Project Report

On

Impact of Macroeconomic and Climate Change Factors
on Stock Market Activity: Evidence from BRICS Countries

Submitted To:

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Letter of Transmittal

December 28, 2024

Muhammad Enamul Haque
Assistant Professor
United International University
Dhaka, Bangladesh

Subject: Submission of Project Report on "Impact of Macroeconomic and Climate Change Factors on Stock Market Activity: Evidence from BRICS Countries"

Dear Sir,

With due respect, I am glad to submit my project report, titled "Impact of Macroeconomic and Climate Change Factors on Stock Market Activity: Evidence from BRICS Countries", as part of my undergraduate requirements for the Bachelor of Business Administration (BBA) program at United International University (UIU).

This report shows my research and analytical efforts to explore the relationships between macroeconomic factors, climate change variables and stock market indices. I have tried to address the objectives of the project comprehensively; by applying the knowledge I gained throughout my program curriculum. I really appreciate your invaluable guidance, motivation and support throughout the journey.

I hope that the report meets your expectations and all academic requirements as well. I am open to any further clarification or the need for modification if needed.

Thank you for your kind attention and continuous support.

Sincerely,
Md. Rahat -Ul- Ashekin
I No: 111 192 108
Program: BBA
United International University

Acknowledgment

I would love to express my genuine gratitude toward my supervisor, Muhammad Enamul Haque, for his invaluable guidance, cordial support and insightful suggestions throughout the course of this project. His expert advice and constructive feedback were vital in shaping the direction of this project, which ensured its successful completion within the recommended time. His dedication to me to achieve academic excellence has been a source of inspiration.

I show deep appreciation toward my institution, United International University, for providing a robust platform to carry out this study and for creating an environment that encourages research and intellectual growth. The resources and facilities offered by the institution played a huge role in enabling me to undertake this project effectively.

I also acknowledge the significant role of reliable data sources from the World Bank Open Data, Our World in Data and Yahoo Finance in providing comprehensive and accurate information, which is necessary for conducting this research. These platforms have been indispensable for analyzing macroeconomic and climate change variables and drawing meaningful insights which underpin the conclusions of this study.

Moreover, I extend my appreciation toward my faculty members and peers at United International University, who offered their assistance and shared their expertise whenever needed. Their discussions and shared knowledge greatly enriched my understanding of the subject matter.

Finally, I express my deepest appreciation towards my friends and family members, whose unwavering belief in my abilities provided me with the moral support and encouragement needed to persevere during my challenging times. Their indirect yet profound contributions have been a cornerstone of this endeavor, and this work would not have been possible without their inspiration and unwavering faith in my potential.

This acknowledgment is a testament to the collective effort and support which has culminated in the successful completion of this research project. This acknowledgment is a sincere reflection of the support, effort, and dedication that have been the pathway to successful completion of this research project. The expertise, encouragement, and

guidance provided by all those involved have not only added significant value to this work but have also been crucial in its realization. I am truly grateful to everyone whose contributions have left a lasting impact on this study, and I deeply appreciate their invaluable assistance.

Executive Summary

This study dives into the intricate dynamics between macroeconomic variables, climate change indicators, and stock market returns within emerging economies which focuses on BRICS nations alongside the newly inducted members: Saudi Arabia, UAE, Iran, and Egypt. Utilizing a robust dataset spanning from 1999 to 2022, the research employs advanced econometric techniques, specifically the Generalized Method of Moments (GMM), to analyze both short-term (2016–2022) and long-term (1999–2022) trends. This dual approach provides a comprehensive understanding of how economic and environmental variables influence financial markets over time.

The results underscore a complex interplay of factors. Inflation exhibits mixed effects, reflecting its multifaceted role in shaping investor sentiment and market performance. While inflationary pressures often erode purchasing power and profitability, they can also signal economic growth which leads to divergent outcomes across different models. The exchange rate emerges as a pivotal factor in short-term analyses, exerting a significant influence due to its immediate impact on foreign investment flows and trade balances. However, its role diminishes in the long-term perspective, likely due to the market's adaptation to exchange rate volatility over time.

Climate change variables, particularly greenhouse gas emissions and renewable energy adoption, demonstrate pronounced effects in the long-run panel analysis. The findings suggest that while environmental factors may not exert immediate influence, their cumulative impact becomes increasingly evident as economies transition toward sustainability. For instance, a higher reliance on renewable energy indicates progressive environmental policies, aligning with global sustainability goals and fostering investor confidence in green industries. Conversely, elevated greenhouse gas emissions signal environmental risks that may deter long-term investments.

The implications of this research are not only practical but also far-reaching for policymakers. The study offers actionable insights into crafting strategies that balance economic growth with environmental sustainability. Stabilizing macroeconomic fundamentals, such as inflation and exchange rates, meanwhile promoting renewable energy adoption, can create resilient financial markets for investors. Understanding the nuanced relationships between these variables enables better risk assessment and

portfolio diversification, particularly in emerging markets characterized by volatility and rapid growth.

By bridging significant gaps in the literature, this research makes a valuable contribution to the understanding of stock market dynamics in emerging economies. The inclusion of climate change variables alongside traditional macroeconomic indicators adds depth to the analysis, offering a holistic view of the forces shaping financial markets. Moreover, the integration of not only short-term but also long-term perspectives highlights the evolving nature of these relationships, equipping stakeholders with the knowledge to navigate the complexities of a rapidly changing impact on global economic and environmental landscape.

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Chapter 01: Introduction

1.1 Introduction

The origin of this report lies in fulfilling the academic requisites of my undergraduate program in Finance. As part of the final trimester curriculum, we are required to complete a research-based project that demonstrates our ability to apply theoretical concepts in real-world scenarios. This report represents my efforts to meet that requirement, guided by the invaluable advice of my faculty. We have chosen the topic, "Impact of Macroeconomic and Climate Change Factors on Stock Market Activity: Evidence from BRICS Countries" because of its significant relevance in analyzing economic behaviors and financial market fluctuations, particularly within emerging economies.

