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**Effect of Weather Conditions in Global Financial Hubs on
the Performance of the Kenyan Equities Markets.**

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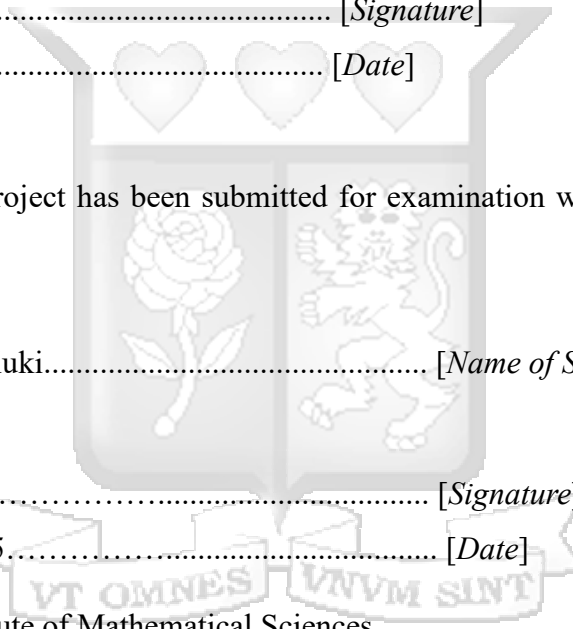


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LIST OF ABBREVIATIONS

AfDB - African Development Bank

ARDL – Autoregressive Distributed Lag

ECB - European Central Bank

EMH - Efficient Market Hypothesis

GARCH – Generalized Autoregressive Conditional Heteroskedasticity

IMF - International Monetary Fund

JSE - Johannesburg Stock Exchange

LSE - London Stock Exchange

NASI - Nairobi Securities Exchange All Share Index

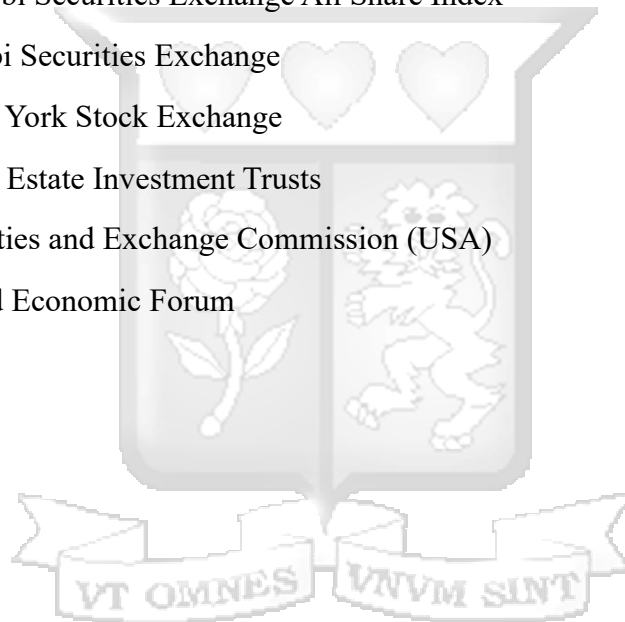
NSE - Nairobi Securities Exchange

NYSE - New York Stock Exchange

REITs - Real Estate Investment Trusts

SEC - Securities and Exchange Commission (USA)

WEF - World Economic Forum



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ABSTRACT

This study investigates the effect of weather conditions in global financial hubs on the performance of the Kenyan equities market. The study's main objective is to assess the effects of rain, temperature and wind speed in these global financial hubs on the Kenyan equities market performance. Employing a causal research design, the study analyzes monthly weather data from New York and London alongside the NSE 20 Share Index performance over an 8-year period from 2015 to 2023. The control variables include Inflation, Interbank Rates and Foreign Exchange Rates of Kenya. The study was based on the hypotheses that the weather variables in these global financial hubs have no significant effect on the performance of the Kenya Equity market. Data was collected from meteorological databases and official NSE records. To cater for both stationary and non-stationary variables that were present in the model the research uses Autoregressive Distributed lag model that caters for both types of variables. This model was able to show the significance of the weather variables at level and lag 1. The study shows that, while meteorological variables in New York and London have modest direct effects on the NSE 20 Index, they may influence market performance indirectly via global investor mood and interconnected financial institutions. Local macroeconomic factors, notably exchange rates, emerged as major predictors, emphasizing the role of currency stability in driving market performance. These findings highlight the importance of flexible investment strategies and more research into the global-local dynamics influencing emerging countries such as Kenya.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The impact of weather conditions on human behavior has been well acknowledged, and it has important consequences for financial markets. The correlation between weather conditions and market performance, especially in major global financial centers, underscores the influence of environmental factors on investor sentiment, perception of risk, and decision-making (Venturini, 2022; Pankratz, Bauer, & Derwall, 2023). Behavioral finance theories propose that market dynamics can be subtly influenced by environmental conditions such as temperature, rainfall, and storms, which in turn affect the psychological state of market players (El Ouadghiri et al., 2021; Antoniuk & Leirvik, 2024). The fluctuations in weather conditions in prominent financial hubs like New York and London are frequently regarded as having a wider-reaching influence, possibly affecting the whole global market sentiment and performance (Sautner et al., 2023; Chen, Luo, & Yan, 2024). Due to the worldwide interconnection of financial markets, disruptions caused by weather conditions in one region can affect the performance of equities in distant markets, especially emerging economies such as Kenya (Ren et al., 2022; Khalfaoui et al., 2022).

Globally, weather conditions are widely acknowledged worldwide as key factors that impact the stability and performance of financial markets. The World Economic Forum (2023) and other institutions have recognized severe weather occurrences as major global hazards, with a particular worry for their potential to disrupt financial markets (Pankratz, Bauer, & Derwall, 2023). The Bank of England (2022) predicts that climate-related risks may cause a decline in global GDP of up to 10% by 2050, mostly owing to their influence on market activity (Venturini, 2022). The European Central Bank (ECB) has noted that unforeseen weather variations, such as intense storms or temperature fluctuations in significant financial centers like London and Frankfurt, result in increased market instability and decreased trading activity. This demonstrates the susceptibility of markets to environmental changes (Sautner et al., 2023; Chen, Luo, & Yan, 2024). According to the Securities and Exchange Commission (SEC) in the United States, more and more companies are including information about weather-related risks in their financial disclosures. They recognize that these factors can impact

the performance of the company and the behavior of investors (Khalifaoui et al., 2022). Extreme weather events have been found to cause significant changes in trading patterns on platforms like the New York Stock Exchange (NYSE). This highlights the global interconnectedness and susceptibility of financial markets to environmental conditions. (Ren et al., 2022; Ginglinger & Moreau, 2023; Han et al., 2024).

In Africa, the impact of severe weather conditions on major financial centers such as New York and London is becoming more apparent, primarily because of the interdependence of global investment networks. Prominent investors in these centers often possess substantial ownership interests in African stocks, particularly in markets like the Johannesburg Stock Exchange (JSE). The International Monetary Fund (IMF) reports that around 30% of foreign direct investment in sub-Saharan Africa comes from nations that are especially susceptible to climate-related hazards. This highlights the strong connections between these markets. Severe weather catastrophes like hurricanes or snowstorms in global capitals can have rippling effects on African markets, leading to swings in stock performance and changes in investor behavior (Makatjane & Moroke, 2021; Adediran, Bewaji, & Oyadeyi, 2024). According to the African Development Bank (AfDB), catastrophic weather events might cause a decrease of 5-10% in the amount of money flowing into African markets (AfDB, 2023). This frequently compels investors to divest from correlated assets on the JSE in order to mitigate risks, hence exacerbating the instability of regional financial markets (Selemela, Ferreira, & Mokatsanyane, 2021).

Locally, the performance of shares on the Nairobi Securities Exchange (NSE) has seen fluctuations over time, driven by a diverse range of factors, both domestic and foreign. The NSE All Share Index (NASI), a prominent gauge of market performance, has seen notable peaks and troughs in reaction to diverse economic, political, and global events. Periods of robust economic expansion in Kenya have consistently shown a positive correlation with upward trends on the Nairobi Securities Exchange (NSE). This was evident during the post-2007 economic recovery, where the NASI index had a substantial increase of almost 30% over a span of a few years (Kalovwe, Mwaniki, & Simwa, 2021). In contrast, the occurrence of political instability, shown by the post-election violence in 2007-2008, resulted in a significant decrease in market performance. The NSE 20-Share Index plummeted by more than 40% due to a reduction in investor confidence (Walela, Omagwa, & Muathe, 2022). Global factors

have also had a considerable impact, especially due to the influence of international investors, who contribute a substantial portion of the trading volumes on the NSE. Worldwide commodity price fluctuations, especially in oil, and worldwide economic policies, such as interest rate adjustments by the U.S. Federal Reserve, have caused capital outflows and market instability on the NSE (Kalovwe et al., 2021). In 2020, the COVID-19 pandemic produced a major decline in the market. The NASI dropped by almost 20% in the first quarter of the year due to worldwide market reactions to the uncertainties and economic disruptions induced by the pandemic (Walela et al., 2022). These instances demonstrate the NSE's susceptibility to several factors, including local political events and global economic changes, emphasizing the intricate and interdependent nature of the market's performance over time.

