CLIMATE CHANGE, INSTITUTIONAL QUALITY, FOREIGN EXCHANGE RATE, FOREIGN DIRECT INVESTMENT AND FISCAL SUSTAINABILITY IN SUB- SAHARAN AFRICA

BY

KINUTHIA RAHAB WANJIKU

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DECLARATION

Declaration by the Candidate

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KINUTHIA RAHAB WANJIKU

PHD/ECON/5534/20

Declaration by the Supervisor

This thesis has been submitted for examination with my approval.

Signature:_____ Date:_____

PROF. PETER OMBOTO

Moi University

Signature:_____ Date:_____

DR. HILARY NDAMBIRI

Moi University

Signature:_____ Date:_____

PROF. SAMUEL MUYIWA ADARAMOLA

Norwegian University of Life Sciences

DEDICATION

This work is dedicated to my family for their patience, encouragement and struggle to enable me to go through the PHD's program. I particularly dedicate this work to my husband CPA, CFE Charles Githinji whose unwavering support and encouragement have been the driving force behind my academic journey. Their belief in my potential has been a constant source of inspiration, shaping this research endeavour. This achievement is a tribute to their enduring love and guidance.

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ABSTRACT

Fiscal sustainability refers to a government's ability to manage its finances in a way that ensures long-term stability, avoiding excessive debt accumulation while maintaining essential public services. It plays a crucial role in economic stability by fostering investor confidence, reducing vulnerability to external shocks, and supporting steady economic growth. In Sub-Saharan Africa it remains a significant hurdle despite numerous economic bailouts. The fiscal imbalance is majorly influenced by economic instability, weak institutional frameworks, and environmental factors. Though studies have addressed these issues separately, findings being mixed, a comprehensive analysis is lacking. Therefore, this study sought to examine the effect of climate change, institutional quality, foreign exchange rate fluctuations, and foreign direct investment (FDI) on fiscal sustainability in Sub Saharan Africa. The study was informed by Keynesian theory, debt overhang theory, institutional theory, and the Environmental Kuznets Curve (EKC) hypothesis. It was anchored in the positivism paradigm. The study used panel data to establish the casual relationship among the study variables. The research employed an explanatory and longitudinal research design, utilizing secondary data from the World Bank for the period 2000–2023. The target population comprised of 43 countries in Sub-Saharan Africa which resulted to 989 observations. The inclusion/exclusion criterion was based on whether the country consistently had available data from 2000 to 2023. Data analysis involved descriptive and inferential statistical methods, with a multiple regression model applied to test the hypotheses. Findings indicate that climate change (β=0.4098, ρ=0.000) and foreign exchange rate (β= 0.7773, ρ=0.000) positively influence fiscal sustainability, while institutional quality (β2= -0.0631, ρ =0.009) and FDI (β= -0.5381, ρ=0.000) have a negative impact. Generalized method of moment results confirmed the fixed effect model results. Based on the results, the study concluded that climate change, institutional quality, foreign exchange rate, and foreign direct investment significantly influence fiscal sustainability. These results have critical policy implications and underscore the need for targeted policy interventions. It urges policymakers/governments to prioritize investments in climate adaptation and mitigation strategies such as resilient infrastructure, sustainable agriculture, and renewable energy projects. These investments can reduce the long-term costs of climate-related disasters, stabilize revenue flows. Particularly enhancing agricultural resilience and seek international collaborations for climate financing and technical support. Conduct institutional reforms aimed at improving transparency, reducing corruption, and enhancing public financial management systems. Strengthening tax compliance, increasing revenue mobilization, and improving resource allocation are key strategies to ensure that governments can meet their fiscal obligations without undermining long-term development objectives. Reduce dependency on foreign-denominated debt; Countries should aim to minimize their exposure to foreign-denominated debt by developing domestic capital markets and issuing debt in local currencies whenever possible. To optimize fiscal benefits of FDI, governments may revise their strategies to draw investments that foster long-term growth and sustainable development. This entails concentrating on non-extractive sectors such as manufacturing, technology, and services, which are more probable to provide employment and substantially enhance local tax revenue. Moreover, debt transparencies to adhere to IMF framework with clear mechanisms for reporting and monitoring public debt to avoid unsustainable debt accumulation.

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ABBREVIATIONS

CBO	Congressional Budget Office
CCG	Climate Change Gap
EIB	European Investment Bank
ESG	Environmental, Social and Governance
FAO	Food and Agricultural Organization
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GHG	Green House Gas
IMF	International Monetary Fund.
OECD	Organization for Economic Co-operation and Development.
SDG	Sustainable Development Goals
SSA	Sub Saharan Africa
UNCTAD	United Nations Conference on Trade and Development.
UNEP	United Nations Environmental Programme
UN-OSAA	United Nations Office for the Special Adviser on Africa
UNWTO	United Nations World Tourism Organization

OPERATIONAL DEFINITION OF TERMS

Climate Change; refers to long-term alterations in temperature, precipitation patterns, and other atmospheric conditions on Earth, primarily driven by human activities such as the burning of fossil fuels, deforestation, and industrial processes. These activities contribute to the release of carbon emissions, which increase the concentration of greenhouse gases in the atmosphere and lead to global warming.

Economic growth: The sustained increase in a country's production of goods and services over time, typically measured by changes in gross domestic product (GDP), reflecting improvements in living standards and well-being (Mankiw et al., 2019).

Fiscal Sustainability; Fiscal sustainability refers to a government's capacity to manage its finances in a way that ensures its ability to meet current and future financial obligations without resorting to excessive borrowing or undermining economic stability.

Foreign Direct Investment: Investment made by a company or individual from one country in business interests in another country, typically involving a long-term relationship and a significant degree of control over the foreign enterprise (Caves, 2018).

Foreign Exchange Rate refers to the value of one country's currency in relation to another country's currency.

Human Capital; refers to the skills, knowledge, experience, and abilities possessed by individuals, which contribute to their productivity and economic value. In terms of health and education, human capital

emphasizes the importance of investments in both physical well-being and intellectual development.

