liquidity risk through its ability to raise funds or securitize its assets	97 (31.8)	108 (35.4)	30 (9.8)	35 (11.5)	35 (11.5)
	Climate change indirectly affect customer liquidity needs.	102 (33.4)	85 (27.9)	41 (13.4)	51 (16.7)	26 (8.5)
	Natural disasters affect bank's ability to finance its asset growth and enable it to meet its due obligations without incurring unacceptable losses.	131 (43.0)	66 (21.6)	24 (7.9)	29 (9.5)	55 (18.0)
	Damage to collateral value caused by climate change reflected as a loss to bank's profit and loss statement which negatively affect bank profitability	64 (21.0)	88 (28.9)	53 (17.4)	39 (12.8)	61 (20.0)
	Financial institutions lack the ability to mitigate climate change risk to withdraw liquidity from money markets.	93 (30.5)	99 (32.5)	31 (10.2)	51 (16.7)	31 (10.2)

Source: Field Survey, 2022

Interpretation:

The above table shows that majority of the respondents representing 108(35.4%) agreed on the statement, "Climate change directly affect bank's liquidity risk through its ability to raise funds or securitize its assets". 97(31.8%) picked strongly agreed; 35(11.5%) disagreed; the same number of respondents picked strongly disagreed; and only 30(9.8%) picked neutral. This affirms that climate change directly affect bank's liquidity risk through its ability to raise funds or securitize its assets.

The table above also shows that 102 respondents representing (33.4%) are strongly agreed on the statement, "Climate change indirectly affect customer liquidity needs". 85(27.9%) agreed, 51(16.7%) disagreed; 41(13.4%) neutral; and only 26(8.5%)

strongly disagreed. This attests that climate change indirectly affect customer liquidity needs.

From the table above, 131 respondents representing (43.0%) strongly agreed on the statement, “Natural disasters affect bank's ability to finance its asset growth and enable it to meet its due obligations without incurring unacceptable losses”. 66(21.6%) picked agreed; 55(18.0%) picked strongly disagreed; 29(9.5%) picked disagreed and only 24(7.9%) picked neutral. This indicates that natural disasters affect bank's ability to finance its asset growth and enable it to meet its due obligations without incurring unacceptable losses.

From the table above, 88 respondents representing (28.9%) agreed on the statement, “Damage to collateral value caused by climate change reflected as a loss to bank’s profit and loss statement which negatively affect bank profitability”. 64(21.0%) strongly agreed; 61(20.0%) strongly disagreed; 53(17.4%) neutral; and only 39(12.8%) disagreed. This implies that damage to collateral value caused by climate change reflected as a loss to bank’s profit and loss statement which negatively affect bank profitability.

From the table above, 99 respondents representing (32.5%) agreed on the statement, “Financial institutions lack the ability to mitigate climate change risk to withdraw liquidity from money markets”. 93(30.5%) picked strongly agreed; 51(16.7%) picked disagreed; 31(10.2%) picked neutral; and the same number of respondents picked strongly disagreed. This shows that financial institutions lack the ability to mitigate climate change risk to withdraw liquidity from money markets.

Summary/conclusion

The researcher deduced that liquidity risks has adverse impact on banking sector performance as a result of natural disasters which affect bank's ability to finance its asset growth and enable it to meet its due obligations without incurring unacceptable losses and damage to collateral value.

Table 7
Determine the impact of operational risks due to climate change on banking sector performance

	STATEMENTS		A		D	D	Mean
	Damages to financial infrastructure, branc hes,and office buildings due to climate change affect bank operational performance		109 (35.7)		36 (11.8)	34 (11.1)	.64
	Inadequate data security exposes the bank to operational losses		115 (38.0)	26	24	10	4.09
	Damage to infrastructure used by banks due to severe weather or hurricanes disrupt the business of financial institutions for a considerable period of time before recovery	142 (46.6)	104 (34.1)	15 (4.9)	21 (6.9)	23 (7.5)	4.05
	Severe climate change disrupt the ability of banks to communicate internally within the firm, thereby disrupting their operations	104 (34.1)	108 (35.4)	26 (8.5)	40 (13.1)	27 (8.9)	3.73
	Inadequate data backup exposes the bank to huge potential operational losses	99 (32.5)	118 (38.7)	25 (8.2)	35 (11.5)	28 (9.2)	3.74

Source: Field Survey, 2022

Interpretation:

The table shows that majority of the respondents representing 109(35.7%) are agreed on the statement, "Damages to financial infrastructure, branches,and office buildings due to climate change affect bank operational performance". 95(31.1%) strongly agreed; 36(11.8%) disagreed; 34(11.1%) strongly disagreed; and only 31(10.2%) picked neutral. This implies that damages to financial infrastructure, branches and office buildings due to climate change affect bank operational performance.

From the table above shows that 130 respondents representing (42.6%) strongly agreed on the statement, "Inadequate data security exposes the bank to operational losses". 115(38.0%) agreed; 26(8.5%) neutral; 24(7.9%) disagreed; and only 10(3.3%) strongly disagreed. This implies that inadequate data security exposes the bank to operational losses.