1.1.1 Weather Conditions in Global Financial Hubs

The impact of weather conditions on market behavior and investor emotion is becoming more recognized in major financial centers such as New York, London, and Tokyo. These cities play a significant role in the global financial system, where the daily trade volume may approach trillions of dollars. The weather in these regions impacts both the practical functioning of financial markets and the mental condition of market participants. Research conducted by Venturini (2022) has found that bright weather is associated with a tendency towards more optimistic trading behavior, whilst overcast or stormy conditions tend to result in more cautious and conservative decision-making. This phenomenon has a significant influence on major financial centers such as New York, where any disturbance can have magnifying consequences on the worldwide financial markets because of the large number of trades conducted.

Extreme weather phenomena such as hurricanes, snowstorms, and heatwaves pose substantial threats to the functioning of major financial centers. An illustration of this is Hurricane Sandy in 2012, which compelled the New York Stock Exchange (NYSE) to shut down for a duration of two days. This event emphasized the susceptibility of even the most technologically sophisticated markets to severe weather conditions (Kmetz et al., 2024). These closures have a negative impact on trade, financial reporting, and communication among market players, resulting in heightened uncertainty and volatility (Chen, Luo, & Yan, 2024). Market activity in London has been significantly affected by heavy snowfalls, resulting in trade delays and impacting

market liquidity. These interruptions serve as a clear reminder of the substantial and rapid effects that weather-related disasters may have on financial markets.

In addition to these immediate disruptions, there is increasing apprehension over the enduring impacts of climate change on global financial centers. Due to the anticipated rise in the occurrence and intensity of extreme weather events caused by climate change, financial markets are already incorporating these risks into their operations and plans (Antoniuk & Leirvik, 2024). Financial institutions are doing more thorough risk assessments in response to the possibility of more volatility and uncertainty caused by climate-related disruptions. Investors are becoming more cognizant of the necessity to integrate climate risk into their decision-making procedures, indicating a wider transition towards sustainable finance and strategic long-term planning (Krutli, Roth Tran, & Watugala, 2023).

1.1.2 Performance of the Kenyan Equities Market

The performance of the Kenyan stocks market, predominantly represented by the Nairobi Securities Exchange (NSE), has been influenced by an intricate interaction of domestic and international factors throughout the years. The NSE, founded in 1954, has transformed from a small exchange to become one of the largest in Africa, mirroring Kenya's overall economic progress. During its initial years, the performance of the NSE was strongly influenced by the economic policies implemented by the country after gaining independence. These policies were designed to promote industrial development and attract foreign investment. In the 1970s and 1980s, the market saw a gradual increase in size, although it was sometimes hindered by political instability and economic difficulties, such as high inflation and limitations on foreign currency exchange. Notwithstanding these obstacles, the NSE All Share Index (NASI) served as a gauge of market activity and investor mood. In the 1990s, market reforms, such as the use of automated trading systems, improved market liquidity and enticed a larger number of investors (Walela, Omagwa, & Muathe, 2022).

The NSE had substantial development during the 2000s due to strong economic expansion and rising international investment. The NSE's market capitalization experienced significant growth, indicating strong investor confidence in the Kenyan economy. During the period from 2002 to 2007, the NSE 20-Share Index had significant growth, increasing by more than 100%, from around 1,500 points to over

5,000 points. This growth was primarily fueled by impressive performances in important sectors like as banking, telecommunications, and energy (Kalovwe, Mwaniki, & Simwa, 2021). Nevertheless, this phase of expansion encountered substantial obstacles. The occurrence of violence during the 2007-2008 elections resulted in a significant decrease in market performance. The NSE 20-Share Index had a steep loss of more than 40% due to political uncertainty and economic disruption, which negatively impacted investor confidence (Walela et al., 2022).

The NSE has had ongoing expansion, however its results have been varied, affected by a blend of worldwide economic patterns and domestic factors. The 2008-2009 global financial crisis caused a substantial decrease in market activity. The NSE 20-Share Index had a dip of over 35% due to the withdrawal of foreign investors from emerging markets (Kalovwe et al., 2021). However, the market had a rebound in the following years, propelled by a revitalized economy and fresh foreign investment. The market has been diversified and a wider spectrum of investors have been attracted via the introduction of new financial instruments, such as Real Estate Investment Trusts (REITs) and the Growth Enterprise Market Segment (GEMS). Nevertheless, the NSE had a challenge in 2020 when the COVID-19 pandemic emerged. The NASI saw a decline of around 20% in the first quarter of the year due to the global market's response to the pandemic's uncertainties and economic disturbances (Walela et al., 2022). Notwithstanding these variations, the NSE continues to be an essential element of Kenya's financial system, demonstrating both the prospects and difficulties confronting the country's economy.

1.2 Problem of the Statement

The global financial market has a high degree of interconnectivity, wherein variables such as weather conditions in prominent financial hubs may exert an influence on stock markets in emerging economies. Nevertheless, the influence of weather occurrences in these major global centers on distant markets remains uncertain. According to the World Economic Forum (2023), extreme weather is seen as a prominent worldwide risk, particularly for financial markets (Pankratz, Bauer, & Derwall, 2023). According to the Bank of England's forecast for 2022, climate-related hazards have the potential to decrease world GDP by as much as 10% by the year 2050, as reported by Venturini in 2022. The Nairobi Securities Exchange (NSE) has had significant fluctuations in its performance, with its primary index fluctuating by as much as 30% as a result of

numerous global and economic occurrences (Kalovwe, Mwaniki, & Simwa, 2021). Nevertheless, the extent to which these alterations may be attributed to weather-related issues in prominent financial hubs remains uncertain. The lack of sufficient understanding of weather-related information is a significant challenge for investors, policy makers, and market regulators who require accurate data to make well-informed judgments.

Furthermore, prior studies reveal areas of inquiry that have not been addressed. Kruttli, Roth Tran, and Watugala (2023) conducted a study that revealed a significant impact of unpredictable weather conditions on the performance of corporations in the stock market. However, it is important to note that their research mostly focused on developed nations. According to the International Monetary Fund (IMF, 2022), about 30% of foreign investment in Africa originates from nations that are very vulnerable to the impacts of climate change. Consequently, any weather-related issues in these nations have the potential to impact African markets. A study conducted by Apergis and Gupta (2017) shown that atypical weather conditions in New York had an impact on the performance of South African equities. This finding implies that similar effects can be observed in other African markets, such as Kenya. According to the African Development Bank (AfDB) in 2023, adverse weather conditions might lead to a decrease in investment in African markets by 5-10%. Hence, this study aims to ascertain the impact of weather conditions in major financial centers worldwide on the performance of the Kenyan stock market. The research is important in the sense that the relationship between the weather conditions in major global financial centres on the Kenyan stock markets is an area that is underexplored in the context of developing markets.

1.3 Research Objective

The main objective is to determine the effect of weather conditions in global financial hubs on the performance of the Kenyan equities market.

The specific objective will be to assess;

- i. The effect of rain in global financial hubs on the performance of the Kenyan equities market.
- ii. The effect of temperature in global financial hubs on the performance of the Kenyan equities market.

- iii. The effect of wind/storms in global financial hubs on the performance of the Kenyan equities market.

1.4 Research Hypotheses

H₀₁: Rain in global financial hubs has no significant effect on the performance of the Kenyan equities market.

H₀₂: Temperatures in global financial hubs have no significant effect on the performance of the Kenyan equities market.

H₀₃: Winds/storms in global financial hubs have no significant effect on the performance of the Kenyan equities market.

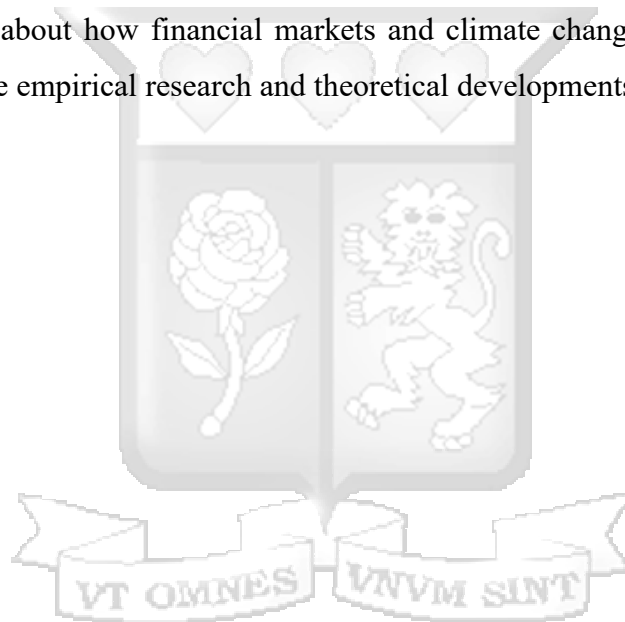
1.5 Scope of the Study

This study will investigate the impact of weather conditions in major global financial centers on the performance of the Kenyan stock market. It will specifically examine the influence of rainfall, temperature, and wind/storms in New York and London on the Nairobi Securities Exchange (NSE). The research will exclusively concentrate on the NSE 20 Share Index as the main indicator of the performance of the Kenyan stock market. The index monitors the performance of 20 prominent firms listed on the NSE, offering a representative sample of the whole market. The research will solely analyze weather data from New York City, USA, and London, UK, as these cities are home to two of the world's most significant financial centers. This research will cover a duration of 10 years, starting from 2014 and ending in 2023. It will gather a thorough dataset that includes different market cycles and weather trends.