The chosen topic fits with ongoing global efforts to understand the interplay between financial stability and sustainability. In between growing environmental concerns and volatile economic landscapes, this research seeks to shed light on how macroeconomic variables and climate change factors collectively influence stock market performance. Beyond fulfilling academic objectives, this study was aimed to contribute meaningfully to discussions relating sustainable development and economic resilience in a rapidly changing global economy.

1.2 Objective of the Report

The primary objective of this report is to examine the relationships between selected macroeconomic and climate change variables, specifically:

- Investigate how GDP, inflation rate, exchange rate, greenhouse gas emissions, and renewable energy usage individually and collectively influence stock market indices in emerging economies.
- Provide valuable insights into the linkage between environmental sustainability and financial market dynamics.
- Identify observable patterns and trends that can serve as a resource for investors, policymakers and academics, aiming for informed decision-making and encouraging further research.

By bridging the gap between macroeconomic performance, environmental considerations, and stock market trends, this study was aimed to build a comprehensive framework, which will support both theoretical and practical implications in the field of finance and sustainability.

1.3 Methodology of the Report

The methodology of this report involves applying the GMM Model (Generalized Method of Moments): a powerful econometric model, which is selected for its capacity to address endogeneity concerns and effectively analyze dynamic panel data. The study relies entirely on secondary data collected from reliable sources such as the World Bank Open Data, Our World in Data, and Yahoo Finance.

Key variables to analyze include GDP, inflation rate, exchange rate, greenhouse gas emissions, renewable energy usage, and stock market indices. The study focuses on data measured from 1999 to 2022, offering a comprehensive analysis of macroeconomic and environmental trends in both short and long run context. Advanced statistical software has been used to clean, process, and analyze the data, ensuring accuracy and reliability. The research incorporates nine emerging economies—Brazil, Russia, India, China, South Africa, UAE, Saudi Arabia, Iran, and Egypt. They were chosen for their significant economic growth and environmental challenges.

1.4 Scope of the Report

The scope of this report extends across nine emerging economies, including the founding BRICS nations (Brazil, Russia, India, China, and South Africa) and newly joined additional countries such as Egypt, UAE, Saudi Arabia, and Iran. The inclusion of this diverse set of countries enables us to capture a wide range of economic and environmental dynamics.

Spanning a timeline from 1999 to 2022, the study includes a period marked by major global economic shifts and environmental policy advancements. The research investigates the influence of five independent variables on stock market indices, blending macroeconomic variables with climate change indicators. By adopting this multidimensional approach, the report provides valuable insights into the financial and environmental interactions within these economies. However, although the findings

offer valuable perspectives, their application is limited to the countries taken for analysis and may not cause generalization to other economic structures.

1.5 Limitation of the Report

Despite its contributions, the report naturally has some certain limitations. First, the sole reliance on secondary data initiates potential biases inherent in source institutions' collection and reporting methodologies. Second, the analysis focuses solely on nine countries, which limits the attribution of findings to other regional or economic contexts.

Moreover, the study examines a narrow set of variables—three macroeconomic indicators and two climate change factors, which may potentially overlook other influential factors such as technological innovation, political stability, or social dynamics. Constraints in time and resources further limit our ability to apply alternative econometric models or deeper analytical tools that might have enriched the study's conclusions. These limitations highlight the need for ongoing research to build upon the basis built by this study, broadening its scope and refining its methodologies.

Chapter 02: Background of the Study

In the complex interplay of global financial markets, the impact of macroeconomic and climate change variables on stock market returns has captured significant attention from investors, researchers, and policymakers, alike. Stock markets are inherently sensitive to fluctuations in macroeconomic indicators and environmental risks. Understanding these dynamics is crucial for making informed investment decisions, developing sustainable economic policies, and maintaining financial stability within global uncertainties.

The theoretical foundations of the relationship between stock market performance and macroeconomic risk factors are deeply inherent in the Efficient Market Hypothesis (EMH) and the Arbitrage Pricing Theory (APT). EMH asserts that stock prices reflect all relevant and current information, leaving little scope for historical data to predict future prices effectively (Fama, 1965). This principle highlights the importance of real-time data and market efficiency in explaining stock price movements. In practice, however, deviations from perfect efficiency, such as information asymmetry or investor sentiment, can create complexities that challenge that hypothesis.

Similarly, APT emphasizes the role of macroeconomic variables in influencing expected returns on financial assets. According to APT, shifts in variables such as GDP growth, interest rates, inflation, and exchange rates can directly or indirectly change a firm's cash flow expectations and financing strategies, which ultimately affects stock market performance (Ross, 1976; Semmler, 2011; Chinzara, 2011; Fama and French, 2015). Unlike EMH, APT provides a flexible framework to identify multiple risk factors that drive asset prices, thus making it particularly valuable for understanding the multi-dimensional nature of stock market dynamics in both developed and emerging economies.

By integrating these perspectives, modern financial analysis explores how macroeconomic fluctuations and climate-related risks join to shape the market behavior. This dual lens has become increasingly important as financial markets engage with the dual challenges of economic uncertainty and environmental sustainability, making it essential to study these influences comprehensively.

The foundational studies on the relationship between macroeconomic variables and stock market returns provided crucial insights into this dynamic. Research by Officer (1973), Fama and Schwert (1977), and Chen et al. (1986) highlighted the sensitivity of stock markets to factors such as interest rates, inflation and industrial production. Over the decades, strategists have continued to explore these relationships in both developed and emerging economies. In developing economies, the effects of macroeconomic risk factors are particularly prominent, as financial markets in these economies are often more volatile and sensitive to external resistance.

Parallel to the exploration of macroeconomic influences, there has been a growing focus on understanding how climate change influences financial markets. Climate risks, such as greenhouse gas (GHG) intensity, carbon emissions, and Environmental, Social, and Governance (ESG) ratings, are increasingly recognized as critical factors that can influence stock market performance and investors' decision-making. Research by scholars like Giglio et al. (2021) and Agliardi et al. (2023) underscores the financial sector's enhanced sensitivity to environmental factors, particularly as global efforts to tackle climate change intensify. Metrics such as carbon intensity (In et al., 2019; Bolton and Kacperczyk, 2021) and GHG emissions (Chang et al., 2020; Hsu et al., 2023) have emerged as significant indicators in estimating a firm's environmental impact and its corresponding financial performance.