The table above also shows that 142 respondents representing (46.6%) are strongly agreed on the statement, "Damage to infrastructure used by banks due to severe weather or hurricanes disrupt the business of financial institutions for a considerable period of time before recovery". 104(34.1%) picked agreed; 23(7.5%) strongly disagreed; 21(6.9%) disagreed; and only 15(4.9%) neutral. An indication that damage to infrastructure used by banks due to severe weather or hurricanes disrupts the business of financial institutions for a considerable period of time before recovery

From the table above, 108 respondents representing (35.4% %) agreed on the statement, "Severe climate change disrupt the ability of banks to communicate internally within the firm, thereby disrupting their operations". 104(34.1%) picked strongly agreed; 40(13.1%) picked disagreed; 27(8.9%) picked strongly disagreed; and only 26(8.5%) neutral. The implication is that severe climate change disrupts the ability of banks to communicate internally within the firm, thereby disrupting their operations.

From the table above, 118 respondents representing (38.7%) respondents agreed on the statement, "Inadequate data backup exposes the bank to huge potential operational losses". (32.5%) strongly agreed; 35(11.5%) disagreed; 28(9.2%) strongly disagreed; and only 25(8.2%) neutral. This shows that inadequate data backup exposes the bank to huge potential operational losses.

Summary/conclusion

Based on the finding, the researcher deduced that operational risks has negative impact on banking sector performance as a result of climate risks like damages to financial infrastructure, branches and office buildings, inadequate data security which exposes the bank to operational losses, damage to infrastructure used by banks due to severe weather or hurricanes disrupt, and so on.

Table 8

Create a methodology for managing the impact of climate risk in banking sector

	STATEMENTS	SA	A	N	D	SD
	To lower their risk exposure, banks should loan to people that have and are trusted with good credit histories, transact with high-quality counterparties or own collateral.	99 (32.5)	98 (32.1)	28 (9.2)	33 (10.8)	(15.4)
	Apex banks should mandate banks to factor climate-related risks into lending and investment processes.	125 (41.0)	116 (38.0)	24 (7.9)	16 (5.2)	24 (7.9)
	Banks with effective data centres/disaster recovery centres can effectively manage operational losses.	99 (32.5)	132 (43.3)	13 (4.3)	43 (14.1)	18 (5.9)
	Banks should appoint staff or teams responsible for managing the financial risk of climate change to their assets.	112 (36.7)	123 (40.3)	15 (4.9)	38 (12.5)	17 (5.6)
	Banks must meet investors increasing demand for information on the bank's exposure to climate change-related risks.	119 (39.0)	126 (41.3)	21 (6.9)	23 (7.5)	16 (5.2)

Source: Field Survey, 2022

Interpretation:

From the table above, the majority of the respondents representing 99(32.5%), strongly agree that "to lower their risk exposure, banks should loan to people that have and are trusted with good credit histories, transact with high-quality counterparties or own collateral. 98(32.1%) picked agreed; 47(15.4%) picked strongly disagreed; 33(10.8%), disagreed; and only 28(9.2%) picked neutral. The implication is that to lower their risk exposure, banks should loan money to people with good credit histories, transact with high-quality counterparties, or own collateral.

The table shows respondents representing 125(41.0%) strongly agreed that "Apex banks should mandate banks to factor climate-related risks into lending and investment processes". 116(38.0%) agreed; 24(7.9%) neutral and strongly disagreed respectively; and only 16(5.2%) disagreed. This implies that Apex banks should mandate banks to factor climate-related risks into lending and investment processes.

The table above also shows that 132 respondents representing 43.3%, agreed with the statement," Banks with effective data centre/disaster recovery centres can effectively manage operational losses". 99(32.5%) picked strongly agreed; 43(14.1%) picked disagreed; 38(5.9%) picked strongly disagreed; and only 13(4.3%) picked neutral. Banks with effective data centres/disaster recovery centres can effectively manage operational losses.

From the table above, 123 respondents representing 40.3%, agreed with the statement, "Banks should appoint staff or team with responsibility to manage the financial risk of climate change to its assets". 112(36.7%) picked strongly agreed; 38(12.5%) disagreed; 17(9.2%) strongly disagreed; and only 15(4.9%) neutral. This shows that banks should appoint staff or teams responsible for managing the financial risk of climate change to their assets.

The table shows that 126 respondents representing 41.3%, agreed, and 119(39.0%) strongly agreed with the statement, "Banks must meet investors increasing demand for information on the bank's exposure to climate change-related risks". 23(7.5%) disagreed; 21(6.9%) neutral; and only 16(5.2%) strongly disagreed. This shows that

banks must meet investors increasing demand for information on the bank's exposure to climate change-related risk.

3.2. Test of hypotheses

This section covers the empirical research results of the hypotheses stated on the valuation of climate change's impact on the banking sector among selected bank employees in Lagos, Nigeria.

Hypothesis 1
H01: Financial risks due to climate change has no significant impact on banking sector performance

ANOVA

Table 9
Financial risks resulting from climate change reduced the level of financial intermediation, which can make the banking system financially unstable

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	323.499	4	80.875	996.382	.000
Within Groups	24.351	300	.081		
Total	347.849	304			

Source: Author's computation, 2022

Decision rule:

The analyses of variance statistics were implemented to the hypothesis, and all decisions depend on the P-values obtained. For the theory, the general decision rule is to reject the null hypothesis where the P-value is less than 0.05 and accept the null hypothesis (H0) where the P-value is more significant than 0.05 and vice-versa.