1.6 Significance of the Study

The findings will offer valuable insights for various stakeholders, including individual investors and national economic planners. This study is significant as it will provide insights into the impact of weather conditions in key financial hubs on the Kenyan stock market, hence addressing a knowledge vacuum pertaining to emerging markets. This data can assist policymakers and market regulators in Kenya in making more informed decisions to safeguard our financial system against abrupt fluctuations. This research aims to assist Kenya in anticipating and preparing for these changes, therefore facilitating long-term economic planning and the development of adaption solutions. The findings will offer useful insights to investors, both local and worldwide, which might potentially result in improved investment strategies. The study will further

enhance risk management for the Kenyan stock market, thereby bolstering its stability and appeal to investors. Furthermore, with the increasing occurrence of severe weather events due to climate change, it is imperative to comprehend their influence on financial markets. Ultimately, this research will contribute to enhancing the resilience and knowledge of the financial sector in Kenya. This study will be very helpful to researchers since it will offer a fresh perspective on how weather patterns in important financial centres affect developing economies such as Kenya. This research will create new opportunities for academic investigation by adding to the comparatively untapped field of climate-related financial impacts on developing economies. This will allow researchers to expand on the findings and investigate comparable effects in other locations or under alternative circumstances. It will also improve the scholarly conversation about how financial markets and climate change interact, providing a basis for more empirical research and theoretical developments in this area.



CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The chapter starts with an introductory section, which is then followed by a comprehensive examination of the Efficient Market Hypothesis, Behavioral Finance Theories, and the Weather Effect Hypothesis. A systematic analysis investigates prior research on the impact of weather conditions on stock markets. The chapter next delineates the research void and culminates with a conceptual framework, establishing the groundwork for the methodology and analysis of weather impacts from worldwide financial centers on the Kenyan stocks market in this study.

2.2 Theoretical Review

This section explores three fundamental hypotheses that establish the basis for comprehending the possible influence of weather conditions in global financial centers on the Kenyan stocks market. The Efficient Market Hypothesis provides understanding of how markets handle information, whereas Behavioral Finance Theories investigate the psychological elements that impact investment choices. The Weather Effect Hypothesis focuses on the impact of weather conditions on financial markets.

2.2.1 Efficient Market Hypotheses

The Efficient Market Hypothesis (EMH), introduced by Eugene Fama in 1970, suggests that financial markets are "informationally efficient," indicating that asset prices include all accessible information (Fama, 1970). According to this hypothesis, investors cannot consistently get better returns than the whole market by choosing specific stocks or trying to time the market, because stock prices already include and represent all the necessary information. The notion discussed here has substantial ramifications for comprehending market dynamics and investment approaches in both well-established and developing markets (Malkiel, 2003).

The EMH is comprised of three distinct forms: weak, semi-strong, and powerful. The weak version of market efficiency posits that future prices are not predictable by the analysis of historical price data. The semi-strong form posits that prices swiftly adapt to newly disseminated public knowledge. The strong form asserts that prices incorporate all information, encompassing both public and private sources (Lo, 2004).

Nevertheless, detractors contend that the Efficient Market Hypothesis (EMH) fails to include market oddities, investor irrationality, and the presence of accomplished investors who repeatedly outperform the market (Shiller, 2003). Behavioral finance theorists, namely, question the Efficient Market Hypothesis (EMH) by emphasizing psychological elements that impact investor decision-making and market results (Barberis & Thaler, 2003).

The EMH enhances our comprehension of how weather data may be integrated into stock market valuations. According to Apergis and Gupta (2017), if the market is efficient, any major weather occurrences in New York or London should have an immediate impact on the prices of the NSE 20 Share Index. Nevertheless, the discovery of a protracted influence of weather conditions on market performance might potentially undermine the assumptions of the Efficient Market Hypothesis (EMH) within the framework of emerging markets (Kathiravan et al., 2021). This hypothesis allows us to structure our investigation of the correlation between weather conditions in major global financial centers and the performance of the Share Index. It provides insight into the effectiveness of information transmission in global financial markets.

2.2.2 Behavioral Finance Theories

Principles of Behavioral Finance Developed by Daniel Kahneman and Amos Tversky, in collaboration with economist Richard Thaler, the field of behavioral economics combines psychological insights to elucidate the process of financial decision-making and market irregularities (Kahneman & Tversky, 1979; Thaler, 1985). Behavioral finance theory suggests that investors do not always make rational decisions and that psychological biases and cognitive mistakes can have a considerable impact on financial markets, causing departures from efficient market projections.

Behavioral finance encompasses many essential elements, including prospect theory, mental accounting, and herd behavior. Prospect theory posits that individuals make decisions by considering the prospective advantages and costs in relation to a reference point, rather than focusing solely on the end results (Kahneman & Tversky, 1979). Mental accounting is the inclination of humans to categorize and assess economic outcomes in separate accounts rather than holistically (Thaler, 1999). Herd behavior refers to the phenomenon where individuals imitate the acts of a bigger group, even

when their own private information indicates that they should behave otherwise (Shiller, 2000). Detractors contend that although these theories elucidate certain market irregularities, they are deficient in terms of their ability to forecast outcomes and their overall coherence compared to conventional finance theories (Fama, 1998).

Behavioral finance theories offer a structure for comprehending the potential impact of weather on investor emotion and decision-making. Inclement weather in prominent financial hubs may have an adverse impact on investor sentiment, resulting in a heightened inclination towards gloomy market evaluations (Hirshleifer & Shumway, 2003). Subsequently, this psychological influence might be disseminated to other markets via investor conduct and market sentiment.

2.2.3 Weather Effect Hypothesis

The Weather Effect Hypothesis, proposed by Saunders (1993) and further supported by Hirshleifer and Shumway (2003), posits that weather conditions, such as sunlight, temperature, and precipitation, have the potential to influence the mood and decision-making of investors, thereby affecting the returns of the stock market. This theory disrupts conventional finance theories by incorporating an external, apparently illogical element into the domain of market forces, connecting behavioral finance and environmental studies inside the framework of financial markets. The Weather Effect Hypothesis comprises many essential elements and mechanisms that explain how weather is believed to influence financial markets. Initially, it suggests a direct psychological impact, wherein weather conditions affect the mood of investors, resulting in either optimistic or pessimistic biases in financial decision-making. For example, sunny weather might cause a more pleasant attitude, which could result in more optimistic evaluations of the market and higher levels of purchasing. In contrast, overcast or rainy conditions may cultivate a more negative perspective, thus promoting the inclination to engage in selling activities. Furthermore, the hypothesis takes into account the potential indirect consequences, such as the influence of weather on economic activities (such as retail sales and productivity), which subsequently impact market performance. Moreover, it is believed that severe weather occurrences have an impact on how people perceive risk and the level of volatility in the market. Detractors of this idea contend that in efficient markets, such irrational impacts should be eliminated through arbitrage. Nevertheless, supporters argue that the widespread impact of weather phenomena and the constraints on

exploiting market discrepancies in real-life scenarios enable these influences to endure (Lucey & Dowling, 2005).

The Weather Effect Hypothesis plays a vital role in our study on the influence of weather conditions in major financial centers worldwide on the Kenyan stocks market. The paradigm provides a means of comprehending how weather conditions in prominent financial hubs such as New York and London may impact not just their local markets but also have ripple effects on geographically remote markets like Kenya's. According to this idea, variations in weather can alter the attitude of investors and traders in global financial centers. This, in turn, might impact their trading choices, potentially impacting the flow of international money and the overall sentiment towards developing markets (Kang et al., 2010). Moreover, it enables us to contemplate the potential impact of severe weather phenomena in these economic hubs on global risk assessments, which might indirectly influence the NSE 20 Share Index. By integrating this hypothesis into our research, we can investigate the direct impact of weather on market performance and the possible psychological transmission mechanisms through which weather in one location may affect market behavior in another. This will lead to a more comprehensive comprehension of the intricate interactions between global financial centers and emerging markets such as Kenya.

2.3 Empirical Review

Antoniuk and Leirvik (2024) investigated how unforeseen political events affected industries that are susceptible to climate change. Their analysis showed that developments pertaining to climate change policy had a big impact on stock returns in a lot of different industries. Events like the Paris Agreement, Climategate, and the Fukushima accident had a favourable impact on the renewable energy sector by raising public awareness of climate change and supporting measures aimed at mitigating its impacts. On the other hand, utilities, energy-intensive businesses, and the transportation sector faced greater political and market risks associated with the change, indicating the necessity for risk compensation. The study also discovered a positive anomalous return for the fossil energy sector was linked to events that weakened climate change legislation. Crucially, the researchers noted that investors in the stock market promptly adjusted to fresh knowledge about climate change, underscoring the market's effectiveness in pricing climate risks and sector development forecasts. Given that investors quickly factor in both climate threats and

sector development expectations when valuing assets, our findings highlight the necessity for policymakers to take the effects of climate-related events on the stock market into account.

Apergis and Gupta (2017) investigated the impact of extraordinary New York weather conditions on stock returns in South Africa. Their study focused on weather factors assessed as departures from monthly averages, using daily data from January 2, 1973, to December 31, 2015. The unexpected weather variances in New York and the stock returns in South Africa were determined to be statistically significantly correlated negatively by the researchers. This result implies that unusual weather conditions in a significant global financial hub can forecast stock returns in a far-off market that would otherwise seem extremely random. Furthermore, the study showed that a trading strategy that used GARCH modeling to incorporate these weather factors performed better than the random walk model, possibly giving investors an edge over the market. These findings challenge conventional ideas of market efficiency and emphasize the significance of taking into account international factors in stock market analysis. They also highlight the interconnectedness of global financial markets and the unexpected influence of localized weather phenomena on distant stock markets.