Institutional Quality refers to the effectiveness, transparency, and reliability/stability of institutions within a society. High institutional quality is characterized by the rule of law, low corruption, efficient public services, and accountable governance, which are essential for promoting sustainable development and attracting investments.(World Bank, 2020).

Population; The total number of individuals inhabiting a specified area, often considered in relation to factors such as resource consumption and environmental impact (World Population Review, 2019).

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter consists of the background of the study, statement of the problem, the objectives of the study, the research hypothesis, and significance of the study and scope of the study

1.1 Background of the study

Fiscal sustainability and climate change are critical global issues. Governments and international organizations have recognized that coordination between the economy and the environment is vital to the success of the sustainable development goals (SDGs) hence have recognized the need to address them both simultaneously. The concept of fiscal sustainability refers to the ability of a government to sustain its current spending, tax and other policies for longer period without failing on some of its liabilities or promised expenditures (Akram & Ratn 2019, Chen 2014, Alesina & Perotti 1990). This involves balancing revenue and expenditure while maintaining an acceptable level of debt, and ensuring that public finances are resilient to both internal and external shocks. According to Alesina and Perotti (1990) it refers to the ability of countries and global economy as a whole to maintain responsible fiscal policies over the long term to ensure the debt-to-GDP ratio is stable.

Fiscal sustainability remains a significant hurdle for many nations globally and more adverse in Sub-Saharan African countries. Ideally, these nations would achieve a balanced budget or even a modest surplus. This would require minimal reliance on debt, with a national debt hovering at a low percentage of GDP as outlined by the IMF Debt Sustainability Framework (IMF 2023). This framework suggests a prudent target of

keeping the present value of debt-to-GDP ratio below 50%. Public spending would be efficient, focusing on essential services, infrastructure development, and social programs, while strong institutions with transparent governance would implement sound economic policies that promote long-term growth.

The reality, however, paints a different picture. Many nations particularly SSA countries struggle with revenue shortfalls and high debt levels, meaning a significant portion of their budget goes towards interest payments. Budget deficits are common, with spending exceeding revenue and necessitating borrowing. The IMF 2023 report states that many African countries rely heavily on commodities exports, and when commodity prices drop, government revenue plummets coupled with weak tax collection systems further constraining revenue generation. Furthermore, poor fiscal management is exhibited due to institutional weaknesses like inadequate governance and a lack of long-term planning (UN-OSAA 2022).

The absence of fiscal sustainability presents a multitude of dangers for a country, jeopardizing its economic well-being and social stability. High and ever-growing debt burdens can crowd out private investment, hindering economic growth. This occurs when governments compete with businesses for loanable funds, driving up interest rates (OECD 2023, Kose et al., 2016). Furthermore, governments may be forced to slash spending on essential services and infrastructure to meet debt obligations, further limiting economic potential and fiscal space which restricts a government's ability to respond to economic downturns or unforeseen events.

The grave issue of national debt solvency, faced by many countries as well as the global financial crisis of 2008 have brought up the debate of how countries can pursue macroeconomic stabilization policies while maintaining the growth of public debt on a

sustainable path (IMF 2023, Obed .et.al 2022, Matuka & Asafo 2018, Adesuyi & Falowo 2013). Developing nations were completely affected by the crisis, despite not being its cause. For several of them, the decline in international trade resulted in severe budgetary imbalances (Collignon, 2012). Inefficiencies in public spending and deficiency in tax collection systems made the situation worse. Consequently, since 2009, fiscal balances have declined dramatically, giving rise to worries that these nations' public finances may eventually become unsustainable (Obed .et al 2022).

The amount of debt in the world is still growing and has been for a while i.e. from 22USD trillion in 2002 to 92USD trillion in 2022 (UNCTAD 2023). Globally, governments rank as the second largest recipients of financial loans (IMF 2023). In both developed and developing nations, the topic of fiscal sustainability has taken center stage in policy discussions since the 2008–2009 global financial crises (D. Mihaljek 2009, M.Canbaz 2019, Nguyen et.al 2010, World Bank, 2018). More specifically, one of the biggest threats to the world economy is thought to be fiscal imbalances (Omiete & Timise 2023, Keho 2016). In USA the fiscal deficit rose by 11.5% in 2023 from a deficit of -5.2 in 2022. The projections indicate an upward trend of up to 92.3% by 2050 (CBO 2023, IMF 2023). OECD 2023 economic outlook reported an increase in fiscal deficit of 41.17% for OECD countries with the UK reporting a debt to GDP ratio of 102.5% in 2023 up from 101% in 2022 illustrating persistent fiscal pressures.

In Asia, fiscal imbalances vary across countries with emerging economies experiencing different levels of fiscal sustainability (Rajakaruna & Suardi 2021, Duy-tung Bui 2019, J. Lee 2017). While some countries maintain prudent fiscal policies, others face challenges due to high government expenditures and limited revenue mobilization. For instance, Japan’s public debt surpassed 261.29 % of GDP in 2022 reflecting significant

fiscal pressure in the region (IMF 2022). Additionally, Mazarei (2023) reports of MENA region's ballooning debt problems which are deeply rooted in a blend of misfortune and poor policy decisions hence highlighting the grave issue of fiscal sustainability.

In comparison to other global regions, in Africa there is a sharp increase in fiscal deficits and public debts particularly SSA which has raised a major concern about sustainability of public finances (Kassouri and Altintas, 2021). The average debt ratio in SSA has almost doubled in just a decade from 30% of GDP at the end of 2013 to almost 60% of GDP by end of 2022 and more than half of low income countries were assessed by IMF to be at high risk or already in debt distress (IMF 2023). Moreover the region's ratio of interest payments to revenue, a key metric to assess debt servicing capacity and predict the risk of fiscal crisis, has more than doubled since early 2010 and is now close to four times the ratio in advanced economies (World Bank 2023). Thus increasing debt raises a serious problem to all of the goals that various citizens expect their government to pursue.