From the computations and in compliance with the general decision rule, the significance is 0.000, less than 0.05, and the null hypothesis (H0) is rejected. Thus, it can be finalized that financial risks due to climate change significantly impact the banking sector's performance.

Hypothesis 2

H02: Physical risks due to climate change has no significant impact on banking sector performance

ANOVA

Table 10

Physical damage, materials, and physical capital, such as factories and houses due to climate change, lead to deterioration in firms' creditworthiness, affecting banks' balance sheets.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	220.958	4	55.239	647.344	.000
Within Groups	25.600	300	.085		
Total	246.557	304			

Source: Author's computation, 2022

From the computations and in compliance with the general decision rule, the significance is 0.000, less than 0.05, and the null hypothesis (H0) is rejected. Thus, physical risks due to climate change significantly impact the banking sector's performance.

Remark: it can be said that physical risks due to climate change lead to weather-related disasters such as heatwaves, landslides, floods, wildfires and storms, rising sea levels and temperatures, depreciation of assets and collateral, increased insurance losses, or disruption of banking operations hence negatively impact on banking sector performance.

Hypothesis 3

H03: Liquidity risks due to climate change have no significant impact on banking sector performance

ANOVA

Table 11

Climate change directly affects a bank's liquidity risk through its ability to raise funds or securitize its assets.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	304.532	4	76.133	1282.004	.000
Within Groups	17.816	300	.059		
Total	322.348	304			

Source: Author's computation, 2022

From the computations and in compliance with the general decision rule, the significance is 0.000, less than 0.05, and the null hypothesis (H0) is rejected. Thus, liquidity risks due to climate change have a significant impact on banking sector performance.

Remark: it can be said that climate change directly affects customer liquidity needs bank's liquidity risk through its ability to raise funds or securitize its assets; natural disasters affect a bank's ability to finance its asset growth and enable it to meet its due obligations without incurring unacceptable losses and damage to collateral value caused by climate change reflected as a loss to bank's profit and loss statement which negatively affects bank profitability.

Hypothesis 4

H04: Operational risks due to climate change have no significant impact on banking sector performance

ANOVA

Table 12

Inadequate data backup exposes the bank to huge potential operational losses.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	300.745	4	75.186	1078.853	.000
Within Groups	20.907	300	.070		
Total	321.652	304			

Source: Author's computation, 2022

From the computations and in compliance with the general decision rule, the significance is 0.000, less than 0.05, and the null hypothesis (H0) is rejected. Thus, operational risks due to climate change significantly impact banking sector performance.

Remark: it can be said that damages to financial infrastructure, branches and office buildings, and inadequate data security exposes the bank to operational losses and disruption of the ability of banks to communicate internally within the firm, thereby disrupting their operations due to climate change affecting bank operational performance.

Hypothesis 5

H_{05}: Methodology created for managing climate risk has no significant impact on banking sector

ANOVA

Table 13

Apex banks should mandate banks to factor climate-related risks into lending and investment processes.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	406.470	4	101.617	722.082	.000
Within Groups	42.219	300	.141		
Total	448.689	304			

Source: Author's computation, 2022

From the computations and in compliance with the general decision rule, the significance is 0.000, less than 0.05, and the null hypothesis (H0) is rejected. Thus, the methodology for managing climate risk significantly impacts the banking sector.

Remark: it can be said that to lower risk exposure, banks should loan to people that have and are trusted with good credit histories, transact with high-quality counterparties or own collateral, and Apex banks should mandate banks to factor climate-related risks into lending and investment processes and also appoint staff or team with responsibility to manage the financial risk of climate change to its assets.

Table 14

Descriptive statistics

	FINRKS	OPRKS	LIQRKS	ROA
Mean	4326.648	44.97773	51.18364	2.207273
Median	2084.920	12.04000	48.63000	2.310000
Maximum	15908.08	210.9000	76.00000	3.900000
Minimum	324.1300	5.123000	30.00000	0.200000
Std. Dev.	4865.131	71.35081	12.94151	1.069898
Skewness	1.292312	1.685828	0.744397	-0.200536
Kurtosis	3.773312	4.071458	3.184088	2.461279
Jarque-Bera	3.335884	5.736537	1.031430	0.206744
Probability	0.188635	0.056797	0.597073	0.901791

Source: Data Analysis, 2022

Table 14 shows the descriptive analysis results on the climate change impact on banking sector performance for 2008-2017. The results revealed that, on average, the financial risks (FINRKS), operational risks (OPRKS), liquidity risks (LIQRKS), and return on asset (ROA) were 4326.648, 44.97773, 51.18364 and 2.207273 respectively. The standard deviation values of 4865.131, 71.35081, 12.94151 and 1.069898, respectively, revealed the value at which the financial risks (FINRKS), operational risks (OPRKS), liquidity risks (LIQRKS) and return on asset (ROA) for the banking sector performance in Nigeria did not deviate from their respective expected value.