These studies reveal that firms with better climate performance, as reflected in the lower emissions and stronger ESG ratings, often exhibit greater resilience and appeal to more environmentally conscious investors. While much of the early research in this field has centered on the United States (Albuquerque et al., 2019; Monasterolo and De Angelis, 2020), European markets (Horváthová, 2012; Ennis et al., 2014) have increasingly become the focus of climate finance studies, demonstrating diverse regional responses to climate change risk factors. The inclusion of climate factors in financial analyses not only reflects a broader shift toward sustainable investing but also emphasizes the growing alignment between long-term market stability, and climate-conscious economic policies. Moreover, as climate change continues to influence regulatory landscapes and investor priorities, its integration into financial frameworks becomes vitally important for promoting sustainability and mitigating systemic risks within global markets.

The BRICS nations- Brazil, Russia, India, China, and South Africa represent some of the world's largest and most dynamic economies. First conceptualized in 2001, the group was officially launched in 2006, with South Africa joining in 2010. Together, these countries account for more than 40% of the global population and nearly 25% of the world's GDP. Each nation brings unique strengths to the table: Brazil and Russia leveraged their abundant natural resources, China and India capitalized on rapid industrialization and economic growth, and South Africa provided critical representation for the African continent. These nations are vital in shaping global economic policies and addressing challenges such as climate change.

In 2023, BRICS expanded to include five additional nations: Saudi Arabia, UAE, Iran, Egypt, and Ethiopia, reflecting its ambition to strengthen its global influence and enhance its capability to structure international economic dynamics. This expansion emphasizes the group's growing role in global affairs, particularly in critical sectors such as energy and trade, where these nations hold significant strategic importance. The inclusion of these diverse economies not only amplifies BRICS' collective economic power but also enhances its geopolitical leverage in addressing global challenges, including climate change, sustainable development and economic inequality.

Our research aims to delve into the intricate interplay between macroeconomic variables, climate change indicators, and stock market index performance within both the pre-existing and newly formed BRICS countries. Unlike prior studies that mainly focused on the founding BRICS nations, our research takes a broader perspective by incorporating an expanded geographical boundary. This inclusive approach captures both the economic and environmental dynamics of these diverse regions, allowing for a richer and more solid understanding of their collective impact on global markets.

By incorporating a comprehensive dataset spanning from 1999 to 2022, our study offers an in-depth analysis of nearly three decades of financial and environmental trends. This long-term perspective lets us see how the relationships between macroeconomic and climate-related variables and stock market performance have changed over time. Furthermore, it sheds light on the distinctive path of these nations in adapting to global economic shifts and environmental challenges. Through this approach, our research seeks to contribute valuable insights into the dynamics that drive sustainable economic growth and inform strategic policy making in a quickly changing global landscape.

Furthermore, our research adopts a dual approach, examining the impact of both macroeconomic variables and climate change factors on stock market indices returns. This comprehensive perspective bridges a critical gap in the existing literature, which frequently examines these factors in isolation, thereby failing to capture the interconnection of economic and environmental dynamics. By addressing this limitation, our study not only strengthens the understanding of how these variables interact but also highlights their joint influence on financial markets. This dual approach enables a broader and more complete analysis, offering insights that are relevant in today's interconnected global economy, where economic policies and environmental factors are increasingly interdependent.

The findings of this research are expected to reveal meaningful and long-run implications. For investors, a better understanding of the sensitivity of stock markets to both macroeconomic and environmental risk factors can guide more informed decisions regarding portfolio allocation and enhance risk management strategies. Recognizing the dual influence of these variables allows investors to adapt to changing market conditions and align their investment choices with long-term sustainability goals. For policymakers, this analysis will provide robust, evidence-based recommendations for stimulating sustainable economic growth while addressing climate-related risks. These insights are crucial for developing policies that balance economic expansion with environmental preservation, ensuring an adaptive financial ecosystem.

Ultimately, this research seeks to shed light on the intricate and dynamic interactions between economic and environmental variables, contributing to a more sustainable global financial system. By offering actionable insights for stakeholders across various sectors, our study aims to enhance decision-making processes, support the transition toward greener economies, and strengthen the foundations of a financial system that is well prepared to adapt to the challenges of a rapidly changing world. Through this integrated lens, we hope to contribute meaningfully to the discourse on building a more inclusive and sustainable economic future.

Chapter 03: Literature Review

This literature review systematically examines the findings from previously conducted studies, shedding light on the diverse methodologies and insights they provide on the impact of both macroeconomic variables and climate change factors on stock market performance across various geopolitical regions. There are various studies that examined that impact. The following subsections present those studies.

3.1: Macroeconomic Variables and Stock Market Returns

Research has consistently revealed that macroeconomic variables significantly influence stock market performance, though the degree and nature of this impact vary across contexts. For instance, Hashmi and Chang (2020) examined emerging stock indices and revealed that the effects of macroeconomic variables vary across quantiles, where negative shocks exert a more pronounced influence on stock prices than positive developments. Similarly, Abbas and Wang (2020) analyzed macroeconomic uncertainty's impact on stock markets in China and the USA, concluding that while both markets are affected, the sensitivity of the Chinese market to economic uncertainties is noticeably higher.

The importance of individual macroeconomic variables is also evident in regional studies. Huy, Dat, and Anh (2020) examined how GDP growth, market interest rates and inflation influence bank stock prices, finding significant relationships that underscore the role of economic indicators in asset valuation. Meanwhile, Mahpudin and Batu (2020) focused on the Brazilian stock market and revealed that money supply significantly impacts stock prices; where traditional indicators like inflation and interest rates show negligible effects, reflecting the unique dynamics of Brazil's economy. Examining long-term dynamics, Asravor and Fonu (2020) analyzed the relationship between macroeconomic variables and Ghana's stock market. They found that factors such as money supply and inflation negatively affect stock market development, where foreign direct investment and interest rates have a positive impact. In contrast, Parab and Reddy (2020) identified structural breaks in the Indian stock market over two decades. Their comprehensive analysis of 22 macroeconomic variables exhibited the market's nuanced responses to major events, such as the 2008 financial crisis.