The debt portfolio in SSA is increasingly characterized by a shift from concessional loans to more expensive commercial debt (Gichuki 2018, IMF, 2023). Most SSA countries have turned to international bond markets, resulting in a higher cost of debt and increased exposure to global financial market volatility (ADB, 2021;IMF, 2023). Countries like Mozambique, Angola, and Zambia have particularly high levels of external debt, leading to concerns about fiscal sustainability.

With the onset of the pandemic COVID-19 in 2019-2020 Government debt significantly increased across Africa, (Abubakar 2020), which raises the questions about the nation's future wealth and whether too much debt could lead to higher interest

rates and even to loss of confidence in the nation's long-term ability and commitment to honor its obligation amidst several shock waves (Mugo et al 2021). Fiscal policy being a vital tool for managing and influencing the country's economy as well as providing a compelling argument for low carbon investment, is challenged by diverse unforeseen shocks (IMF 2023) e.g. Ukraine war, structural trends, unemployment and climate change which put additional pressure on public finances. The fiscal space is not sufficient to counter either a specific or diverse shocks. In the event of major negative shocks, like natural catastrophes, it might make it more difficult for governments to adopt efficient fiscal policy as a tool for managing macroeconomic risk. It is common to refer to "fiscal space" as the availability of such budgetary resources to implement successful fiscal policy (Nugraha & Darono, 2022).

Therefore, this subject becomes increasingly pertinent not only in Sub-Saharan Africa but also in the global economies which are hit by a variety of unanticipated shocks (Tibulca, 2021). A number of factors may influence the sustainability of public finances. However, this research is going to investigate the influence of climate change, institutional quality, foreign exchange rate and foreign direct investment (FDI) on fiscal sustainability. Governments, corporate and investors all around the world are aware of the need to increase integrated effort in Environmental, Social and Governance (ESG) factors into their policies and practices to help reduce carbon intensity of their economies, make them climate resilient and reduce social inequalities (ADB, 2022; OECD 2021).

In today's rapidly changing world, the significance of accurate weather forecasts cannot be overstated (Koem & Tantanee, 2022). Climate change poses significant challenges to fiscal sustainability as its impacts are far reaching, affecting various aspect of human

life including the economy, environment and social well-being (Agarwala 2021, Shirai 2022, World Bank 2021). Although there is limited empirical literature specifically focusing on the intersection of climate change and fiscal sustainability, researchers have started to acknowledge the potential implications of climate change on fiscal sustainability (Kling et al 2018, Parrado et al., 2020, Holland et al., 2021), even though UN Intergovernmental Panel on Climate Change (IPCC 2007) provided substantial scientific evidence regarding its impacts as far back as 2007.

Around the world climate change manifests through various observable phenomena such rising global temperatures, melting ice caps and glaciers, shifting precipitation patterns, increased frequency and intensity of extreme weather events, rising sea levels and changes in ecosystems and biodiversity (IPCC 2022). Global warming is primarily caused by the release of greenhouse gases (CO_2, CH_4-methane N_2O-nitrous oxide) in to the atmosphere. These events cause a lot of disruptions in production especially agricultural productivity and infrastructural damage leading to substantial economic losses, affecting government revenues, public expenditure and overall fiscal stability (Koetsier, 2017; Bachner 2018, Schuler et al., 2019).

As described in Bachner et al. (2015a), climate change impacts materialize in economic terms via five different channels: Changes in public relief payments, changes in production costs structures, changes in productivity, changes in final demand as well as changes in investments. Changes in public relief payments directly affect the structure and level of public expenditures, whereas the other four channels work in an indirect way, as they affect the tax base. The associated disruption of economic activity affects taxable income and growth similarly (Acevedo, 2014; Botzen et al, 2019; Schuler et al, 2019). Other impacts include the effects of inflation and interest rates due to supply or

demand shocks (Farhi and Gabaix, 2016), changes to commodity prices and damage to physical property requiring intervention programmes.

Carbon emissions which contribute immensely to global warming have emerged as a critical issue on the global agenda. The Paris Agreement (2015), a global effort to combat climate change, recognizes the importance of reducing carbon emissions from all sectors, including buildings (Baek & Lee, 2019). Focusing on reducing electricity consumption and increasing energy efficiency in buildings is critical to achieving the Paris Agreement commitment and the United Nations Sustainable Developments Goals (UNSDG). (Wang et al., 2021).

Both COP27 and Paris Agreement recognizes the need to reduce carbon emissions and transition to more sustainable energy sources in order to combat climate change. By transitioning to cleaner and more sustainable energy sources in the oil and gas sector, countries can reduce their carbon emissions and minimize the long-term economic risks associated with reliance on fossil fuels (Tol, 2018). Governments spend considerable amounts of funds to subsidize the production and consumption of energy. This fiscal entanglement creates specific challenges for countries in preparing for low carbon future. Despite largely not having contributed to global warming, SSA countries confront significant adaptation needs and are constrained by a lack of fiscal space, limited capacity, or both (IMF. 2021)

In SSA, the primary emphasis of climate change policies has been on adaptation and mitigation. This involves the implementation of Nationally Determined Contributions (NDCs) by nations in accordance with the Paris Agreement. Nevertheless, the execution of these programs has been hindered by insufficient financial resources and institutional capability. The Green Climate Fund and other international mechanisms have offered

partial assistance; however the money remains insufficient in comparison to the magnitude of the problem (UNEP, 2021). The cost of adaptation and mitigation efforts can strain public budgets (Parrado et al., 2020). The transformation of infrastructure and energy systems to be low-carbon requires significant investments (Bastien-Olvera & Moore, 2020, Agarwala 2021).

The impacts of climate change on Sub-Saharan Africa are far-reaching, affecting both the environment and the economy. Climate change poses a significant threat to key sectors such as agriculture, water supply, and infrastructure, which are vital for the region's economic development (Deressa et al 2008). Increased temperatures and changes in precipitation patterns are expected to have a detrimental effect on agricultural productivity in Sub-Saharan Africa. This is particularly concerning as agriculture serves as the backbone of many economies in the region, providing employment opportunities and contributing to food security. As a result, climate change could lead to a decrease in crop yields, an increase in food prices, exacerbating poverty and inequality, strain a country's finances and increase its debt burden. (Gonzalez 2022, World Bank 2021).