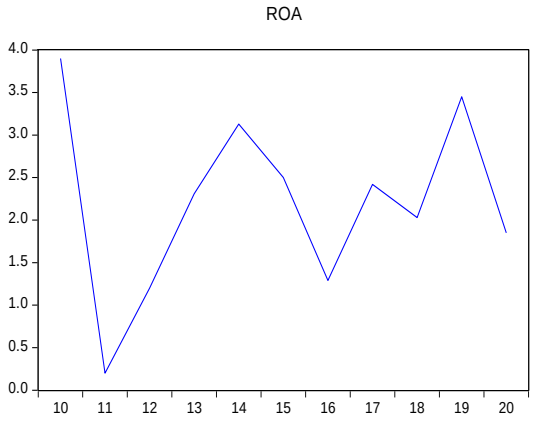
Also, it was discovered that the banking sector performance measured by financial risks (FINRKS), operational risks (OPRKS), liquidity risks (LIQRKS), and return on asset (ROA) in Nigeria deposit money banks were positively and negatively skewed with skewness given as 1.292312, 1.685828, 0.744397 and -0.200536 respectively. Thus, the variables were distributed with a long tail to the right, which was more evident in climate risks. However, the kurtosis of the performance variables showed that financial risks (FINRKS), operational risks (OPRKS), liquidity risks (LIQRKS), and return on asset (ROA) for the banking sector performance of quoted banks in Nigeria were with kurtosis coefficient indexes of 3.773312, 4.071458, 3.184088 and 2.461279 respectively. The Jarque-Bera and probability values revealed that the financial risks (FINRKS), operational risks (OPRKS), liquidity risks (LIQRKS), and

return on asset (ROA) were statistically significant in observing the impact of climate change impact on banking sector performance in Nigeria.

Unit root test result

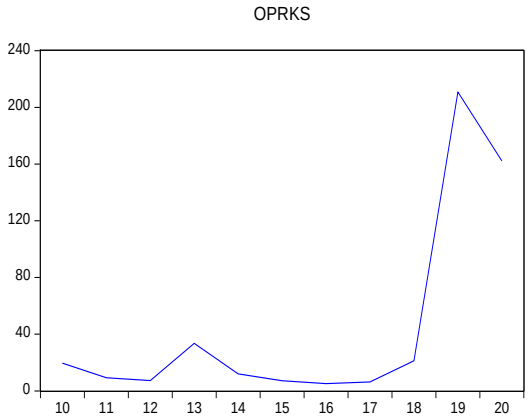
Unit root was conducted using the Augmented Dickey-Fuller test, which was used to test for the stationarity of the data at 1%, 5% and 10 % critical values. The Ho is the presence of the unit root, and H_1 is the absence of the unit root. But first, the stationary test can be presented in a graphical view;

Figure 4



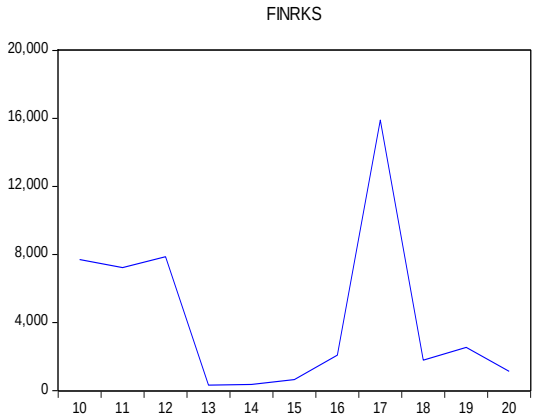
Source: Data Analysis, 2022

Figure 5



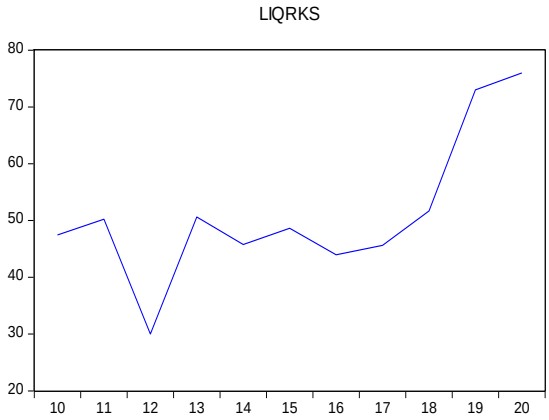
Source: Data Analysis, 2022

Figure 6



Source: Data Analysis, 2022

Figure 7



Source: Data Analysis, 2022

Graphical representation of unit root test

The graphical presentation of the series above shows that only two ROA (return on asset) FINRKS (financial risks) are stationary at level. The result is tested with the ADF unit root test and presented in the table below.

Results of the unit root tests are presented in the Table 15

Variable	At level			2nd difference		
	ADF test Statistic	Sig. level	t-Statistics	ADF test Statistic	Sig. level	t-Statistics
ROA	0.0142	1%	-4.297073	0.0168	1%	4.582648
		5%	-3.212696		5%	3.320969
		10%	-2.747676		10%	2.801384
FINRKS	0.0887	1%	-4.297073	0.0824	1%	4.803492
		5%	-3.212696		5%	3.403313
		10%	-2.747676		10%	2.841819
OPRKS	0.7265	1%	-4.297073	0.0048	1%	4.582648
		5%	-3.212696		5%	-3.320969
		10%	2.747676		10%	2.8
LIQRKS	0.7606	1%	-4.297073	0.0004	1%	4.5
		5%	-3.212696		5%	3.3
		10%	-2.747676		10%	2.8

Source: Authors' computations, using EViews10

The lag length was chosen using Schwarz Information Criterion, indicating an optimal lag length of 8. For each series, the series' levels are preferred first. The Augmented Dickey-Fuller (ADF test result of the null hypothesis based on the unit root cannot be rejected in all the series except at 1%, 5% and 10%, thereby indicating that all series are non-stationary on levels except for ROA and FINRKS. They are, however, stationary at a second difference. Since all the remaining series are found to be fixed at the first difference, it is concluded that each series are intergraded of order one, I.(1) and ROA & FINRKS are integrated of I.(0).