Further enriching this discussion, Jamaludin, Ismail, and Manaf (2017) analyzed the effects of inflation, exchange rates, and money supply on ASEAN stock indices,

revealing that inflation poses the most significant inverse effect. Their findings emphasized the importance of monetary policies in stabilizing inflation to bolster the capital market. Similarly, Khan and Khan (2018) examined stock prices in Pakistan and revealed that while exchange rates negatively affect short-term performance, money supply and interest rates significantly influence long-term trends, indicating the duality of macroeconomic impacts across temporal scales.

Issahaku, Ustarz, and Domanban (2013) explored the Ghanaian market and discovered significant long-term relationships between stock returns, money supply, inflation, and foreign direct investment. They also revealed causality between exchange rates and stock returns, indicating that economic shocks require prolonged market adjustments. This is supported by Quadir (2012), who analyzed Dhaka Stock Exchange data and revealed that treasury bill rates and industrial production illustrate positive yet statistically insignificant effects on stock returns, underscoring the need for broader variable inclusion in predictive models.

From a comparative perspective, Sahoo and Patnaik (2020) analyzed macroeconomic effects on the Indian and American stock markets. Their findings concluded GDP and GDP per capita significantly influence the Indian market, where all variables were statistically insignificant in the American market. This contrast shows the varying sensitivities of developed and developing economies to macroeconomic shocks. Similarly, Kalam (2020) concluded that while inflation negatively impacts short-term returns in Malaysia, GDP and foreign direct investment reveal positive long-term effects, highlighting the duality of macroeconomic influences.

Expanding this analysis to Vietnam, Huy et al. (2021) explored real estate stock prices and showed that inflation and risk-free rates negatively affect market performance, where GDP growth and lending rates show positive effects. Their study reveals the interplay between domestic and global factors in shaping stock market trends. Humpe and McMillan (2020) found that industrial production and consumer prices positively impact stock prices, where long-term interest rates exhibit a negative relationship. Their findings emphasized the role of inflation hedging and economic output in long-term stock performance.

In developed economies, Bhuiyan and Chowdhury (2019) examined asymmetric dynamics between macroeconomic variables and stock indices in North America. They found that industrial production positively affects stock prices, while rising interest rates diminish market performance. Lastly, Verma and Bansal (2021) systematically reviewed literature spanning 50 years, indicating that while GDP, foreign direct investment, and foreign institutional investment generally strengthens stock indices, interest rates and inflation often act as adverse factors. Sector-specific responses further show the heterogeneous nature of macroeconomic impacts across economic contexts.

Together, these studies emphasize the multifaceted and context dependent effects of macroeconomic variables on stock markets. By integrating insights across diverse regions and economic conditions, the literature highlights the essential role of tailored policy interventions in enhancing and stabilizing market performance.

3.2: Climate Change Variables and Stock Market Returns

Recent studies increasingly focused on the interaction between climate change variables and stock market performance, showing the growing importance of environmental influences in financial markets. Barbera-Mariné et al. (2021) examined the influence of carbon emissions and environmental ratings on company performance within the Stoxx 600 index. Their findings revealed that higher environmental ratings correlated positively with stock returns, elevated carbon emissions negatively affected performance. This emphasizes the role of environmental responsibility in enhancing financial outcomes and guiding investors to make decisions. Examining the role of transparency, Antoniuk (2022) analyzed the impact of climate disclosure on stock market performance in Norway and revealed that companies which have higher climate disclosure scores gain superior stock returns, highlighting the value investors put on transparent reporting of climate risks and mitigation efforts. Similarly, Antoniuk and Leirvik (2021) examined the effects of climate related political events on sector-specific stock returns. Their findings revealed that positive climate policies boost returns in clean energy sectors but are adversely affected in traditional energy sectors. This reveals the stock market's sensitivity to policy changes, and its capacity to drive sector-specific investment realignments.

The impact of corporate climate risk disclosures was the focus of Wu et al. (2022), who analyzed performance briefing impacts on stock prices. They found that increased disclosure of climate risks often triggers negative stock price reactions in the short run, which reflects investor concerns regarding potential future costs or liabilities associated with these risks. Similarly, Wen, Wu, and Gong (2020) explored the carbon emissions trading market of China and revealed that participating companies had experienced increased excess returns. This reflected the market's recognition of regulatory framework and environmental commitments as valuable traits.

Adding further variation, Venturini (2022) reviewed multifaceted ways in which climate risks impact stock market dynamics, highlighting both macroeconomic and microeconomic indicators. The review showed that investors' personal beliefs and evolving awareness significantly affected market reactions to climate-related developments, making adaptation and mitigation strategies crucial for sustained financial performance. Moreover, Ji et al. (2021) analyzed mutual funds in BRICS countries, finding green funds consistently outperform their counterparts, demonstrating the financial viability of environmentally conscious investments.

Another study by Aswani, Raghunandan, and Rajgopal (2023) critically explored the relationship between carbon emissions and stock returns. They argued that prior research overstates the link between stock performance and emissions due to methodological biases, tempting a shift towards metrics like emissions intensity for more accurate evaluation. Similarly, Wen et al. (2021) investigated the pricing of climate related risks in the European stock market and introduced a "Greenness and Transparency" factor combining environmental disclosures and greenhouse gas (GHG) emissions. They got evidence of negative greenium, meaning investors accept lower returns for holding stocks of greener and more transparent companies as a hedge against climate related risks. Their findings illustrated the importance of integrating both transparency and environmental performance into pricing models.

Together, these studies exhibit the critical role that climate change indicators play in shaping stock market dynamics. They provide critical insights into how environmental factors and corporate sustainability practices jointly influence financial markets, offering essential guidance for investors, researchers, and policymakers.

Chapter 04: Methodology

To investigate the impact of macroeconomic and climate change variables on stock market returns across BRICS countries, this study employs the Generalized Method of Moments (GMM). GMM is a robust method particularly suited for panel data, especially when dealing with potential endogeneity issues. Endogeneity may arise if any of the explanatory (independent) variables are correlated with the error term, which could bias the estimates. GMM addresses this by using internal instruments derived from lagged values of the variables. Thus, enabling more reliable estimations.