Given the difficulties presented by climate change for fiscal sustainability, it is essential to prioritize strong institutional quality to achieve sustainable development goals. While energy is estimated to grow under current and announced policies to achieve the UNSDG’s objectives and climate targets set at COP 212, a dramatic reshuffle in the world of fiscal discipline, mobilization of private capital and institutional quality will need to take place (Latif. et al 2023,. Musah 2023, Azam et al 2021, Barbier2021). Institutional quality refers to the effectiveness, transparency and efficiency of institutions within a country, including government agencies, legal systems, regulatory

bodies, and public administration. It encompasses aspects such as rule of law, control of corruption, government effectiveness regulatory quality and voice & accountability (Acemuglu et al 2008; Azam et al 2021)

The importance of institutional quality towards fiscal sustainability is significant. Strong and transparent institutions play a crucial role in ensuring sound fiscal management, promoting economic stability and enhancing investor confidence (Musah 2023, Kwaw-Nimeson & Tian, 2023; Acemoglu & Robinson 2012; Nguyen & Luong 2021). Institutions that prioritize fiscal transparency, codes of good practices and fiscal discipline contribute to fiscal sustainability. This is because institutional factors directly impact the ability of governments to manage public finances, ensure transparency and accountability, and maintain a stable fiscal environment (Nguyen& Luong 2021, Kargol-Wasiluk & Wildowicz-Giegiel, 2018).

On the other hand institutional quality is an important pillar of not only sustainable economic growth but also green growth which consists of combinations of low carbon emissions, macroeconomic growth, environmental protections and social inclusion (Ahmed.et al., 2021; Ahmed. I et al., 2020). Quality institutions augment economic sustainability by ensuring domestic resource optimization with equitable development principles (Khan et al., 2019).

Institutional frameworks direct policy, as well as the procedures for allocating resources so that public money can be used to implement pertinent initiatives, programs, and policies (Hussein, 2023). It plays a crucial role in shaping foreign exchange rates and can have significant implications for a country's economy (Chee Loong Lee.et al 2023). Weak institutional quality, characterized by corruption, political instability, and

inadequate governance mechanisms, can undermine investor confidence and lead to a depreciation of the local currency.

Additionally, institutional quality influences the effectiveness of debt relief measures. Countries with stronger institutional quality are more likely to successfully implement and benefit from debt relief programs, as they have the necessary governance mechanisms in place to ensure that the resources from debt relief are used effectively and efficiently for economic development (Hussein, 2023).

Fiscal policy is also affected by Foreign exchange rate fluctuations/ volatility thus can have an impact on a country's fiscal sustainability. When a country's currency depreciates, it can lead to higher import costs, which can increase government spending and worsen fiscal deficits (Odera 2015). This can have implications for debt sustainability as increased borrowing may be necessary to cover the deficit (World Bank, 2018).

The study of (Kuncoro, 2011) highlights several factors that contribute to the link between foreign exchange rate and fiscal sustainability. These factors include the adjustment of debt maturity with tax revenues, exchange rate fluctuations, foreign exchange reserves, consumption expenditure, and government investment spending. Additionally, the document emphasizes the impact of capital flows on exchange rate regimes and how it can lead to a real appreciation of the exchange rate and a worsening of the current account, which in turn affects fiscal sustainability. The SSA countries face massive debt accumulations and some countries are already in distress. The transactions by these countries and the developed nations are transacted in dollars hence it is imperative to analyze the effect of foreign exchange rate fluctuations on the fiscal structure.

It is also important to note that majority of SSA countries rely on external financing (debt) a move that compromises the stability of exchange as highlighted by (Nguyen, 2018). The maturity and composition of the debt play a crucial role in maintaining exchange rate stability and any misalignments can complicate the assessment of fiscal sustainability. Same insights are raised by (Shevchuk & Kopych, 2018) that factors such as debt maturity, exchange rate fluctuations, and foreign currency exposure can significantly impact the sustainability of fiscal policy.

However, in developing nations, the relationship between foreign exchange rates and fiscal sustainability can be particularly challenging. These countries often have lower levels of fiscal flexibility and may heavily rely on external borrowing to finance their budget deficits or debt obligations (IMF 2023). As a result, any volatility or misalignment in the exchange rate can have significant implications for their fiscal sustainability. Moreover large depreciations can lead to an increase in public sector debt and deterioration in fiscal positions (Cruz-Rodríguez, 2013). Therefore, careful management (through institutional quality) of the exchange rate regime and external debt is essential for ensuring long-term fiscal sustainability.

Achieving the Sustainable Development Goals (SDGs) and fulfilling climate change obligations necessitates substantial investment. Foreign direct investment (FDI) can significantly contribute to fulfilling these investment requirements. The efficacy of FDI flows in this context relies not alone on their volume but also on their ability to promote sustainable development. FDI would play a crucial role in addressing fiscal sustainability by providing financial support to countries burdened with high current account deficits, (through corporate income tax revenue for the government) helping them achieve fiscal stability and create conditions for long-term economic growth. It

is imperative to mention that FDI is attracted by a sustainable fiscal and monetary policy of a country. A weak fiscal position raises difficulties in countries to respond to shocks and can discourage investors (Pires et al 2023).

Emerging market and developing economies currently are considered the perfect destination for FDI and as such are encouraged to adopt measures to improve the public debt profile within sustainable threshold (IMF, 2021). SSA is a prime example, however high public debt levels can be a deterrent to FDI because large debt burdens can limit government spending on infrastructure and social programs, reducing the overall attractiveness of the economy.