A comprehensive analysis of the literature on the impact of weather on stock market behaviour was carried out by Kathiravan et al. in 2021. The study used Google Scholar as its main search engine and looked at 51 research publications published between 1993 and 2019 from different parts of the world. According to their data, since the start of the twenty-first century, there has been a little rise in studies on the impacts of weather on stock market behaviour. Temperature was the most often researched variable among the several weather factors that were examined. The authors pointed out important gaps in the literature in this area and offered some directions for further investigation.

Venturini (2022) provided a comprehensive review of the literature exploring climate change as a potential source of market risk. In order to investigate climate risk factors and their effects on equity market dynamics, the study looked at a variety of data sets. The author examined the degree to which equity markets factor in climate change and related hazards, providing actual data at both the macro and local levels. In order to ascertain whether climate risks are most likely to affect cross-sectional stock returns

within and across sectors, the review contrasted top-down and bottom-up methodologies. The study also stressed the importance of investors' perceptions of the risks associated with climate change and how such perceptions affect asset price. The author emphasized the rising significance of climatic factors in financial analysis and decision-making by combining current studies. The review also pointed out areas of current knowledge gaps and offered recommendations for future theoretical and empirical research in the field of climate finance, highlighting how this field is still developing and how important it is to comprehending stock market behavior in the context of environmental changes on a global scale.

Pankratz, Bauer, and Derwall (2023) conducted an extensive study examining the impact of heat exposure on firm performance and investor expectations across a large global sample. From 1995 to 2019, their study included more than 17,000 companies in 93 countries and connected firm-specific heat exposure metrics to stock returns surrounding earnings releases, financial performance, and equity analyst estimate mistakes. The study found a strong negative correlation between businesses' financial performance and more exposure to extremely high temperatures. In particular, they discovered that the average quarterly sales and operating income decreased by 0.6% and 1.8%, respectively, for every one standard deviation rise in the number of hot days. These results highlight the real effect that climate-related risks have on the financial performance of corporations. In addition, the researchers found that higher heat exposure had a detrimental impact on the financial performance of the company in comparison to analyst forecasts and returns from earnings announcements. This implies that heat, as the main physical climatic risk is not properly anticipated by capital market players, even professional experts. Investors and business management should both take note of these findings. They draw attention to the possibility for more precise financial forecasting that takes climate factors into account, as well as the need for enhanced methods of climate risk assessment and disclosure.

In their study, Sun et al. (2020) examined how climate change risks affect the financial performance of mining businesses that are publicly listed in China. The researchers utilized a distinctive climate risk indicator that encompasses five distinct forms of climate hazards. They discovered a noteworthy association between climate change and the financial performance of mining businesses. Their research revealed that enterprises involved in the extraction of diverse natural resources demonstrated

distinct sensitivities to climate risks, which might result in both favorable and unfavorable financial consequences. The researchers have found both direct and indirect pathways by which climate concerns impact company performance. The study suggested that mining businesses adopt low-carbon policies and aggressively publish emission information in order to improve their brand value and gain a competitive edge.

Kruttli et al. (2023) investigated the influence of severe weather occurrences, particularly hurricanes, on the amount of uncertainty inside firms and the fluctuation of stock returns. By analyzing stock options data, researchers discovered substantial rises in implied volatility for companies with locations in regions affected by hurricanes, both before to and following the effect. The study found that investors had a tendency to not respond adequately to these occurrences, as seen by the comparison of implied and subsequent realized volatility. However, the level of response dropped for disasters that occurred following Hurricane Sandy, which had a significant impact on the financial hub of the United States. Although storms are typically regarded as idiosyncratic shocks, they have been observed to impact the anticipated stock returns of the companies that are hit. The researchers conducted a textual study of communication between business management, analysts and investors. They saw an increase in conversations regarding the effects of hurricanes throughout the extended period of high uncertainty that occurred after the hurricane made landfall.

Huynh et al. (2020) investigated the correlation between the likelihood of drought and the expense of equity capital. Their research uncovered a notable and favorable association between these variables, wherein companies impacted by extreme drought conditions observed a 92 basis point rise in their cost of equity capital. The study revealed that companies with greater local institutional ownership experienced an increased cost of equity capital during droughts. This finding supports the notion of local bias among institutional investors and implies that diversification alone cannot completely mitigate the financial losses caused by droughts. The study also shown that the length and severity of droughts led to a greater level of risk premium for a company. Nevertheless, the influence of drought on projected profits was much diminished for companies that have diversified cash flows/investments, activities spread across several locations, and substantial cash reserves.

Yang et al. (2021) performed an extensive investigation of the effects of climate change on the energy efficiency and thermal comfort of residential buildings in Europe. By analyzing climate data from 38 European cities across five climatic zones over a 90-year timeframe (2010-2099), researchers discovered that the need for cooling is predicted to rise by an average of 28%, while the need for heating is anticipated to decline by 16%. The study emphasized that severe weather events have a substantial impact on the highest levels of energy demand and the level of comfort in buildings. Discomfort hours are expected to significantly rise in cooling-dominated climatic zones, while remaining essentially constant in heating-dominated zones. The study highlighted the need of taking into account both prolonged climatic changes and immediate severe events when conducting building energy evaluations. These findings emphasize the necessity of using flexible techniques in building design and energy systems to tackle the evolving climatic conditions and their influence on energy consumption patterns in residential buildings throughout Europe.

In their study, Muhlack et al. (2022) examined the influence of several weather phenomena, such as cloud cover, humidity, air pressure, precipitation, temperature, and wind speed, on the German stock market. The study examined stock market data from the DAX, MDAX, SDAX, and TecDAX indices between 2003 and 2017, focusing on returns, trading volume, and volatility. The researchers utilized contemporary time-series GARCH models to determine that air pressure was the sole weather variable that had a possibly consistent impact on the stock market. Observations indicated that air pressure had a diminishing effect on trading volume in the SDAX and TecDAX indices. Conversely, alterations in air pressure resulted in higher returns in the DAX, MDAX, and SDAX indices. The study observed that the impacts of other weather factors did not exhibit a discernible pattern. This study adds to the existing discourse on the impact of weather on financial markets by offering fresh perspectives on the German environment and emphasizing the possible significance of air pressure as a weather variable in stock market dynamics.

Adediran et al. (2024) examined the influence of climate risk on stock markets in developed and developing nations, including environmentally friendly firms. The researchers developed a daily climate risk index and applied a methodology akin to the Sharpe ratio to analyze the incorporation of climate risk in stock prices, therefore reevaluating market efficiency. The study utilized an econometric model to assess the

forecasting capability of the climate risk index for stock returns. Their research revealed that markets demonstrated efficiency when climate risk was included into stock prices, but exhibited inefficiency in other cases. The research findings indicate that over 85% of developed stock markets, 17% of emerging stock markets, and all environmentally sustainable stocks have the potential to safeguard investors against climate-related risks. After accounting for macroeconomic factors, the climate risk index demonstrated its effectiveness as a reliable indicator of stock returns. This study enhances our comprehension of climate risk in financial markets by providing valuable insights into market efficiency and the capacity to anticipate returns across various market types. It emphasizes the significance of taking climate factors into account when making investment choices and formulating policies.

2.4 Research Gap

Although Apergis and Gupta (2017) have investigated the influence of weather conditions in New York on the South African market, there is a lack of study explicitly addressing the Kenyan stocks market. The distinct attributes of the Kenyan market, as a burgeoning economy in East Africa, may lead to divergent reactions to weather conditions in international financial centers in contrast to other markets. In addition, the majority of research has been on established markets or bigger developing markets, resulting in a lack of knowledge on the response of smaller, less liquid markets such as Kenya's to external weather-related factors. Our work can provide new insights into how global weather patterns and growing African markets are related. Furthermore, the current body of literature mostly focuses on analyzing the influence of regional weather conditions on regional markets, as seen in the research conducted by Muhlack et al. (2022) and Yang et al. (2021).

However, there is a scarcity of studies examining the impact of weather conditions across borders, namely from prominent financial centers to less significant markets. The objective of our study is to address this deficiency by particularly investigating the impact of weather conditions in global financial hubs on the Kenyan market. This approach is consistent with Venturini's (2022) call for further investigation into the transmission mechanisms of climate-related hazards across markets. In addition, while previous studies such as Kruttli et al. (2023) have focused on extreme weather events, our research aims to investigate the effects of monthly weather fluctuations in financial