We specify the model as follows:

$$Y_{i,it} = \alpha + \beta_1 X_{1,it} + \beta_2 X_{2,it} + ...+ \beta_{k,it} + \mu_i + \varepsilon_{it} \tag{1}$$

Were,

* Y_{it} represents the dependent variable, the stock market return for country i in year t.
* $X_{1,it}$, $X_{2,it}$, ..., $X_{k,it}$ are the independent variables, which include macroeconomic indicators such as GDP growth, inflation, exchange rates, and climate-related indicators such as greenhouse gas emissions and renewable energy usage.

*α is the intercept term.
* μ_i represents the unobserved individual effects (fixed effects for each entity),
* ε_{it} is the idiosyncratic error term.

The GMM estimator is applied in such a dynamic panel data setting, where lagged values of the dependent variable or other independent variables may serve as instruments. This helps to control potential endogeneity by leveraging internal instruments, allowing us to achieve more reliable results.

For our study, the GMM model specification might include lagged values of not only stock market returns but also both independent variables as instruments & addressing possible reverse causality between economic indicators and stock market performance. Specifically, we use the following dynamic form:

$$Y_{it} = \alpha + \beta Y_{i,t-1} + \sum_{k=1}^{k} \gamma_k X_{k,it} + \mu_i + \varepsilon_{it} \tag{2}$$

In this model:

* $Y_{i, t-1}$ is the lagged dependent variable, serving as an explanatory factor to capture previous period effects on the current stock market return.

* γ_k represents the coefficients of the independent variables.

The choice of instruments is crucial in GMM estimation. We select lagged values of both the independent variables and stock market returns as instruments, as they are assumed to be correlated with the endogenous variables but also uncorrelated with the error term ε_{it} .This instrument selection ensures the consistency of the GMM estimator.

Using GMM allows us to control Endogeneity. Since economic indicators like GDP, inflation, and exchange rates could be influenced by stock market performance, GMM's use of instruments helps address reverse causality. Another advantage is that it handles Dynamic Relationships. By incorporating lagged dependent variables, GMM captures the persistence in stock market returns and other time-dependent effects. Moreover, controlling Country-Specific Effects Such as: The model accounts for unobserved heterogeneity across BRICS countries, such as institutional factors and economic policies.

To test for model validity, there are two ways here. The first one is the Hansen Test of Overidentifying Restrictions. This test checks if the instruments used are valid, meaning they are uncorrelated with the error term. A higher p-value indicates that the instruments are valid. Another test is Arellano-Bond Test for Autocorrelation. This test checks if there is serial correlation in the error terms, which should not exist in a well-specified GMM model. Specifically, AR (2) tests if second-order autocorrelation is absent, which ensures the model's assumptions hold.

The GMM methodology allows us to robustly estimate the impact of macroeconomic and climate change factors on stock market returns across BRICS countries, accommodating both endogeneity and dynamic relationships. This approach helps yield insights into both short-term and long-term relationships, making it highly suitable for this study.

The purpose of this study is to investigate how macroeconomic variables (GDP, inflation rate, and official exchange rate) and climate change indicators (annual greenhouse gas emissions and renewable energy usage) influence stock market

performance across all RRICS countries (India, China, South Africa, Brazil, Russia, Ethiopia, UAE, Saudi Arabia, Iran, and Egypt). With the findings from previous literature and economic theory, the following hypotheses are developed:

GDP and Stock Market Returns:

Hypothesis 1 (H1): There is a positive relationship between GDP growth and stock market returns.

Higher GDP growth often reflects a strong economic environment, leading to increased corporate earnings and investor confidence, which positively influences stock market return.

The following studies have explored the relationship between GDP growth and stock market returns from empirical studies [Asravor & Fonu, 2023; Antoniuk, 2022; and Wu et al., 2021].

Inflation Rate and Stock Market Returns:

Hypothesis 2 (H2): Inflation rate has a negative impact on stock market returns.
Rising inflation typically diminishes purchasing power and increases expenses for businesses, which may reduce profit margins and discourage investment, potentially leading to lower return percentage and stock price.

The following studies have explored the relationship between GDP growth and stock market returns from empirical studies [Abbas & Wang, 2021; and Huy et al. 2022].

Exchange Rate and Stock Market Returns:

Hypothesis 3 (H3): Exchange rate fluctuations significantly impact stock market returns, where appreciation in the domestic currency correlates positively with stock market performance.

An appreciating domestic currency has the potential to attract foreign investment and reduce costs for importing, enhancing profitability for firms relying on importing, which can increase stock returns.

The following studies have explored the relationship between GDP growth and stock market returns from empirical studies [Antoniuk & Leirvik, 2022; and Wu et al. 2021].

Greenhouse Gas Emissions and Stock Market Returns:

Hypothesis 4 (H4): An increase in greenhouse gas emissions negatively impacts stock market returns.

Rising greenhouse gas emissions can lead to economic inefficiencies and environmental degradation, leading to an increase in potential regulatory costs, which may reduce investor confidence and negatively impact stock prices and market return. The following studies have explored the relationship between GDP growth and stock market returns from empirical studies [Barbera-Mariné et al., 2020; and Antoniuk & Leirvik, 2022].

Renewable Energy Usage and Stock Market Returns:

Hypothesis 5 (H5): A higher percentage of renewable energy usage in primary energy consumption positively influences stock market returns.

An increased use of renewable energy can accelerate sustainable economic growth, reduce exposure to volatile fossil fuel markets, and satisfy several Sustainable Development Goals (SDG), attracting investments into the stock market and leading to an increase in stock market return.

The following studies have explored the relationship between GDP growth and stock market returns from empirical studies. [Antoniuk, 2022; Huy et al., 2022; and Barbera-Mariné et al., 2020].

Chapter 05: Results and Discussions

This section aims to present the key findings of the study and interpret them in the context of existing literature. This part begins by summarizing the descriptive statistics of the data, highlighting the variation and distribution of key macroeconomic and climate variables across the chosen countries over the selected study period. These initial observations set the stage for deeper statistical analysis for providing insights into the relationships between GDP, inflation, exchange rates, greenhouse gas emissions, renewable energy usage, and stock market index returns. The analysis incorporates both short and long panel data models through the application of the Difference Generalized Method of Moments (GMM) and Orthogonal Deviations techniques. This dual approach ensures a comprehensive exploration of the selected dataset, enabling reliable findings across varying time frames and data structures.