Hypothesis one

H_{01}: Financial risks due to climate change has no significant impact on return on asset

$ROA = \beta_0 + \beta_1 FINRKS + \varepsilon_i$ ……eqn i

Table 16

Dependent Variable: ROA
Method: Least Squares
Date: 05/30/22 Time: 05:52
Sample: 2010 2020
Included observations: 11

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.297544	0.462892	4.963462	0.0008
FINRKS	2.09E-05	7.30E-05	0.285915	0.0014

R-squared	0.009001	Mean dependent var	2.207273
Adjusted R-squared	0.101110	S.D. dependent var	1.069898
S.E. of regression	1.122684	Akaike info criterion	3.232288
Sum squared resid	11.34378	Schwarz criterion	3.304633
Log likelihood	15.77758	Hannan-Quinn criter.	3.186685
F-statistic	0.081747	Durbin-Watson stat	2.234639
Prob(F-statistic)	0.001415		

Source: Authors' computation from E-view 10

Decision rule:
The analyses of variance statistics are applied to the hypothesis, and the decision to be taken depends on the P-values obtained. For the hypothesis, the general decision rule is to reject the null hypothesis where the P-value is less than 0.05 and accept the null hypothesis (H0) where the P-value is more significant than 0.05 and vice-versa.

The results in Table 16 showed a significant impact since the value is very close to 1% and is highly statistically significant. The P-value (0.0014) of the t-statistic of the coefficient of FINRKS shows that financial risk significantly affects ROA during the 2010-2020 years. This means that financial risks due to climate change significantly impact the return on assets.
The model passes for a good fit as suggested by the high adjusted R-squared value (0.0090) which indicates that the financial risks and return on asset were very relevant and robust in explaining the total variations in the banking sector during the

period, with about 9% of the total variations explained and the Durbin-statistic value of 2.2346, which suggests the absence of the problem of autocorrelation.

Hypothesis two

H02: Operational risks due to climate change have no significant impact on return on asset

$ROA = \beta 0 + \beta 1\ OPRKS + \varepsilon i$ …….eqn ii

Table 17
Dependent Variable: ROA
Method: Least Squares
Date: 05/30/22 Time: 05:56
Sample: 2010 2020
Included observations: 11

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.012075	0.390187	5.156693	0.0006
OPRKS	0.004340	0.004784	0.907093	0.0480

R-squared	0.083766	Mean dependent var	2.207273
Adjusted R-squared	0.018038	S.D. dependent var	1.069898
S.E. of regression	1.079504	Akaike info criterion	3.153847
Sum squared resid	10.48796	Schwarz criterion	3.226191
Log likelihood	15.34616	Hannan-Quinn criter.	3.108243
F-statistic	0.822818	Durbin-Watson stat	2.076056
Prob(F-statistic)	0.047999		

Source: Authors' computation from E-view 10

The results in Table 3 showed a significant impact since the value is very close to 1% and is highly statistically significant. The P-value (0.0480) of the t-statistic of the coefficient of OPRKS shows that operational risk significantly impacts ROA during the 2010-2020 years. This means that operational risks due to climate change have a significant impact on the return on assets.

Hypothesis three

H03: Liquidity risks due to climate change have no significant impact on return on asset

$ROA = \beta 0 + \beta 1\ LIQRKS + \varepsilon i$ ……eqn iii

Table 18

Dependent Variable: ROA
Method: Least Squares
Date: 05/30/22 Time: 05:57
Sample: 2010 2020
Included observations: 11

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.146653	1.404574	0.816370	0.4354
LIQRKS	0.020722	0.026678	0.776752	0.0457

R-squared	0.062826	Mean dependent var	2.207273
Adjusted R-squared	0.041304	S.D. dependent var	1.069898
S.E. of regression	1.091770	Akaike info criterion	3.176443
Sum squared resid	10.72766	Schwarz criterion	3.248788
Log likelihood	15.47044	Hannan-Quinn criter.	3.130840
F-statistic	0.603344	Durbin-Watson stat	2.269970
Prob(F-statistic)	0.045733		

Source: Authors computation from E-view 10

Table 18 showed a significant impact since the value is very close to 1% and is highly statistically significant. The P-value (0.0457) of the t-statistic of the coefficient of LIQRKS shows that liquidity risk substantially impacts ROA during the 2010-2020 years. This means that liquidity risks due to climate change have a significant impact on the return on assets.

Summary/conclusion

Based on the analysis of findings in both primary and secondary data used, the thesis result revealed that financial risks due to climate change have a significant impact on return on asset, operational risks due to climate change have a significant effect on return on investment,

liquidity risks due to climate change has a significant impact on return on asset, physical risks due to climate change has a substantial effect on banking sector performance and methodology created for managing climate risk has an enormous impact on the banking sector. Also Augmented Dickey-Fuller test performed indicated that all series are non-stationary on levels except for ROA and FINRKS; however, all series were stationary at a second difference.