1.1.2 Sub Saharan Africa

This is an area that lies south of the Sahara Desert of the African continent thus all countries that are located in this region are termed as Sub-Saharan African countries. It consists of forty nine countries. These countries' economies are highly dependable on their natural resource and much of the realm's economic activity is conducted in the informal sector. This makes them highly vulnerable to climate change and other chronic buildup of vulnerabilities such as imbalances caused by servicing of debt (UNEP 2023). Sub-Saharan Africa continues to face the challenge of achieving fiscal sustainability as the region grapples with high public debt levels, constrained revenue bases, and substantial expenditure needs (Obinyeluaku, 2015, IMF 2023, ADB 2023). Despite various reform efforts to enhance fiscal management in the region, countries continue to operate under volatile fiscal conditions characterized by chronic fiscal deficits and a burgeoning public debt (World Bank 2022, Gichuki 2018). For instance, average overall fiscal deficit had marginally declined while public debt experienced a lift, increasing from an average of 49% of the GDP during 1997-2006 to 50% during 2007-

2016. However by 2022 the fiscal deficit had increased to -5.2% and public debt at 57% (IMF 2023). This clearly attests to the fact that in the wake of persistent external macroeconomic shocks such as the recent global economic depression and Covid 19 pandemic, the pursuit for fiscal sustainability in the region has remained a far-fetched phenomenon.

Most countries in this realm are in the earlier stages of the index of economic development and as such are classified as either low or low-middle income countries. The sub-Saharan region faces low not steady economic growth. According to World Bank report (2022) Economic growth in Sub-Saharan Africa (SSA) slowed to 3.6% in 2022, from 4.1% in 2021; and economic activity in the region is projected to further slow down to 3.1% in 2023. The downgrade is attributed to harsh global and domestic financial conditions, high inflation, global warming and high debt levels (UNEP 2023). Moreover this growth is not uniform across sub-regions and countries. The GDP growth of Western and Central Africa is estimated to decline to 3.4% in 2023, from 3.7% in 2022, while that of Eastern and Southern Africa declines to 3.0% in 2023, from 3.5% in 2022.

The fiscal landscape in SSA is far from uniform. Ghana serves as a cautionary tale. Despite initial economic booms, the country succumbed to excessive government spending, resulting in a staggering debt-to-GDP ratio exceeding 83% by 2022. This unsustainable trajectory raises concerns about its ability to meet future financial obligations. Conversely, Rwanda presents a beacon of hope. By prioritizing fiscal discipline, the nation has maintained a debt ratio below 50%. This commitment to sustainability has not only bolstered investor confidence but also fueled Rwanda's impressive economic growth trajectory.

On the other hand, the impact of climate change on fiscal sustainability in the region is a topic of growing importance (ADB 2022). Africa is the most climate-sensitive continent on the globe, and the economic and social costs of climate change are expected to grow as they are disproportionally high compared to other regions (UNEP 2020). The United Nations Economic Commission for Africa (2015) estimates that climate change could reduce Africa's GDP by 7% to 20% by 2100. Such estimates are based on the assumption of 4^{O} Celsius warming, a situation that is projected to lead to rapid expansion of deserts in the northern parts of Sub-Saharan Africa and the drying-up of the Congo Basin. Revenues from agriculture are expected to fall by 16-28 percent (World Bank 2021). In addition, climate change poses a significant threat to agriculture, which is the main source of employment for around 60% of the population in SSA. The alterations in precipitation patterns, recurrent periods of drought, and escalating temperatures are presently exerting an adverse influence on agricultural productivity. According to the World Bank (2022), climate change has the potential to decrease agricultural production by as much as 20% by the year 2050, which would worsen the issues of food insecurity and poverty.

Based on the Worldwide Governance Indicators from the World Bank, numerous nations in Sub-Saharan Africa (SSA) have poor scores on governance criteria. The average score for government effectiveness in Sub-Saharan Africa (SSA) in 2022 was -0.71 on a scale ranging from -2.5 to 2.5. This score suggests the presence of inadequate institutional frameworks (World Bank (2022).

Corruption remains pervasive in SSA, with the region scoring an average of 32 out of 100 on Transparency International's Corruption Perceptions Index (CPI) in 2023 (Transparency International, 2023).

In conclusion Sub-Saharan African countries (SSA) face triple challenges that are jeopardizing its efforts and slowing/eroding decades of developmental gains: Rising debt levels which has more than tripled since 2010 and an increasing frequency and severity of climate shocks (World Bank 2021). These challenges escalated with the break out of Covid- 19 as well as Ukraine war that halted the fiscal consolidation process of many countries coupled by weak institutions as well as lack of a political goodwill. In attempt to caution its people from adverse effects of war and the pandemic, the fiscal deficit of the region increased to 6.49% of GDP in 2020, up from the estimated 3.49% of GDP in 2018 as shown in the diagram below (IMF 2023)

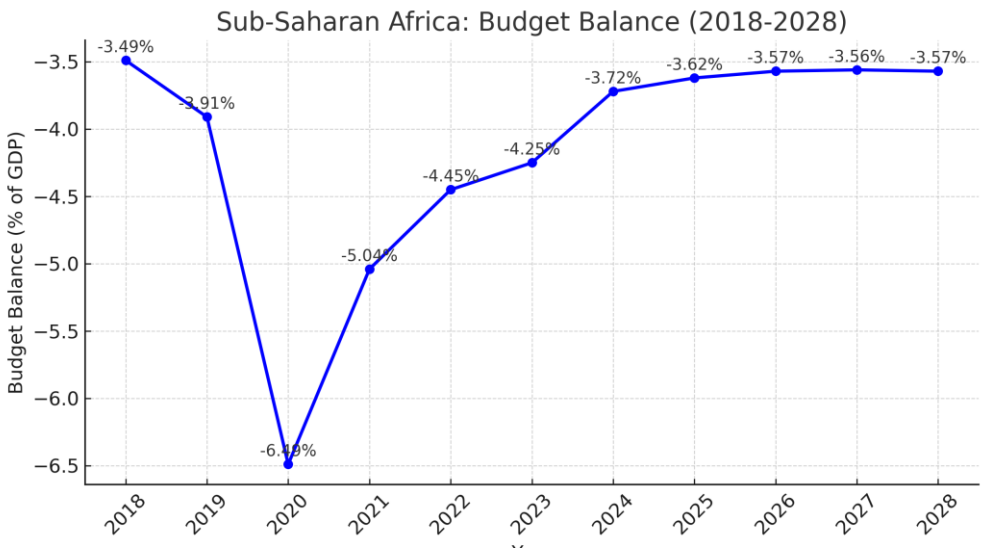

Figure 1. Sub Saharan Africa budget balance

Recent evidence from the IMF (2023) shows that due to the interconnectedness of these issues, countries now have deteriorating public finances, low resiliency to climate shocks, and insufficient resources to fund adaptation. Hence sovereign default becomes inevitable.