Table 01: Descriptive Statistics (Short Panel Data)

Statistic	Annual GDP	Exchange Rate	GDP	Index Return	Inflation	Renewable Energy
Mean	2.69E+09	4354.214	2.58E+12	0.137425	7.391594	9.314324
Median	9.30E+08	14.4480	8.39E+11	0.069200	4.120200	5.153100
Maximum	1.39E+10	42000.0	1.79E+13	2.925500	43.48850	48.82380
Minimum	2.59E+08	3.191400	2.40E+11	-0.510100	-2.09000	0.003900
Std. Dev.	3.83E+09	12437.75	4.43E+12	0.419195	9.844114	13.69084
Skewness	2.127281	2.537799	2.461360	3.968612	2.510306	2.066839
Kurtosis	6.158555	7.549017	7.685211	25.06223	8.882838	5.970002
Jarque-Bera	73.70412	121.9450	121.2340	1443.071	157.0216	68.09003
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	1.69E+11	274315.5	1.63E+14	8.657800	465.6704	586.8024
Sum Sq. Dev.	9.07E+20	9.59E+09	1.22E+27	12.50678	6008.208	11621.23
Observations	63	63	63	63	63	63

The table summarizes key statistics for six variables: Annual GDP, Exchange Rate, GDP, Index Return, Inflation, and Renewable Energy. The mean represents the average value, such as a GDP of 2.58×10122.58 \times 10^ {12}2.58×1012 and an Index Return of 0.137425. Median values, like 8.39×10118.39 \times 10^ {11}8.39×1011 for GDP, show the midpoint, and differences between mean and median indicate possible outliers.

Standard deviation shows variability, with the exchange rate by far demonstrating the most fluctuation. Skewness indicates whether data leans more to one side; for example, Index Return has a strong positive skew. Kurtosis shows how peaked the data is, with

Index Return having extreme values, suggesting outliers. The Jarque-Bera test confirms that none of the variables follow a normal distribution.

Lastly, the dataset is diverse, with large ranges between both maximum and minimum values for variables like GDP and Inflation, reflecting varied economic and environmental conditions. This variability highlights the need for careful analysis methods.

Table 02: Descriptive Statistics (Long Panel Data)

Statistic	Annual GDP	Exchange Rate	GDP	Index Return	Inflation	Renewable Energy
Mean	2.22E+09	2121.802	1.54E+12	0.177232	7.560090	8.176758
Median	8.22E+08	7.061300	4.86E+11	0.096950	5.182850	5.180300
Maximum	1.39E+10	40000.0	1.79E+13	2.925500	85.74650	48.82380
Minimum	1.13E+08	1.672800	7.88E+10	-0.729800	-2.09000	0.000000
Std. Dev.	3.08E+09	7676.070	2.91E+12	0.423113	9.980830	12.84894
Skewness	2.398551	4.184227	3.732803	2.207504	4.156692	2.182688
Kurtosis	8.178326	19.10913	17.47916	9.621288	29.95565	6.357687
Jarque-Bera	442.8400	3267.915	2380.627	1008.021	7161.475	272.9207
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	4.80E+11	458309.2	3.32E+14	38.28220	1632.890	1766.180
Sum Sq. Dev.	2.04E+21	1.27E+10	1.82E+27	38.49022	17749.56	35495.51
Observations	216	216	216	216	216	216

The table presents descriptive statistics for long panel data on variables including annual GDP, exchange rate, GDP, stock index return, inflation, and renewable energy usage.

On average, the annual GDP is 2.22×1092.22 \times 10^92.22×109, with a significant variation as shown by the standard deviation of 3.08×1093.08 \times 10^93.08×109. The median GDP is much lower (8.22×1088.22 \times 10^88.22×108), suggesting the data might be skewed, which is supported by a positive skewness of 2.39. Exchange rates average at 2121.80, ranging widely between 1.67 and 40,000, with a high standard deviation of 7676.07. GDP values also exhibit a large spread, with a mean of 1.54×10121.54 \times 10^ {12}1.54×1012 and a standard deviation of 2.91×10122.91 \times 10^{12}2.91×1012.

Stock index returns have a mean of 0.177 and are positively skewed (2.20), ranging from -0.72 to 2.92. Inflation averages at 7.56%, but extreme values exist between -2.09% and 85.75%. Renewable energy usage has a mean of 8.17%, showing variability with a standard deviation of 12.85%.

At last, the data suggests notable variability across all variables, with some distributions highly skewed, as seen in kurtosis and skewness values.

Table 03: Short Panel Data Results (First Difference GMM)

Variable	Coefficient	Std. Error	t-Statistic	Probability
Index Return(-1)	-0.05305	0.18652	-0.28441	0.783
GDP	7.17E-14	6.23E-13	0.114928	0.911
Inflation Rate	-0.020615	0.032074	-0.642736	0.5384
Exchange Rate	0.000211	0.000156	1.349894	0.2140
Annual Greenhouse Gas Emission	3.02E-10	2.59E-09	0.116740	0.9099
Renewable Energy Usage	-0.131814	0.078624	-1.676510	0.1322

The analysis using short panel data and the first difference GMM shows largely insignificant relationships between stock market returns and the explanatory variables. The lagged dependent variable, INDEX_RETURN (-1), has a small negative coefficient (-0.053050) with a high p-value (0.7833), indicating that past stock market returns have little to no influence on current returns within the short-term panel setting. Similarly, GDP has an almost negligible positive coefficient (7.17E-14) with a very high p-value (0.9113), suggesting that changes in GDP have no statistically meaningful effect on stock returns over the observed period.

The inflation rate exhibits a negative coefficient (-0.020615), but its p-value (0.5384) indicates that this relationship is not statistically significant. This suggests that inflation does not have a clear or measurable impact on stock returns in the short term. On the other hand, the exchange rate shows a positive coefficient (0.000211), but this relationship is also statistically insignificant (p = 0.2140), implying minimal influence on stock market performance.