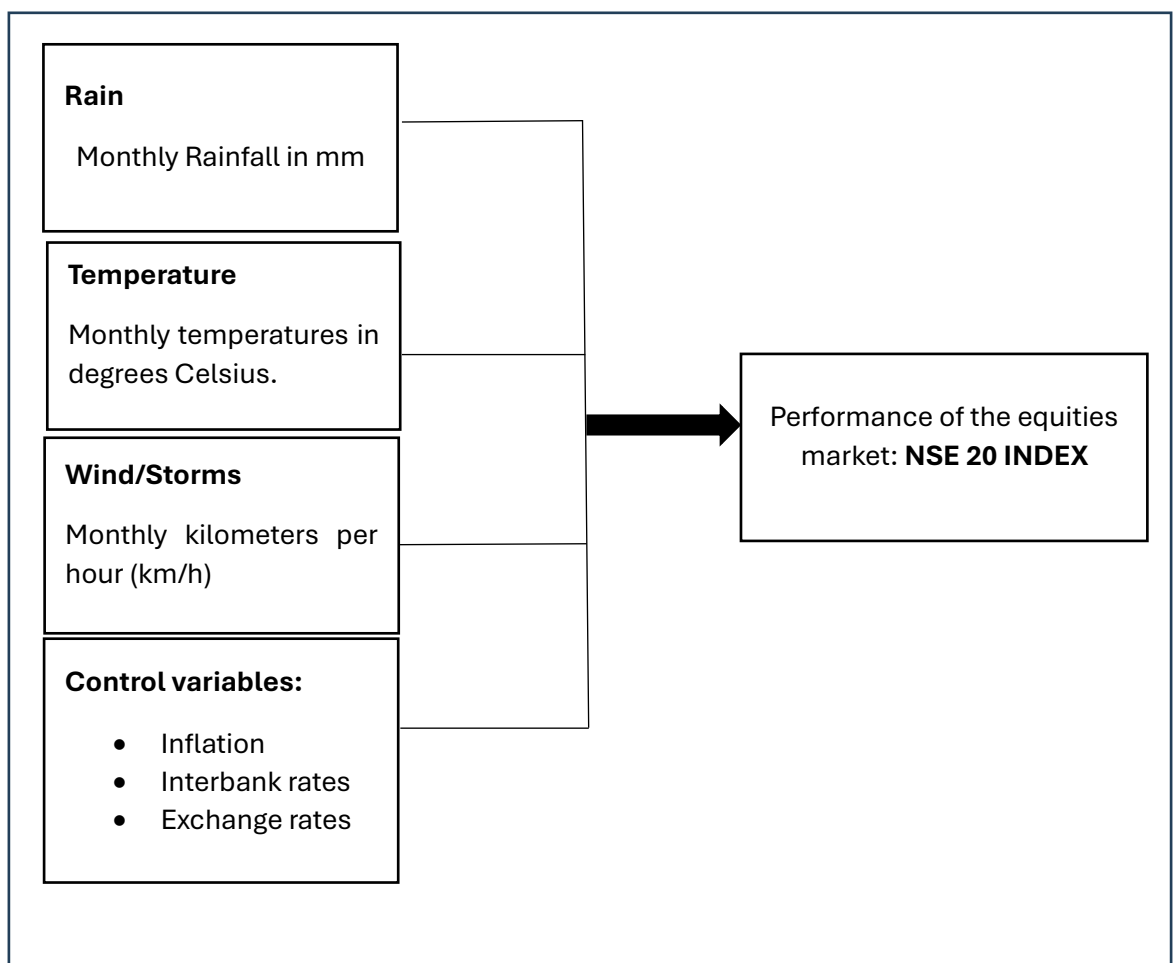
centers on a remote market. This analysis has the potential to uncover previously unexplored connections within the context of the Kenyan equities market.

2.5 Conceptual Framework

The conceptual framework for this study examines the relationship between weather conditions in global financial hubs and the performance of the Kenyan equities market.

This is as shown in

Figure 2. 1: Conceptual Framework



The independent variables consist of weather conditions in major financial locations, which are assessed using three primary indicators: monthly rainfall measured in millimeters, monthly temperatures measured in degrees Celsius, and monthly wind speeds recorded in kilometers per hour. The weather elements are believed to have an impact on the performance of the Kenyan equities market, which is represented by the NSE 20 Share Index. This concept suggests that fluctuations in precipitation, temperature, and wind/storm patterns in these major financial centers worldwide might

impact investor attitude, decision-making processes, and therefore, the performance of the Kenyan stock market. The study seeks to examine the existence of a substantial correlation between weather conditions in remote financial hubs and the fluctuations of the NSE 20 Share Index. The control variables, which could also have an effect on the performance of the NSE 20 Share Index will include Inflation, Interbank Rates and Exchange Rates.



CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Chapter Three describes the approach used in this study to examine how weather conditions in major financial centers across the world affects the performance of the Kenyan stock market. The chapter commences with an overview of the research methodology then followed by an elaborate exposition of the selected research design aimed at fulfilling the study's objectives. Next, it examines the demographic and sampling techniques employed to get the data for analysis. The data collecting section delineates the origins of weather and stock market data, as well as the temporal extent encompassed in the study. The chapter finishes by providing an overview of the data analytic methodologies used to investigate the correlation between weather factors in global financial hubs and the performance of the NSE 20 Share Index.

3.2 Research Design

This study utilizes a causal research methodology to examine the influence of weather conditions in key global financial centers on the performance of the Kenyan stocks market. A causal approach is suitable as it seeks to prove a cause-effect link between meteorological factors and stock market performance, surpassing mere correlation (Sekaran & Bougie, 2016). The rationale for this method is supported by the study's foundation in the Weather Effect Hypothesis, which suggests a cause-and-effect relationship between weather conditions and market performance (Hirshleifer & Shumway, 2003).

3.3 Population and Sampling

The study's population consists of the daily performance of the Kenyan stock market from January 1, 2015, to December 31, 2023, as well as the weather variables in the major financial hubs that is United States and United Kingdom together with the control variables, all recorded between the same period. The research used sample monthly data, which focusses on the London Stock Exchange (LSE) and the New York Stock Exchange (NYSE) over an eight-year period from January 1, 2015, to December 31, 2023. This sample comprises the NSE 20 Share Index closing values for the same period as well as monthly measures of temperature, wind speed and rainfall for New York and London. The choice of the NYSE and LSE is consistent with the technique

of Apergis and Gupta (2017), who investigated the impact of the weather in New York on a distant market.

3.4 Data Collection

The research utilized secondary data sources to collect time series data on weather patterns, stock market returns, and pertinent economic indicators. Reputable meteorological databases, such as the National Oceanic and Atmospheric Administration (NOAA) for the United States and the Met Office for the United Kingdom, will be used to collect monthly meteorological data for New York and London. This data included measurements of rainfall, temperature, and wind speed. The NSE 20 Share Index statistics and economic indicators were obtained from the official records of the Nairobi Securities Exchange and the Central Bank of Kenya. The data collection will occur over a period of 8 years, commencing in January 2015 and concluding in December 2023. There will be a total of 108 monthly observations for each variable.

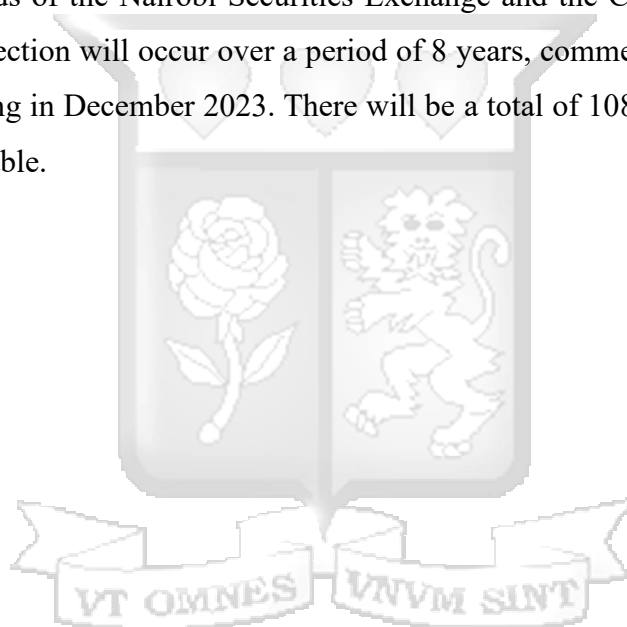


Table 3. 1 : Variables, Definitions and Sources.

Variable	Definition (and Measure)	Source
Rainfall	Monthly total precipitation in New York and London (measured in millimeters)	NOAA (for New York), Met Office (for London)
Temperature	Monthly average temperature in New York and London (measured in degrees Celsius)	NOAA (for New York), Met Office (for London)
Wind Speed	Monthly average wind speed in New York and London (measured in kilometers per hour)	NOAA (for New York), Met Office (for London)
NSE 20 Share Index	Monthly closing value of the NSE 20 Share Index, representing the performance of the 20 blue-chip companies listed on the Nairobi Securities Exchange	Nairobi Securities Exchange
Inflation	Monthly inflation rate in Kenya (measured as percentage change in Consumer Price Index)	Central Bank of Kenya
Interbank Rates	Monthly average interbank lending rate in Kenya (measured as a percentage)	Central Bank of Kenya
Exchange Rates	Monthly average KES/USD exchange rate	Central Bank of Kenya

3.5 Data Analysis

3.5.1 Econometric model

$$\text{NSE 20 Index}_t = \beta_0 + \beta_1 \text{Rainfall}_t + \beta_2 \text{Temperature}_t + \beta_3 \text{Wind}_t + \beta_4 \text{Inflation}_t + \beta_5 \text{Interbank Rates}_t + \beta_6 \text{Exchange Rates}_t + \epsilon_t$$

3.5.2 Descriptive statistics

In this project, descriptive statistics was used in summarizing and describing the main elements of weather data obtained from worldwide financial hubs and how this relates to the Kenyan equities markets. Such measures for mean, median, standard deviation

and range was included so that an overview with regard to central tendency, dispersion and distribution can be clear, which becomes very important in understanding the underlying patterns and characteristics of variables before further analysis is done.

3.5.3 Unit root tests

Unit root tests in a time series analysis enables one to check the stationarity of a dataset. In other words, it is the unchanged ness of its statistical features, mean, and variance over time. Non-stationary data may yield spurious results in regression analysis. Stationarity of the variables used in this study were checked through the augmented Dickey-Fuller test. First, stationarity must be verified before proceeding to applying Autoregressive Distributed Lag model.