Despite largely not having contributed to global warming, these countries confront significant adaptation needs and are constrained by a lack of fiscal space, limited capacity, or both (Obinyeluaku, 2015, Thacker et al. 2019).

1.2 Statement of the Problem

Despite the numerous support and economic bailout that Sub Saharan Africa receives, it continues to suffer from a multifaceted fiscal issues encompassing increased government spending, limited governance quality and widen budget /fiscal deficits which have led to massive debt accumulation (heavy debt burden surpassing the 40%-threshold). The volume of nominal public debt stood at 1.14 USD trillion at the end of 2022 , a figure believed to have more than tripled since 2010 (IMF 2023). The fiscal deficit widened to 5.2 % of GDP in 2022, up from an estimated 4.8 % of GDP in 2021. This pushed the median public debt-to-GDP ratio from 32 % in 2010 to 57 % in 2022. The number of SSA countries at high risk of external debt distress or already in debt distress currently stands at 22 (up from 20 in 2020) (World Bank 2023). This imbalance has an overall negative effect on the fiscal structure and space (narrowed space) which results to fiscal sustainability challenge confronting governments in the SSA, which is exacerbated during a time of crisis. It thus raises the question of how can African countries achieve fiscal sustainability while meeting their climate financing goals and conducting domestic infrastructural developments?

SSA's economy is heavily reliant on natural resources, making it highly vulnerable to climate change and other structural challenges (Adika, 2020; World Bank, 2018). These vulnerabilities impact public finances and government expenditures. While the economic effects of climate change are increasingly evident, there is a lack of studies addressing its relationship with fiscal sustainability (Osberghaus & Reif, 2010; Bachner

& Bednar-Friedl, 2019; IMF, 2021). Furthermore, the region's poor institutional frameworks hinder fiscal stability. Weak institutions, marked by corruption and inefficiency, are linked to poor economic performance (Aron, 2000; Butkiewicz & Yanikkaya, 2006).

Public debt in SSA is a growing concern, with interest payments posing a significant burden on economic growth potential (Oliver, 2011). Most SSA countries' public debt is denominated in foreign currency (95%), exposing them to exchange rate risks, which exacerbate fiscal rigidities and broaden the fiscal burden (EIB, 2022; Helmut, 1988). Foreign Direct Investment (FDI) can potentially improve debt servicing by stimulating growth and revenue (Lim & Groschek, 2021). However, attracting FDI often requires significant government spending, initially widening fiscal deficits (Asiedu, 2022). Moreover, FDI is concentrated in the extractive industries, exposing the region to global commodity price fluctuations and limiting broader economic benefits (UNCTAD, 2023).

While studies have addressed these issues separately, a comprehensive analysis of how climate change, institutional quality, exchange rates, and FDI affect fiscal sustainability in SSA is lacking. This study aims to fill this gap by providing a holistic examination of these interconnected factors and their implications for fiscal sustainability in the region.

1.3 Objectives of the study

1.3.1 General objective of the study

The study analyzed the relationships between climate change, foreign exchange rates, institutional quality, foreign direct investment, and fiscal sustainability

1.3.2 Specific Objectives of the study

1. To determine the effects of climate change on fiscal sustainability in SSA
2. To determine the influence of institutional quality on fiscal sustainability in SSA
3. To determine the influence of foreign exchange rate on fiscal sustainability in SSA
4. To determine the effect of FDI on fiscal sustainability in SSA

1.4 Hypotheses of the study

H_{O1}: Climate change has no significant effect on fiscal sustainability in SSA

H_{O2}: Institutional quality do not significantly influence fiscal sustainability in SSA

H_{O3}: Foreign exchange rate do not have a significant impact on fiscal sustainability in SSA

H_{O4}: FDI has no significant influence on fiscal sustainability in SSA

1.5 Significance of the Study

The study provides a holistic understanding of the complex interactions between climate change, macroeconomic factors, institutional quality and fiscal sustainability. This multifaceted approach allows for a more comprehensive analysis of the challenges and opportunities faced by sub Saharan countries. The study's findings are crucial for policymakers to educate SSA countries on the driving factors behind fiscal imbalance, how it affects sustainable development, and what can be done to improve the situation.

Fiscal sustainability is key for the achievement of SDGs. This study contributes to policy discourse by offering practical solutions to enhance fiscal sustainability, strengthen governance, promote climate resilience, and optimize FDI strategies. It offers practical policy recommendations to governments, international organizations

and development partners. Policy makers may use the insights to design strategies that address climate change, improve fiscal sustainability and promote economic growth.

This study serves as a roadmap for policymakers seeking to enhance fiscal sustainability, promote climate resilience, and implement governance reforms. Its insights can shape policies that support stable, inclusive, and sustainable economic growth across the region. Sub-Saharan Africa is particularly vulnerable to the impacts of climate change, including extreme weather events, droughts, and food insecurity. Therefore addressing carbon emissions is essential for mitigating climate change and building resilience to its adverse effects. Research on climate change, institutional quality, and FDI can provide valuable insights into the drivers of environmental degradation and opportunities for transitioning towards cleaner and more sustainable energy systems in the region. By identifying policy measures to reduce carbon emissions while promoting economic growth, research can contribute to global efforts to combat climate change and achieve sustainable development goals.

Business and investors operating in sub Saharan Africa will gain from the study by gaining a deeper understanding of fiscal and environmental risks they face. The knowledge can guide risk mitigation strategies and sustainable investment decisions. Investors are increasingly recognizing the importance of sustainability and environmental considerations in their decision-making processes. Understanding both economic and environmental dynamics as well as institutional quality in Sub-Saharan Africa can provide valuable insights for investors seeking opportunities in the region. By assessing the environmental sustainability of investment projects, identifying emerging trends in climate mitigation and adaptation, and evaluating the weight of

governance factors on project risks, investors can avert risks and align objectively with their environmental, social, and governance (ESG) criteria.