Environmental variables also fail to demonstrate significant relationships. The coefficient for annual greenhouse gas emissions is very small (3.02E-10) with a high p-value (0.9099), indicating no notable impact. Renewable energy usage, while showing a more substantial negative coefficient (-0.131814), also lacks statistical significance (p = 0.1322). This result suggests that the adoption of renewable energy practices does not have a strong or measurable short-term effect on stock market returns.

The effects specification and model diagnostics suggest a moderate fit. The mean dependent variable (-0.016740) and its standard deviation (0.592412) reflect stability in the data. The standard error of regression (0.618286) indicates acceptable precision in the model's predictions. The J-statistic (2.668397) and its associated probability (0.445625) suggest that the instrument specification is valid. Overall, the results indicate weak or insignificant relationships in the short-term panel data, emphasizing the potential need for longer-term analysis or alternative modeling approaches to uncover more robust relationships.

Table 04: Short Panel Data Result (Orthogonal Deviation GMM)

Variable	Coefficient	Std. Error	t-Statistic	Probability
Index Return (-1)	-0.141868	1.074578	-0.13202	0.8982
GDP	8E-14	8.64E-13	0.092599	0.9285
Inflation Rate	-0.016357	0.031455	-0.52002	0.6171
Exchange Rate	0.000222	0.000444	0.500331	0.6303
Annual Greenhouse Gas Emission	3.53E-10	2.61E-09	0.135369	0.8957
Renewable Energy Usage	-0.139364	0.057081	-2.44149	0.0405

The orthogonal deviations GMM method examines the relationship between stock market returns and selected independent variables for the short panel data (2018–2022). The lagged dependent variable, INDEX_RETURN (-1), has an insignificant coefficient (-0.141868) and a high p-value (0.8982), suggesting that past stock market returns have no substantial influence on current returns. GDP shows a very small positive coefficient (8.00E-14) with an extremely high p-value (0.9285), indicating no statistical significance. This implies that GDP growth might not be a key driver of stock market performance over the short term.

The inflation rate, with a coefficient of -0.016357, indicates a weak and insignificant negative relationship (p-value = 0.6171), suggesting that inflation does not strongly impact stock market returns in this timeframe. The exchange rate presents a small positive coefficient (0.000222) but remains statistically insignificant (p-value = 0.6303), implying a negligible short-term effect.

Greenhouse gas emissions, represented by Annual Greenhouse Gas Emission, have an almost zero coefficient (3.53E-10) and a high p-value (0.8957), indicating no observable influence on stock returns. However, renewable energy usage emerges as significant (p-value = 0.0405) with a negative coefficient (-0.139364). This finding

suggests that higher reliance on renewable energy may be associated with lower stock market returns in the short term, potentially due to transitional economic costs or market uncertainties linked to renewable energy investments.

Finally, the J-statistic (2.330478) and its probability (0.506707) indicate that the model's instruments are valid and not over-identified. The effects specification, incorporating orthogonal deviations, captures cross-sectional variations effectively. However, the results highlight that most variables lack significant explanatory power in the short panel data, except for renewable energy usage, warranting deeper exploration in future research.

Table 05: Long Panel Data Results (First Difference GMM)

Variable	Coefficient	Std. Error	t-Statistic	Probability
Index Return (-1)	-1.203179	0.59074	-2.036545	0.0761
GDP	-1.23E-12	4.25E-13	-2.887620	0.0203
Inflation Rate	-0.213998	0.22721	-0.941640	0.3739
Exchange Rate	3.66E-05	4.61E-05	0.793861	0.4502
Annual greenhouse Gas Emission	2.12E-09	8.07E-10	2.633137	0.0300
Renewable Energy Usage	-0.014615	0.86289	-0.016938	0.9869

The analysis of the long panel data using orthogonal deviations GMM reveals significant and nuanced relationships between macroeconomic and environmental variables and stock market performance. The lagged dependent variable, INDEX_RETURN (-1), exhibits a strong and statistically significant negative coefficient (-4.243118, p = 0.0072), indicating a substantial mean-reverting tendency in stock returns, where past returns negatively impact current performance. GDP also demonstrates a highly significant negative relationship with stock returns (-6.34E-13, p = 0.0034), suggesting that economic growth can exert adverse effects on market returns, possibly due to structural adjustments or economic complexities.

The inflation rate, on the other hand, has a significant positive coefficient (0.212954, p = 0.0122), indicating that rising inflation is associated with increased stock returns. This could reflect businesses' ability to transfer rising costs to consumers, leading to improved revenues and stock performance. In contrast, the exchange rate has a negligible and statistically insignificant effect (-8.58E-06, p = 0.8199), suggesting limited direct influence on stock returns within this model framework.

Environmental variables yield interesting insights. Annual greenhouse gas emissions are positively and significantly correlated with stock returns (6.65E-10, p = 0.0195), potentially highlighting the positive economic performance of emissions-intensive industries. Meanwhile, renewable energy usage also shows a significant positive relationship (0.371229, p = 0.0096), underscoring the favorable impact of transitioning toward green energy on market dynamics.

The diagnostics further affirm the robustness of the model. The J-statistic (5.52E-19) confirms the validity of the instruments employed, and the standard error of regression (1.798343) is reasonably low, indicating an accurate estimation. The mean dependent variable (0.020794) and its standard deviation (0.393166) also reflect stability in model performance. Collectively, these findings underscore the significant roles of macroeconomic and environmental variables in shaping stock market returns, providing valuable insights into their interplay over time. Further exploration through alternative specifications or datasets could enrich the understanding of these dynamics

Table 06: Long Panel Data Results (Orthogonal Deviations GMM)

Variable	Coefficient	Std. Error	t-Statistic	Probability
Index Return (-1)	-4.243118	1.185339	-3.579668	0.0072
GDP	-6.34E-13	1.55E-13	-4.100088	0.0034
Inflation Rate	0.212954	0.066116	3.220913	0.0122
Exchange Rate	-0.00000858	0.0000365	-0.235303	0.8199
Annual greenhouse Gas Emission	2.12E-09	8.07E-10	2.633137	0.0300
Renewable Energy Usage	-0.014615	0.86289	-0.016938	0.9869

The analysis of the long panel data using orthogonal deviations GMM uncovers significant relationships between macroeconomic and environmental variables and stock market performance. The lagged dependent variable, INDEX_RETURN (-1), has a strongly negative and statistically significant coefficient (-4.243118, p = 0.0072). This indicates a substantial mean-reverting tendency in stock returns, where past returns negatively impact current performance. GDP similarly shows a highly significant negative relationship with stock returns (-6.34E-13, p = 0.0034), suggesting that economic growth can adversely affect stock market performance, possibly due to structural adjustments or economic complexities.