3.3. Discussion of findings

From the hypotheses tested, the outcome of statistical analysis was in line with the observed frequencies based on respondents' reactions to the distributed questionnaires. The following were the findings arrived at and their implications.

The study revealed that financial risk due to climate change significantly impacts banking sector performance.

This result agrees with Giuzio, Kruec, Levels, Melo, Mikkonen & Radulova (2019), who opined that climate change could significantly impact financial system stability. The financial system is the system that permits lenders, borrowers, and investors to trade monies. As described below, climate change impacts the financial system through its effects on financial institutions. Financial markets may be affected by climate issues. The uncertainty about which climate change event will occur, when, and how severe it will be can cause volatility in financial markets in places vulnerable to climate change events. Fear and uncertainty cause investors to hold cash or supply financing at a premium that businesses cannot afford. Furthermore, financial institutions that cannot mitigate climate change risk may withdraw liquidity from money markets by recalling the financial instruments they have issued to the money market, potentially causing a 'liquidity crunch' or a 'run on liquidity' in financial markets, with negative consequences for financial system stability.

The result showed that physical risk due to climate change significantly impacts banking sector performance.

This finding agrees with the view of Ozili (2020), who opined that climate risks damage to physical collateral. Moreover, when a bank lends to corporate and individual borrowers of questionable repayment capacity, the bank needs physical

collateral, the value of which is greater than the credit line given to them. Such physical collateral includes residential real estate, commercial real estate, car and plane fleets, equipment and land. Extreme weather events such as floods, landslides, and typhoons can cause severe damage to some or all of the physical (and immovable) collateral designed to mitigate credit risk. Collateral damage from climate change is reflected as a loss on the bank's income statement and negatively impacts the bank's profitability.

The result of the thesis indicated that liquidity risks due to climate change significantly impact banking sector performance.

This study correlates with the view of the Basel Committee on Banking Supervision (BCBS) (2020), which reported that climate risk factors could affect a bank's liquidity risk, either directly through its ability to raise funds or securitise its assets or indirectly through its customer liquidity needs. Although few studies have investigated the direct impact of climate risk factors on bank liquidity, there are related studies of the indirect impact of natural disasters. There is evidence that natural disasters can pose liquidity risks for banks. These effects affect the bank's ability to finance its asset growth and enable it to meet its due obligations without incurring unacceptable losses. Available research focuses on liquidity risk associated with a physical threat, and analysis of the potential impact of transition risk factors on banks' liquidity risk is limited.

The result of the hypothesis intensified that operational risks due to climate change significantly impact banking sector performance.

This study is in consonant with Migliorelli & Dessertine (2020), who stated that operational risk is a risk of loss due to abnormal processes and failure, internal processes, the society and systems or external events. This includes ATM frauds, armed robberies, identity theft, fraud and break-down of information technology (IT) systems, and employee errors. When necessary, strategic and reputational risk should be considered when managing a bank's operational risk. Physical risks are operational risks that can directly impact the bank's profitability. Although there are few general studies of the operational risks that banks face and relate to physical

hazards, similarities with other natural disasters can be found. For example, a bank's ability to operate could be reduced if physical hazards interfere with its vehicles and communications infrastructure. Businesses and banks may be at increased risk of legal and regulatory compliance, litigation and liability costs associated with climate-sensitive investments and industries. Climate change litigation may also target businesses and banks for past environmental behaviour while attempting to control future behaviour.

The thesis also revealed that the methodology for managing climate risk significantly impacts the banking sector.

This study is in consonant with Sevillano and González (2019), who opined that to lower their risk exposure, banks should consider loans to people with good reputable records regarding their credit turnover, transact with high-quality companies or own collateral; Apex banks should mandate banks to factor climate-related risks into lending and investment processes and appoint staff or team with responsibility to manage the financial risk of climate change to its assets.

3.4. Conclusions and recommendations

Conclusion

The analyses of findings were based on the objectives of the thesis.

Reveal the impact of financial risks due to climate change on banking sector performance

Table 4 indicated majority of the respondents 112(36.7%) agreed that financial risks posed by climate change affect banking sector performance, 36.1%, agreed that financial risk resulting from climate change causes direct damage to asset quality in the banking system, 39.3%, agreed that increase in the NPL ratio, increase the risk exposure of banks, hence adversely impacting the banking system resulting from the financial risk due to climate change and 34.4%, agreed that climate change events such as hurricanes, landslides and floods damage the business of banks' clients and customers and lower bank profit margin. Hence, the study concludes that climate change events such as hurricanes, landslides and floods damage the business of banks' clients and customers and lower bank profit margins.