The research aligns with several United Nations Sustainable Goals (SDGs) including those related to climate action, responsible consumption and production, and partnerships for the goals. It will contribute to the global agenda for sustainable development. The findings will have relevance for international agreements related to climate change and sustainable development as it will inform negotiations and commitments made by SSA countries in global climate and trade agreements.

Institutional quality plays a critical role in shaping fiscal policies, regulatory frameworks, and investment climates in Sub-Saharan Africa. Weak governance structures, corruption, and regulatory barriers often hinder progress. The findings of this study urges governments in SSA to implement institutional reforms aimed at improving transparency, reducing corruption, and enhancing public financial management systems. Strengthening tax compliance, increasing revenue mobilization, and improving resource allocation are key strategies to ensure that governments can meet their fiscal obligations without undermining long-term development objectives.

The study enriches the academic literature. Academia plays a vital role in advancing knowledge and understanding the field of environmental economics, public policy and economic development. Academics can use findings from the study to develop theoretical frameworks, test hypotheses, and refine methodologies for studying complex socio-economic and environmental issues. Moreover, academic research can inform interdisciplinary collaborations, policy debates, and capacity-building efforts aimed at addressing the region's energy and sustainability challenges.

1.6 Scope of the study

The study covered climate change, institutional quality, foreign exchange rate, foreign direct investments and fiscal sustainability. The study focused on 49 countries in Sub-Saharan Africa between the years 2000 to 2023. The study employed secondary data and panel approach as it involved observing a broad cross section of countries over time

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview.

This chapter reviews the extant literature by providing a review of concepts, theories and empirical studies leading to conceptual framework.

2.1 Concepts of the Study

2.1.1 Fiscal Sustainability

Fiscal sustainability is a crucial aspect of a country's economic stability. It refers to the ability of a government to manage its finances in a way that ensures long-term solvency and avoids excessive accumulation of debt. This requires the government to have the fiscal capability (balance between tax revenues and government expenditure) to meet its debt obligations consistently and retain its current policies for an unlimited duration (Chepnyongoi & Kiriga, 2020). It indicates the structural health of a country, ensuring ongoing revenue is sufficient to cover recurring costs and whether the government can handle future challenges without compromising service quality or financial stability (Pradhan, 2015).

Several indicators help gauge whether a local government is on a sustainable path. First, structurally balanced budgets, where ongoing expenditures are matched by ongoing revenues, are foundational. Healthy reserves, typically in the range of 15 to 25 percent of annual operating expenditures, provide a buffer against economic downturns or unexpected costs. A well-balanced revenue portfolio that grows with the economy is another sign of sustainability. And perhaps most importantly, a country should have a credible, long-range financial forecast that identifies fiscal imbalances before they become unmanageable (Marín-Rodríguez et al. 2023; Kaur et al. 2022).

It calls for governments to shift the focus from year-to-year survival to long-term service delivery and investment. This means that a sustainable fiscal policy should be able to pay off debt while maintaining the consistency of fiscal policies and controlling revenue volatility. In other words, a government with fiscal sustainability is able to fund its budget without excessive accumulation of long-term public debt. Additionally, a sustainable fiscal policy aims to keep the debt-to-GDP ratio stable or even revert it back to its initial level (Alesina & Perotti (1996).

Considering fiscal and other measures to meet the expenditures required to provide goods and services promised to the citizens without defaulting on the same or other responsibilities, governments have been concerned about fiscal sustainability as a matter of public finance (Gondor, 2019). According to Mahmah and Kandil (2019), this is a fundamental tenet of macroeconomic stability and a primary area of emphasis in public finance management that requires space for smarter decisions, greater transparency and better alignment with community priorities and long-term financial goals.

However, for the majority of nations, fiscal sustainability has proven to be a significant challenge to governments due to a number of issues, such as poor financial risk management, inadequate policy design and implementation brought on by weak institutional frameworks or infrastructure that supports policy development and implementation, and lack of support from legislatures (Tofan et al., 2020). Additionally it requires careful budget management and the ability to react actively to changing economic conditions. It also necessitates making informed decisions based on factors such as interest rates, primary surpluses, and public debt levels. In line with literature, two factors often cited as contributing to fiscal sustainability are political instability and

the level of debt deepened by fiscal deterioration following the global financial crisis in 2008 (Abanikanda et al, 2023).

Political leaders play a crucial role in ensuring fiscal sustainability by implementing and executing budget processes effectively. They are sensitive to changes in the legal framework related to fiscal sustainability and may be impacted by speculation in global markets. They also bear the responsibility of reducing dependency on fiscal transfers from higher levels of government, as this reliance indicates a weakness in fiscal sustainability (Brender & Drazen, 2008). However, fiscal sustainability often takes a back seat in day-to-day governance. One reason is political: elected officials operate on election cycles that prioritize short-term wins and visible improvements. Long-term financial planning, while critical, doesn't always generate immediate credit or public recognition. Capacity is another challenge. Many finance teams are stretched thin managing annual budgets, audits and reporting obligations. Carving out time for forecasting and strategy development can feel like a luxury, especially in smaller or fast-growing communities. There's also a tendency to assume that strong reserves or recent economic growth equate to long-term stability. But even cities with solid financial snapshots can face structural deficits if cost growth consistently outpaces revenue capacity, particularly in communities reliant on property taxes constrained by legal caps. In short, sustainability is often neglected not because it's unimportant, but because it's easy to defer until it's too late.

Furthermore, fiscal sustainability is not only important at the national level but also at the local government level. A higher fiscal mismatch at the local government level is an evidence of a weakness in fiscal sustainability, which hinders the ability to finance expenditure using own-source revenues and reduces reliance on fiscal transfers. This

lack of fiscal sustainability at the local government level can ultimately hinder the implementation of public services provision and impede local economic development. Fiscal sustainability is a critical aspect of a government's budgetary framework, encompassing measures that maintain the stability of its financial position and promote sustainable economic development (Wójtowicz & Hodžić, 2021).