3.5.4 Autoregressive Distributed Lag (ARDL)

In this study, the ARDL model was used to examine the short-term and long-term relationship between the NSE 20 Share Index and its independent factors. This model is especially helpful in that it can be used whether the variables are purely stationary at level $I(0)$ or stationary at first difference $I(1)$ if found to be non-stationary. Using the ARDL model which is very flexible, this study elaborated on both the short-term and long-term meteorological and economic factors on the equity market of Kenya.

3.5.5 Bounds test for cointegration.

This study applied a bounds test for cointegration to establish the long-term relationship of the NSE 20 Share Index with other variables, including weather and economic data. This test, used in the ARDL framework is important in establishing whether a set of stationary and non-stationary variables moves together over time, that is, they have some common long-term equilibrium relationship despite short-term fluctuations.

3.5.6 Diagnostic tests

Diagnostic tests will be conducted to check the robustness and reliability of the models used in this research. They shall include tests for serial correlation, heteroskedasticity and multicollinearity. Ensuring these assumptions will go a long way in ensuring the validity of the inferences drawn from these econometric models and hence the credibility of the research results.

CHAPTER 4

RESULTS AND DATA ANALYSIS.

4.1 Introduction

This chapter will be presenting an analysis of the data collected to explore the relationship between weather conditions in Global financial hubs and the performance of the NSE 20 share index. Firstly, the analysis started with looking at the descriptive statistics of the data to give an overview of key characteristics of each variable that is the mean, variance and median. Secondly, there was the unit root test using the Augmented Dickey Fuller test, which is performed to test for stationarity of the variables. This is important because it helps in choosing an appropriate econometric model. Also, a correlation matrix test was done for all variables to identify potential relationships between the weather variables, the NSE share index and the control variables. This illustrates how the variables move together and whether there is multicollinearity of the variables.

Guided by the results of the stationarity test the analysis will use an Autoregressive Distributed Lag (ARDL) model to explore the short term and long-term relationship between the weather variables, control variables and NSE 20 share index. The control variables that include inflation, exchange rates and interbank rates are included to account for broader economic influences. Then lastly a diagnostic test will be applied to test the robustness and reliability of the model. The programming language used to do the data analysis was R.

4.2 Descriptive statistics.

Table 4. 1: Descriptive statistics

Variable	Min	Max	Std Dev	Median	Mean	Obvs
NSE 20 Index	1461.0000	5476.0000	1029.4100	2649.0000	2759.0000	108
Wind UK (mph)	5.8000	16.4000	2.2200	9.8500	11.5000	108
Rainfall UK (mm)	0.8000	165.8000	29.4700	48.8500	51.4900	108
Temp UK (°C)	8.6000	30.1000	5.3300	16.4000	17.2100	108
Wind US (mph)	22.0000	49.0000	5.5300	35.0000	35.0500	108
Rainfall US (mm)	0.0000	218.1900	49.0600	85.9700	92.1300	108
Temp US (°C)	-6.7200	25.9400	8.7900	12.6100	12.3900	108
Interbank rates %	2.1200	19.8500	3.1600	5.0500	6.0700	108
Inflation %	3.6700	11.7000	1.4900	5.9400	6.0800	108
USD/KES	91.3600	154.0900	12.9200	103.5300	108.9200	108
GBP/KES	125.5000	195.0000	141.4800	141.5000	143.8000	108

For descriptive statistics, above is the summary of all the variables individually, showing the minimum values, the maximum values, the standard deviation values, the mean values and the median values. The NSE 20 index did show significant variability, ranging from 1461 to 5476 over the observed period, indicating substantial fluctuations in the performance of the Kenyan stock market. The variations indeed do indicate that there are external forces that are influencing the index.

Significant variations were also seen in the weather factors in New York, USA and London, UK. London, UK had significant wind, rainfall and temperature patterns, with wind speeds ranging from 5.80mph to 16.40 mph, rainfall ranging from 0.80 mm to

165.80 mm and for the temperature it ranged from 8.60°C to 30.10 °C. Similarly, there was more noticeable variation in New York, US weather data, especially in temperature ranging from -6.72°C to 25.94°C and rainfall ranging from 0.00 mm to 218.19 mm.

The economic indicators that is the control variables also had significant fluctuations, with interbank rates ranging from 2.12% in the year 2020 to 19.85% in 2015. Looking at the inflation rates in Kenya over the years the range was 3.67% in the year 2015 and it peaked at 11.70% in the year 2019, the overall mean was at 6.08%. For the USD/KES exchange rates the range was between Ksh 91.36 for a dollar in the year 2015 and it peaked at Ksh 154.09 for a dollar in the year 2023 with an overall mean of ksh108.92. For the GBP/KES exchange rates the range was between Ksh 125.47 a pound in the year 2016 peaking at Ksh 195.00 a pound in the year 2023 with an overall mean of Ksh 143.80.

4.3 Stationarity Tests

Table 4. 2: The ADF Results.

Variable	ADF Statistic	P-value	Stationary
NSE 20 Index	-2.8011	0.2443	No
Wind UK	-6.1614	< 0.01 0.00000	Yes
Rainfall UK	-5.4647	< 0.01	Yes
Temp UK	-9.7726	< 0.01	Yes
Wind US	-4.8796	< 0.01	Yes
Rainfall US	-3.540	0.0419	Yes
Temp US	-11.3890	< 0.01	Yes
Interbank rates	-2.8881	0.2083	No
Inflation	-3.9522	0.0141	Yes
USD/KES	1.4914	> 0.99	No
GBP/KES	-1.1493	0.9111	No

NOTE: A p-value of less than 0.05 implies stationarity at the 5% level of significance.

For time series analysis to guarantee consistent statistical qualities over time, **stationarity** is essential. For every variable, the **Augmented Dickey-Fuller (ADF) test** was used.

H_0 : The series is non-stationary and has a unit root.

H_1 : The series is stationary and does not have a unit root.

The results of the ADF test show that while wind in the UK, rainfall in the UK, temperature in the UK, rainfall in the US, wind in the US, temperature in the US and inflation rates in Kenya are stationary, while the NSE 20 Index, the interbank rates in Kenya, USD/KES and GBP/KES are not stationary. To confirm stationarity in the variables, compare the ADF statistic to the critical values. Where when the p – value < 0.05 , reject the H_0 and that the series is stationary and when the p – value is ≥ 0.05 , fail to reject H_0 and that the series is non- stationary.

Differencing the non-stationary variables: differenced NSE 20 index, differenced Interbank rates, differenced USD/KES and differenced GBP/KES produced stationary transformed variables to solve this. The differencing was done only once for each variable. Below are the results:

Table 4. 3 : Differencing Non-stationary Variables.

Differenced Variable	ADF statistic	P-value	Stationary
Diff NSE 20 index	-3.9330	0.0151	Yes
Diff Interbank rates	-5.0527	< 0.01	Yes
Diff USD/KES	-3.5778	0.0385	Yes
Diff GBP/KES	-3.9376	0.0149	Yes

NOTE: A p-value of less than 0.05 implies stationarity at the 5% level of significance.

4.4 Correlation Matrix

In this section, the focus is on the correlation between NSE 20 Index and the rest of the variable as shown below:

Table 4. 4: Correlation matrix between NSE 20 INDEX and the Variables

<u>Variables</u>	<u>NSE 20 INDEX</u>	<u>Relationship.</u>
NSE 20 INDEX	1.0000	+
Wind UK	0.0200	+
Rainfall UK	-0.0319	-
Temperature UK	-0.0819	-
Wind US	-0.0154	-
Rainfall US	-0.0265	-
Temperature US	-0.0920	-
Interbank rates	0.2343	+
Inflation	0.1814	+
USD/KES	-0.6926	-
GBP/KES	-0.3165	+

A correlation matrix was generated to understand the relationship between the different variables. There are significant variations in the strength and direction of the connections between the variables and the NSE 20 Index. UK temperature (-0.0819) and rainfall (-0.0319) have modestly negative correlations, indicating little influence, whereas wind speed (0.0200) shows a very minor positive link. The weather in both locations has a small effect on the index, as evidenced by the minor negative correlations shown by US weather variables such as temperature (-0.0920), rainfall (-0.0265) and wind speed (-0.0154). Economic indicators, on the other hand, exhibit larger associations: inflation (0.1814) and interbank rates (0.2343) exhibit moderately positive correlations, indicating that increases in the NSE 20 Index are linked to higher interbank rates and inflation. The strongest influence is seen in the exchange rates, with USD/KES (-0.6926) showing a strong negative correlation and GBP/KES (-0.3165) showing a moderately negative correlation. This suggests that declines in the NSE 20 Index are linked to currency appreciation against the US dollar and British pound. These results indicate that economic factors—in particular, exchange rates are

more important in explaining changes in the NSE 20 Index than meteorological factors.

4.5 ARDL Model

The association between the NSE 20 Index and its predictor variables were evaluated using an **Autoregressive Distributed Lag (ARDL)** model. The ARDL model is well-suited to time series data with mixed levels of stationarity (both $I(0)$ and $I(1)$), making it a versatile tool for investigating both short-term and long-term processes. The dependent variable in this model was the NSE 20 Index (NSE_20_index), with the independent variables being weather indicators from the UK and US (such as wind speed, rainfall, and temperature) and economic indicators (interbank rates, inflation, and exchange rates).