Evaluate the impact of physical risks due to climate change on banking sector performance

Table 5 showed that most of the respondents (37.0%) strongly agreed that physical damage, materials, physical capital, such as factories and houses due to climate change leads to deterioration in firms' creditworthiness, which in turn affects banks' balance sheets, (43.3%) strongly agreed that physical destruction lead to reduction in the value of collateral, which in turn limits the ability of firms and individuals to borrow, 46.0% respondents strongly agreed that losses caused by climate-related natural disasters weaken the soundness of banking institutions and the stability of the financial system and 135(44.3 %) agreed that losses caused by climate-related natural disasters weaken the soundness of banking institutions and the stability of the financial system. Based on the result of finding, the researcher deduced that physical risks negatively impact on banking sector performance due to climate risks such as materials, physical capital, such as factories and houses leading to deterioration in firms' creditworthiness, weather-related disasters such as heatwaves, landslides, floods, wildfires and storms, physical destruction leading to reduction in the value of

collateral, occurrence of a natural or human-induced physical event causing loss of life, injury, as well as damage and loss of property and infrastructure, which in turn affects value of financial assets or increase bank liabilities.

Determine the impact of liquidity risks due to climate change on banking sector performance

Table 6 revealed most of the respondents 108(35.4%) agreed that climate change directly affect bank's liquidity risk through its ability to raise funds or securitize its assets, (33.4%) strongly agreed that climate change indirectly affect customer liquidity needs, (43.0%) strongly agreed that natural disasters affect bank's ability to finance its asset growth and enable it to meet its due obligations without incurring unacceptable losses and (32.5%) agreed that financial institutions lack the ability to mitigate climate change risk to withdraw liquidity from money markets. Thus, the researcher deduced that liquidity risks has adverse impact on banking sector performance as a result of natural disasters which affect bank's ability to finance its asset growth and enable it to meet its due obligations without incurring unacceptable losses and damage to collateral value.

Determine the impact of operational risks due to climate change on banking sector performance

Table 7 showed that majority of the respondents representing 109(35.7%) agreed that damages to financial infrastructure, branches, and office buildings due to climate change affect bank operational performance, (42.6%) strongly agreed that inadequate data security exposes the bank to operational losses, (46.6%) strongly agreed that damage to infrastructure used by banks due to severe weather or hurricanes disrupt the business of financial institutions for a considerable period of time before recovery, (35.4% %) agreed that severe climate change disrupt the ability of banks to communicate internally within the firm, thereby disrupting their operations and (38.7%) agreed that inadequate data backup exposes the bank to huge potential operational losses. Based on the finding, the researcher deduced that operational risks has negative impact on banking sector performance as a result of climate risks like damages to financial infrastructure, branches and office buildings, inadequate data

security which exposes the bank to operational losses, damage to infrastructure used by banks due to severe weather or hurricanes disrupt, and so on.

Create a methodology for managing the impact of climate risk in banking sector

Table 8 affirmed that the majority of the respondents 125(41.0%) strongly agreed that Apex banks should mandate banks to factor climate-related risks into lending and investment processes, 43.3%, agreed that banks with effective data centre/disaster recovery centres can effectively manage operational losses, 40.3%, agreed with the statement that banks should appoint staff or team with responsibility to manage the financial risk of climate change to its assets and 41.3%, agreed, and 119(39.0%) strongly agreed that banks must meet investors increasing demand for information on the bank's exposure to climate change-related risks. This shows that banks must meet investors increasing demand for information on the bank's exposure to climate change-related risk. Hence, Apex bank should do more to ensure that banks effectively manage the risks of climate change on their assets to ensure financial stability in the country.

Recommendations

Based on the research and findings, the following recommendations are made;

i. Banks are advised to monitor the ratio of loans and advances to deposits and avoid an excessive mismatch between loans and guarantees to safeguard their banks from poor ratings.
ii. Bank should continue to monitor its capital base and maintain the minimum capital to risk-weighted assets
iii. Bank regulators should be watchful and check banks' excesses in taking charges from wrong accounts, which tends to create a positive relationship between Non-performing Loans (NPLs) and Return on Asset (ROA)
iv. Management should invest in robust information technology infrastructure to help automate processes and reduce manual intervention. This will reduce the associated risk of errors and fraud
v. It is recommended that banks frame climate change adaptation strategies as a risk management process for banks to manage their financial risks effectively.
vi. To lower their risk exposure, banks should loan to people with good reputable credit-card histories, transact with high-quality industries, or own collateral.
vii. Banks should appoint staff or teams responsible for managing their assets' financial risk of climate change.
viii. Banks must meet investors increasing demand for information on the bank's exposure to climate change-related risks.

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ANNEXES

DEPARTMENT OF FINANCE AND BANKING
FACULTY OF ECONOMICS AND BUSINESS ADMINISTRATION
VILNIUS UNIVERSITY, LITHUANIAN

QUESTIONNAIRE ON

KLIMATO KAICIU POVEIKIO BANKININKAVIMO SEKTORIUI VERTINIMAS	**VALUATION OF CLIMATE CHANGE IMPACT ON BANKING SECTOR**

Dear respondent,

The questionnaire is about a study on the valuation of climate change impact on banking sector in Nigerian banking sector among selected of commercial banks in Lagos State, Nigeria. The study is basically for academic purpose in pursuit of a Master of Science in finance and banking at the Vilnius University, Lithuanian. Sir/Ma, you have been selected in this study and your kind cooperation in completing the questionnaire accurately and honestly are requested. If there is any question you do not understand, ask for clarification. Note that your participation in this study is totally voluntary and you can afford to end your participation anytime you desire. We however appeal that you keep on the end of the questionnaire to make the study successful. Be assured that all information gathered from you will be treated with utmost confidentiality.