The inflation rate, however, demonstrates a positive and statistically significant coefficient (0.212954, p = 0.0122), suggesting that rising inflation is associated with increased stock returns. This may reflect the ability of businesses to pass higher costs to consumers, thereby improving revenues and stock performance. In contrast, the exchange rate exhibits a negligible and statistically insignificant effect (-8.58E-06, p = 0.8199), indicating that exchange rate fluctuations have minimal direct influence on stock market returns within this framework.

Environmental variables also yield interesting results. Annual greenhouse gas emissions show a positive and significant relationship with stock returns (6.65E-10, p = 0.0195), which could reflect the economic performance of industries reliant on emissions. Renewable energy usage, on the other hand, has a significant positive coefficient (0.371229, p = 0.0096), highlighting the favorable impact of transitioning to green energy on stock market performance.

Model diagnostics provide additional confidence in these findings. The J-statistic (5.52E-19) supports the validity of the instruments used in the analysis. The mean dependent variable (0.020794) and its standard deviation (0.393166) reflect stable model performance. The standard error of regression (1.798343) is reasonably low, indicating a precise estimation. Taken together, these results underscore the critical roles of both macroeconomic and environmental variables in shaping stock market dynamics, providing valuable insights for policymakers and investors. Further,

research could expand on these findings by exploring alternative model specifications and datasets.

The hypothesis testing results reveal varied outcomes for the relationships between macroeconomic and climate change variables and stock market performance across both short and long panels. For GDP (H1), the variable showed no significant relationship with stock market returns in either the short or long panels under both first difference GMM and orthogonal deviations methods. This suggests that GDP, as a broad economic measure, may not have directly or immediately influenced market indices, highlighting the need to consider other sector-specific or indirect factors. Inflation (H2), however, presented a mixed outcome: it was negatively related to stock returns in the short panel analysis using first difference GMM, partially supporting the

hypothesis, but had also shown a significant positive effect in the long panel analysis. This dual behavior can indicate that inflation's impact varies, with time, with short-term inflationary pressures potentially hurting investment returns but moderate inflation over longer periods signaling economic growth and boosting corporate profitability. The exchange rate (H3) demonstrated a significant positive relationship with stock returns in the short panel under the first difference GMM model, aligning with the hypothesis, but became insignificant in the other models, pointing to a context-dependent or weak influence on market performance. Both greenhouse gas emissions (H4) and renewable energy usage (H5) were largely insignificant in the short panel, indicating limited immediate effects. However, in the long panel analysis, greenhouse gas emissions showed a positive and significant relationship, potentially reflecting the robust performance of emissions-intensive industries. Similarly, renewable energy usage emerged as significant and positive in the long-term analysis, supporting the notion that sustainable energy adoption may be increasingly valued in financial markets over extended periods. These findings underline the complexity of interactions between these variables and highlight the importance of time horizon and methodology in uncovering their effects.

Overall, this section highlights the nuanced and often complex relationships between macroeconomic and climate change variables and stock market performance. While certain variables like inflation and renewable energy usage demonstrate significant effects in specific contexts, others, such as GDP and exchange rate, exhibit limited or inconsistent impacts. These findings emphasize the importance of considering both the time horizon and the methodological approach when studying such interactions.

Chapter 06: Conclusion & References

6.1 Conclusion

This study aimed to investigate the impact of macroeconomic variables, including GDP, inflation, and exchange rates, as well as climate change indicators, such as greenhouse gas emissions and renewable energy usage, on stock market performance across selected countries. By employing both short and long panel data with advanced econometric techniques, including Difference GMM and Orthogonal Deviations, the analysis ensured robust results while addressing data heterogeneity and endogeneity concerns. This methodological rigor allows the study to contribute meaningful insights into the nuanced dynamics of both economic and environmental factors influencing financial markets.

The findings from this study reveal varying impacts of macroeconomic and climate change variables on stock market returns, depending on the panel data approach and time horizon used. The short panel analysis suggests largely insignificant relationships, except for renewable energy usage, which showed a statistically significant negative relationship under the orthogonal deviations GMM model. This result may reflect the transitional economic costs, technological challenges, or uncertainties associated with adopting renewable energy in the short term. Conversely, the long panel data results emphasize more substantial relationships, uncovering deeper insights into how these variables influence stock markets over time. Inflation demonstrated a significant positive effect on stock returns, likely due to businesses' ability to transfer increased costs to consumers, thereby enhancing revenue streams and profitability. Greenhouse gas emissions and renewable energy usage both exhibited positive and significant impacts on stock market performance, indicating the resilience of emissions-intensive industries and the growing investor confidence in green energy transitions. Interestingly, GDP, though significant, revealed a negative effect, potentially attributed to structural adjustments, economic realignments, or sector-specific growth patterns that are not immediately reflected in broad market indices.

These findings underscore the intricate interplay between both macroeconomic indicators, environmental considerations, and stock market dynamics, highlighting the necessity for policymakers and investors to adopt a balanced approach. Addressing short-term volatilities while remaining cognizant of long-term trends is crucial for informed decision-making in the evolving global financial landscape. The emphasis on

renewable energy transitions and climate-conscious investments further underscores the increasing relevance of environmental sustainability in shaping financial markets.

While the study offers valuable contributions, certain limitations must be acknowledged. These include data constraints, the focus on selected variables, and the limited geographic scope, which could be expanded in future research. Incorporating more dynamic climate indicators, such as carbon pricing mechanisms or adaptation measures, and extending the analysis to additional emerging and developed markets could provide a broader and more comprehensive perspective. Despite these limitations, this research successfully bridges macroeconomic and environmental dimensions, offering an integrative framework to understand their combined influence on financial markets. It serves as a foundation for further studies and supports the growing discourse on sustainable economic and financial development

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