4.5.1 ARDL Model Specifications

The ARDL model was set up with a lag structure of (1, 1, 1, 1, 1, 1, 1, 1, 1, 1), which means that each variable received one lag. This lag setting was used because of because of sample size constraints and to provide simplicity and interpretability of the results. Using one lag enables the model to capture the effect of both the current and previous periods on the NSE 20 Index, giving a more complete picture of how these variables affect the index over time. The standard errors are robust and the Newey West method of getting robust standard errors was used this was done to cater for serial correlation and heteroskedasticity.

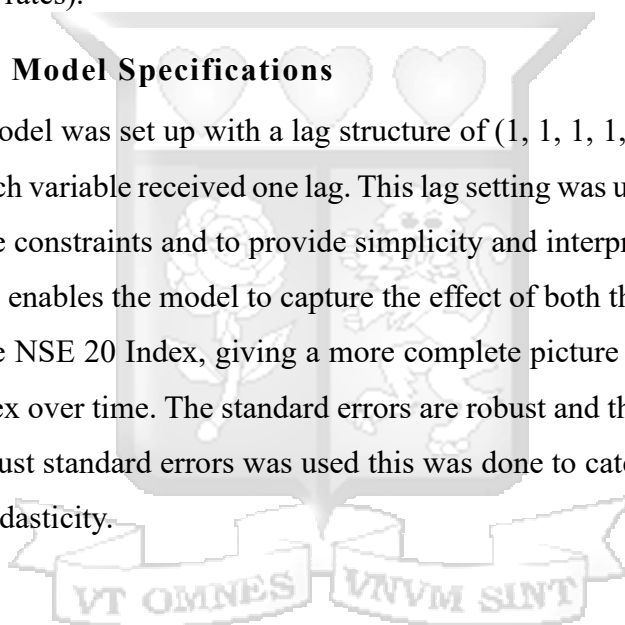


Table 4. 5 : ARDL Model variables and their lags, coefficients, standard errors, T-Value, Probability of t.

Variables	Coefficients	Standard Errors	T-Value	Pr(> t)
Intercept	121.6905	361.4025	0.3367	0.7372
L (NSE 20 index, 1)	0.9740	0.0207	46.9752	0.0000***
Wind UK	-9.9217	7.4424	-1.3331	0.1861
L(Wind UK, 1)	-5.3945	5.3924	-1.0004	0.3200
Rainfall UK	-0.2175	0.4697	-0.4632	0.6444
L(Rainfall UK, 1)	0.0866	0.4260	0.2033	0.8394
Temperature UK	8.0034	5.9186	1.3522	0.1799
L(Temp Uk, 1)	-0.2497	5.6881	-0.0439	0.9651
Wind US	0.0657	3.0266	0.0217	0.9827
L(Wind US, 1)	-2.3382	2.8680	-0.8152	0.4172
Rainfall US	0.0706	0.2125	0.3321	0.7406
L(Rainfall US, 1)	-0.1446	0.2226	-0.6493	0.5179
Temperature US	-7.5239	3.5922	-2.0945	0.0392*
L(Temp US, 1)	0.5437	4.4202	0.1230	0.9024
Interbank rates	3.9605	11.5233	0.3437	0.7319
L(Interbank Rates, 1)	-6.1011	9.8278	-0.6208	0.5364
Inflation	-7.5953	13.7891	-0.5508	0.5832
L(Inflation, 1)	14.2954	12.1303	1.1785	0.2419
USD/KES	-42.1289	17.3600	-2.4268	0.0173*
L(USD/KES, 1)	43.3339	18.5521	2.3358	0.0219*
GBP/KES	12.0493	3.6697	3.2835	0.0015**
L(GBP/KES, 1)	-12.2192	3.6861	-3.3149	0.0013**

*** Statistical significance at 1% level (p value < 0.01); ** Statistical significance at 5% level (p value < 0.05); * Statistical significance at 10% level (p value < 0.1).

4.5.2 Interpretation of ARDL

The intercept has a coefficient of 121.6905 with a very high p-value of 0.7372, this shows that it is not statistically significant, indicating that the constant term does not significantly contribute to predicting the NSE 20 Index. The lagged value of the NSE 20 index has a coefficient value of 0.9740 and it is highly statistically significant ($p < 0.01$). This strong significance and with a coefficient close to 1 it suggests that the index exhibits substantially significant persistence over time and that its past values strongly influence its current performance.

For the weather variables in London, United Kingdom, the UK wind speed at level the coefficient is -9.9217 with a p - value of 0.1860 and the lagged value coefficient is -5.3945 with a p - value of 0.3200. This result indicates that there is no statistically significant relationship between the wind speed in the UK and the NSE 20 Index even with a lag. The rainfall in the UK at level the coefficient is -0.2175 with a p - value of 0.6444 and the lagged value coefficient is 0.0866 with a p - value of 0.8394. This result indicates that there is no statistically significant relationship between the rainfall in the UK and the NSE 20 Index even with a lag. The temperature in the UK at level the coefficient is 8.0034 with a p - value of 0.1799 and the lagged value coefficient is -0.2497 with a p - value of 0.9651. This result indicates that there is no statistically significant relationship between the temperature in the UK and the NSE 20 Index even with a lag.

For the weather variable in New York, United States, the US wind speed at level the coefficient is 0.0657 with a p - value of 0.9872 and the lagged value coefficient is -2.3382 with a p - value of 0.4172. This result indicates that there is no statistically significant relationship between the wind speed in the US and the NSE 20 Index even with a lag. The rainfall in the US at level the coefficient is 0.0706 with a p - value of 0.7406 and the lagged value coefficient is -0.1446 with a p - value of 0.5179. This result indicates that there is no statistically significant relationship between the rainfall in the US and the NSE 20 Index even with a lag. The temperature in the US at level the coefficient is -7.5239 with a p - value of 0.0392* and the lagged value coefficient is 0.5437 with a p - value of 0.902. This result indicates that there is a statistically significant relationship between the temperature in the US and the NSE 20 Index at level but there is no statistical significance with a lag.

For the economic indicators variables, the coefficient for interbank rates at level is 3.9605, with a p-value of 0.7319, indicating that it is not statistically significant. Similarly, the lagged value of interbank rates has a coefficient of -6.1011 and a p – value of 0.7319, which is not significant. This shows that interbank rates, whether current or lagged, have no meaningful statistical significance on the NSE 20 Index under this paradigm.

The inflation coefficient is -7.5953, with a p-value of 0.5832, whereas the lagged coefficient is 14.2954, with a p-value of 0.2419. These p-values imply that inflation has no statistically significant effect on the NSE 20 Index at level or with lag. As a result, fluctuations in inflation rates do not appear to play a significant influence on the NSE 20 index using this methodology.

The USD/KES exchange rate has an influence on the NSE 20 Index. The current period coefficient is -42.1289, with a p-value of 0.0173*, indicating significance at the 10% level. The coefficient of -42.1289 indicates a negative association between the USD/KES exchange rate and the NSE 20 Index, implying that an increase in the exchange rate (showing a weakening of the Kenyan Shilling) may marginally lower the NSE 20 Index. The lagged value of USD/KES has a coefficient of 43.3339 and a p-value of 0.0774, which is similarly statistically significant at 10%. This lagged coefficient is positive, indicating that previous rises in the USD/KES exchange rate may have had a delayed positive impact on the index.

The GBP/KES exchange rate is the most important economic variable in this model. The current period coefficient is 12.0493, with a p-value of 0.0015, indicating significance at the 5% level. This demonstrates that an increase in the GBP/KES exchange rate (showing a weakening of the Kenyan Shilling relative to the British Pound) has a positive impact on the NSE 20 Index. However, the lagged value of GBP/KES has a coefficient of -12.2192 and a p-value of 0.0013, making it significant at the 5% level. These results indicate that past increases by lag of 1 in the exchange rate negatively impact the NSE 20 index.

4.6 Cointegration test.

Cointegration test is done to check for existence of a long run relationship between the dependent and independent variables. In this research bounds test for cointegration was used. The interpretation of the results for the ARDL is as follows an F-statistic of

0.9281 with a p-value of 0.9875 which was below the lower bound of the critical values (interpret p value against the 5%) which leads us to fail to reject the null hypothesis of no cointegration. This clearly indicates that there is no evidence of a long run relationship between the NSE 20 index and the independent variables.

H_0 : No cointegration.

H_1 : Cointegration exists.

4.7 Diagnostic Tests.

4.7.1 Serial Correlation

The Breusch-Godfrey test was conducted to detect the presence of serial correlation in the model's residuals, with the null hypothesis of no serial correlation.

Breusch-Godfrey test for serial correlation of order up to 1

LM test = 77.662, df = 1, p-value < $2.2e^{-16}$

The results show a large LM test statistic of 77.662 with 1 degree of freedom and an extremely small p-value (< $2.2e^{-16}$), providing strong evidence to reject the null hypothesis. This indicates significant first-order serial correlation in the model, suggesting that the error terms are not independent across observations.

The Newey-West test was applied to the ARDL model to correct for the detected serial correlation by generating robust standard errors. This adjustment ensures more reliable statistical inference when using the ARDL model.

Breusch-Godfrey test for serial correlation of order up to 1

LM test = 1.4116, df = 1, p-value = 0.2348

From the above results achieved after using robust standard errors when using the Breusch – Godfrey test they yielded an LM test statistic of 1.4116 with 1 degree of freedom and a p – value of 0.2348. The interpretation is that since the p – value is greater than the the conventional significance level of 0.05, therefore it shows that we fail to reject the null hypothesis which states that there is no serial correlation in the residuals of the model.