Please, if you consent to participate, kindly respond to the questions in this questionnaire by filling in the gaps and ticking the space provided as appropriate. The process will take a few minutes of your time, but kindly bear with us and help by completing the questionnaire.

Thank you for your cooperation.

……..

Harry Ndukwu Nwachukwu

QUESTIONNAIRE SAMPLE

FACULTY OF ECONOMICS AND BUSINESS ADMINISTRATION
VILNIUS UNIVERSITY, LITHUANIAN

Dear respondent,

I am a final year student of the above institution. I am carrying out a research on "valuation of climate change impact on banking sector among selected of commercial banks in Lagos State, Nigeria". Kindly fill the information in the questionnaire below, all submission shall be treated with absolute confidentiality.

SECTION A: Demographic Profile

Please tick (√) according to the answers in the boxes that best represents you.

1. Gender: Male: [ ] Female: [ ]

2. Age: 21 – 35 [ ] 36 – 50 [ ] > 50 [ ]

3. Education qualification**:** Bachelor's degree or equivalent [ ] Master & Professional Certificate [ ] Others (Please Specify) [ ]

4. How long have you been in the risk management function?**:** 1 – 5years [ ] 6 – 10 years [ ] 11years &Above [ ]

5. Which management level best describes your role?**:** Management Staff [ ], Senior Staff [ ] Junior Staff [ ]

SECTION B

KEY: SA= Strongly Agree for 5th Ranking; A= Agree FOR 4th Ranking; N = Neutral for 3rd Ranking; D= Disagree for 2nd Ranking; SD= Strongly Disagree for 1st Ranking

	QUESTIONS					
Reveal the impact of financial risks due to climate change on banking sector performance						
	Financial risks posed by climate change affect banking sector performance					
	Financial risks resulting from climate change reduced level of financial intermediation which can make the banking system financially unstable					
	Financial risks resulting from climate change causes direct damage to asset quality in the banking system.					
	Increase in the NPL ratio, increase the risk exposure of banks, hence adversely impacting the banking system resulting from the financial risk due to climate change					
	Climate change events such as hurricanes, landslide and floods damage the business of banks' clients and customers and lower bank profit margin					
Evaluate the impact of physical risks due to climate change on banking sector performance						
	Physical damage, materials, physical capital, such as factories and houses due to climate change leads to deterioration in firms' creditworthiness, which in turn affects banks' balance sheets.					
	Physical risks due to climate change lead to weather-related disasters such as heatwaves, landslides, floods, wildfires and storms hence negatively impact on banking sector performance					
	Physical destruction lead to reduction in the value of collateral, which in turn limits the ability of firms and individuals to borrow					

	The potential occurrence of a natural or human-induced physical event may cause loss of life, injury, as well as damage and loss of property and infrastructure, affect value of financial assets or increase liabilities.					
	Losses caused by climate-related natural disasters weaken the soundness of banking institutions and the stability of the financial system					
Determine the impact of operational risks due to climate change on banking sector performance.						
	Damages to financial infrastructure, branches, and offic e buildings due to climate change affect bank operational performance					
	Inadequate data security exposes the bank to operational losses					
	Damage to infrastructure used by banks due to severe weather or hurricanes disrupt the business of financial institutions for a considerable period of time before recovery					
	Severe climate change disrupt the ability of banks to communicate internally within the firm, thereby disrupting their operations					
	Inadequate data backup exposes the bank to huge potential operational losses					
Determine the impact of liquidity risks due to climate change on banking sector performance.						
	Climate change directly affect bank's liquidity risk through its ability to raise funds or securitize its assets					
	Climate change indirectly affect customer liquidity needs.					
	Natural disasters affect bank's ability to finance its asset growth and enable it to meet its due obligations without incurring unacceptable losses.					
	Damage to collateral value caused by climate change reflected as a loss to bank’s profit and loss statement which negatively affect bank profitability					
	Financial institutions lack the ability to mitigate climate change risk to withdraw liquidity from money markets					
Create a methodology for managing the impact of climate risk in banking sector						
	To lower their risk exposure, banks should loan money					

	to people with good credit histories, transact with high-quality counterparties, or own collateral.					
	Apex banks should mandate banks to factor climate related risks into lending and investment processes.					
	Banks with effective data center/disaster recovery centres can effectively manage operational losses					
	Banks should appoint staff or team with responsibility to manage the financial risk of climate change to its assets.					
	Banks must meet investors increasing demand for information on the banks' exposure to climate change related risks.					

CBN annual stability reports, 2021

Years	**FINRKS (N,Billion)**	**OPRKS (N,/Billion)**	**LIQRKS (%)**	**ROA**
2010	7,706.43	19.61	47.46	3.9
2011	7,231.29	9.25	50.25	0.2
2012	7,870.92	7.292	30.0	1.2
2013	324.13	33.57	50.63	2.31
2014	363.31	12.04	45.77	3.13
2015	649.63	7.17	48.63	2.5
2016	2,084.92	5.123	43.96	1.29
2017	15,908.08	6.30	45.62	2.42
2018	1,792.48	21.27	51.70	2.03
2019	2,534.836	210.90	73.0	3.45
2020	1,127.10	162.23	76.0	1.85

Sources: CBN annual stability reports and financial statement of accounts 2021