4.7.2 Heteroskedasticity

The heteroskedasticity test was conducted using the Breusch-Pagan test to examine whether the variance of the model's residuals remained constant across observations.

Breusch-Pagan test:

BP = 48.284, df = 21, p-value = 0.000629

The results revealed significant heteroskedasticity in the model, with a Breusch-Pagan test statistic of 48.284 with degrees of freedom at 21 and a p-value of 0.000629, which is well below the 0.05 significance level. This clear rejection of the null hypothesis of homoskedasticity indicated that the model's error terms had non-constant variance, necessitating the use of robust standard errors in subsequent analyses to ensure valid statistical inference.

To introduce robust standard errors the Newey west method was applied to the ARDL model. Using Breusch Pagan test the results are as follows:

Breusch-Pagan Test:

BP = 10.5640, df = 21, p-value = 0.4560

The test revealed significant homoskedasticity, with a Breusch-Pagan test statistic of 10.5640 with degrees of freedom at 21 and a p – value of 0.4560, which is well above the 0.05 significance level. This clearly indicates that we must not fail to reject the null hypothesis of presence of homoskedasticity, that the variances of the model's standard errors have a constant variance.

4.7.3 Multicollinearity

The multicollinearity test was conducted using Variance Inflation Factors (VIF) to assess whether there were problematic correlations among the independent variables that could affect the model's reliability.

Table 4. 6 : Multicollinearity Outputs

Variable	VIF Value
Wind UK	1.2300
Rainfall UK	1.0700
Temperature UK	6.1800
Wind US	1.5600
Rainfall US	1.0700
Temperature US	7.4400
Interbank Interest Rate	2.0000
Inflation	1.0500
USD/KES	3.1500
GBP/KES	4.5800

The results show varying levels of multicollinearity among the variables, with most displaying acceptable VIF values below the common threshold of 10. Temperature variables for both the US (7.44) and UK (6.18) showed the highest VIF values, indicating moderate correlation with other predictors, while GBP/KES (4.58) and USD/KES (3.15) demonstrated modest levels of multicollinearity. The remaining variables, including Wind UK (1.23), Rainfall UK (1.07), Wind US (1.56), Rainfall US (1.07), Interbank Interest Rate (2.00), and Inflation (1.05), exhibited low VIF values, suggesting minimal correlation with other variables. Since all VIF values are below 10, multicollinearity is not a significant concern for this analysis.

CHAPTER 5

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction.

This chapter summarizes the study's findings, linking them to the current body of knowledge and offering a framework for interpretation of the study. This chapter seeks to place the findings within a broader academic and practical context, focusing on their importance and consequences for Kenya's equities market markets. The chapter also discusses the study's shortcomings, how they affect the validity of the findings and prospective areas for future research. As a result, it provides a thorough review of the study's accomplishments and lays the groundwork for future research in weather and market analysis.

5.2 Discussions

The outcomes of this study highlight the relationship between New York, US and London, UK meteorological variables, the Kenyan macroeconomic indices and the performance of the NSE 20 Index. The investigation demonstrated that weather variables in New York and London that is the wind speed, rainfall and temperature, had a limited direct impact on the NSE 20 Index. This finding differs with the Weather Effect Hypothesis (Saunders, 1993; Hirshleifer & Shumway, 2003), which holds that weather conditions have a major impact on investor sentiment and market behavior. While research in industrialized countries has found strong correlations between their local weather and stock performance (Arpegis & Gupta, 2017; Muhlack et al, 2022), this study demonstrates the complexities of these linkages in emerging markets such as Kenya. The findings also correspond with behavioral finance theories (Kahneman & Tversky, 1979; Thaler, 1985), implying that, while weather may not have a direct impact on market performance in Kenya, it may shape the behavior of investors in interconnected worldwide markets, indirectly influencing the NSE 20 Index.

The study also highlighted the importance of local macroeconomic data (control variables), including exchange rates, inflation and interbank rates, in determining the NSE 20 Index. Exchange rate fluctuations, particularly those involving USD/KES and GBP/KES, have emerged as strong predictors of market performance. This is consistent with prior research literature emphasizing the importance of currency stability in driving emerging market economies (Venturini, 2022). Exchange rates

reflect fundamental economic factors including inflation, trade balances and capital flows, which all have a direct impact on investor confidence in financial markets (Adediran et al, 2024). The study also found that, while interbank rates and inflation were less significant, their impact highlighted the interconnection of monetary policy and stock market dynamics. High inflation frequently reduces investor returns, while fluctuations in interbank rates can signify shifts in liquidity and borrowing costs, both of which influence trading volumes and stock prices in any market. The research also showed that there was a significant influence of past NSE 20 Index on the present NSE 20 Index and that this impact should not be ignored when policies for the Kenyan equities are being made.

The absence of cointegration between the NSE 20 Index and the analyzed variables indicates that these relationships are primarily short-term. This finding is consistent with the Efficient Market Hypothesis (EMH) (Fama, 1970), which holds that markets rapidly integrate existing information, leaving limited room for long-term predictive relationships. However, the absence of cointegration shows the Kenyan market's volatile nature, with short-term changes outweighing solid long-term tendencies. This emphasizes the importance of investors implementing agile strategies that consider changing global and local situations rather than relying on static prediction models.

5.3 Conclusions

This analysis suggests that global weather variables have little influence on the NSE 20 Index, and there is little evidence of significant long-term linkages. While weather conditions in global centers such as London and New York are known to influence local market sentiment, their direct impact on the Kenyan stock market appears to be limited. However, the possibility of indirect consequences from global economic disruptions needs more investigation. The findings also emphasize the relevance of macroeconomic data, notably currency rates, in determining stock market success. The strong influence of USD/KES and GBP/KES demonstrates Kenya's economic reliance on global markets and the importance of stable currency policy in fostering market resilience.

5.4 Recommendations

To address the findings and their implications, some recommendations are made.

The low direct influence of weather variables on the NSE 20 Index, along with the possibility of indirect effects via global financial links, underscores the necessity for Kenyan financial policymakers to include climate risk assessments in their regulatory frameworks. This would allow for the forecast and mitigation of any disruptions caused by global weather patterns. For example, early warning systems and regulations targeted at maintaining market stability amid global weather-related crises could lower volatility in the NSE 20 Index. This proposal is consistent with the findings of Apergis and Gupta (2017), who observed the influence of weather in global hubs on distant markets such as South Africa.

The study also discovered that exchange rate variations, notably USD/KES and GBP/KES, were significant predictors of NSE 20 Index performance. Investors should incorporate these macroeconomic risks into their analytical models, particularly when investing in export-oriented or weather-sensitive industries such as agriculture and tourism. According to Kathiravan et al. (2021), global weather patterns and economic shocks have a significant impact on these businesses. By incorporating global risks into their plans, investors can better manage uncertainty and protect their portfolios.

Given the importance of exchange rate changes to the NSE 20 Index, policymakers should prioritize exchange rate stability to improve market performance. Strategies such as keeping sufficient foreign exchange reserves, encouraging foreign direct investment, and limiting speculative currency movements could help to reduce the volatility associated with currency swings. This advice is based on a prior study by Venturini (2022), which underlined the importance of currency stability in boosting market confidence and encouraging emerging market growth.

Finally, the lack of cointegration and the dominance of short-term dynamics in the NSE 20 Index indicate a need for more granular and high-frequency market data. Policymakers and academics should prioritize increasing the availability of daily or even hourly data in order to capture short-term responses to global and local shocks. According to Muhlack et al. (2022), more granular data can provide greater insights into market behavior, allowing more informed decision-making and better forecasting of market moves.

5.5 Limitations of the Study

The study has significant limitations, which should be noted when interpreting the findings. The findings' applicability to other regions is limited because they are based on weather data from only two global financial hubs, the United Kingdom and the United States. This restricted focus was informed by the enormous importance these markets play in global finance, as well as their established ties to the Kenyan economy. Including more worldwide markets, such as those in Asia or the Middle East, may provide a more complete picture of international influences on Kenya's stock market, given the importance of Asian and Middle Eastern Markets in global trade and investments today.

Finally, the study's emphasis on quantitative variables that ignores important behavioral and psychological aspects, such as investor sentiment, which may influence market performance. The removal of these characteristics was motivated by the difficulty of consistently quantifying sentiment, as well as the emphasis on observable weather conditions and macroeconomic indicators. However, incorporating behavioral and psychological aspects into future studies may provide deeper insights into how investor emotions and biases interact with environmental shocks such as weather, providing a more comprehensive perspective of market behavior.

Future studies may resolve these limitations by incorporating broader datasets and exploring qualitative aspects of market behavior. This enables a richer understanding of the factors driving emerging markets like Kenya

5.6 Future Research Directions.

Future research could explore the impact of weather conditions in other major financial centers, particularly those in Asia and the Middle East, to provide a more comprehensive understanding of global weather effects on the Kenyan equities market.

Additionally, incorporating higher-frequency data (daily or hourly) and examining specific sector-wise impacts could offer more granular insights into the relationship between global weather patterns and local market performance.

Also, future research could look into how behavioral and psychological factors, such as investor sentiment and mood, influence the relationship between meteorological conditions and market performance. Combining sentiment research from social media,

polls, and news data with weather and market data would provide a more complete picture of these dynamics in Kenya's equities market.



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