In the global arena fiscal sustainability state is currently under pressure due to a number of factors, including: The COVID-19 pandemic, which has led to a sharp increase in government spending and a decrease in revenue, war in Ukraine, which has caused energy prices to rise and has disrupted supply chains and aging population in many countries, which is putting additional strain on social safety nets. These factors have led to a rise in government debt levels around the world. In 2022, average global government debt-to-GDP ratio was 90%, up from 78% in 2019. In the United States, the federal debt-to-GDP ratio has reached 135%, the highest level in history (IMF 2022). In SSA the issue is complex and multifaceted with a wide range of factors contributing to the current state of affairs. First SSA is home to some of the poorest countries in the world, with a large majority of the population living below the poverty line. This means that governments have limited resources to raise revenue, making it difficult to finance essential services and infrastructure. Secondly, weak institutions have led to corruption, mismanagement and inefficient use of public funds. This can further strain government budgets and make it more difficult to achieve fiscal sustainability. Thirdly the region is vulnerable to a number of external shocks, such as natural disasters, commodity price fluctuations, and global economic downturns. These shocks can have a significant impact on government revenues and expenditures, making it more difficult to maintain fiscal sustainability. Fourthly, high levels of debt, which can make it difficult to finance essential services and infrastructure. For example,

Ghana's public debt-to-GDP ratio is over 70%, and Zambia's is over 100%. Fifth, SSA governments often struggle to collect enough revenue to meet their spending needs. This is due to a number of factors, including a large informal sector, low tax rates, and poor tax administration and lastly governments face increasing pressure on their spending budgets, due to factors such as population growth, urbanization, and rising demand for public services.

Based on the fiscal balance data, the developed nations are in a better position than developing nations. One factor is that the developed nations have a relatively high revenue-to-GDP ratio. This means that the government is able to collect a significant amount of tax revenue, which helps to finance its spending. Another factor is that they have a relatively low expenditure-to-GDP ratio; this means that the government is able to keep its spending in check (OECD 2022). In contrast, developing nations have lower revenue-to-GDP ratios and higher expenditure-to-GDP ratios (World Bank 2022). This means that they are struggling to collect enough revenue to finance their spending. As a result, they are running budget deficits and accumulating debt (OECD 2021).

Therefore, ensuring fiscal sustainability is crucial for maintaining macroeconomic stability, managing public debt levels, and promoting long-term economic growth. It is essential for governments to prioritize fiscal sustainability in order to ensure the stability and well-being of their economies both at the national and local levels (Krugman, 2015). In regard to local level Tomasz Uryszek (2018) evaluated the degree of fiscal sustainability in the economies of the Visegrad Group (V4) at the local government level. The paper employed two distinct approaches to assess the sustainability of the local government deficit: evaluating the no-Ponzi conditions and computing the threshold primary balance. The research period spanned from 2001 to

2016. Information was collected from the Eurostat database. The findings indicated that three out of four V4 countries fulfilled the initial no-Ponzi requirement. With the exception of Poland, all local governments had positive sums of discounted primary balances. Nevertheless, such amounts were inadequate to fully cover the initial amount of debt. It was exclusively feasible in Hungary. The prevalence of the Ponzi scheme was substantially diminished during the period of economic recuperation following the financial crisis of 2008-2009. In general, all countries have demonstrated the capacity to generate primary surpluses at the national level and have largely succeeded in stabilizing the ratio of local debt to GDP. Nevertheless, the surpluses in the Czech Republic, Slovakia, and Poland were inadequate to fully offset the initial debt level. Poland, in particular, should focus on generating larger primary local surpluses to prevent the occurrence of a Ponzi scheme and enhance fiscal sustainability at the local government level in the future. Hence, it is imperative for governments to take measures, such as monitoring and managing the fiscal balance and public debt, reducing dependency on fiscal transfers, and implementing relevant strategies.

Another approach to assessing fiscal sustainability is by analyzing the government's budget constraint (Akduğan & Agun, 2018). This approach, as described by Hamilton and Flavin, examines whether the current budget deficit or debt stock can be met with future budget surpluses. Furthermore, the concept of lifetime budget constraints is considered a marker of fiscal sustainability. In the literature, fiscal policy is often modeled using constant or time-varying policy rules to test long-run fiscal sustainability (Staszewska-Bystrova & Bystrov, 2022). These policy rules help determine if the historical dynamics of public debt align with the intertemporal budget constraint of the public sector, regardless of specific policy regimes implemented.

This sustainability is often evaluated by examining the dynamics of public debt and assessing whether the current fiscal policy can be sustained without significant adjustments to taxes or spending (Bornhorst et al., 2011). To evaluate fiscal sustainability, various techniques and analytical frameworks have been developed. One such framework is the fiscal trilemma, which highlights the challenge of balancing three potentially conflicting interests: maintaining a sustainable fiscal policy, implementing effective tax policies, and achieving economic equilibrium (Nugraha & Darono, 2022).

Fiscal sustainability is a crucial aspect of economic policy as it ensures the long-term stability and solvency of a country's finances. As highlighted in the literature, is closely linked to the dynamics of public debt (Ahmed & Juboori, 2020). Unsustainable fiscal policy occurs when the ratio of public debt to GDP continues to grow without limits, leading to potential economic sanctions such as inflation, fiscal austerity, unemployment, and monetary tightening. One widely used measure of fiscal sustainability is the comparison of the present value of the primary surplus with the debt/GDP ratio (Özkan, 2005). This measure, proposed by Blanchard and Cuddington (1996), helps determine if a fiscal policy package is sustainable and does not violate the government's intertemporal budget constraint. Additionally, the ability-to-pay concept is often considered when evaluating fiscal sustainability (Akduğan & Agun, 2018). It examines the ability of the central government or municipalities to fulfill their debt commitments and covers factors such as revenue generation, expenditure control, and debt repayment capacity. Therefore, to assess fiscal sustainability, it is important to consider measures such as the present value of the primary surplus, the debt/GDP ratio, the government's budget constraint, and the ability-to-pay concept (Özkan, 2005). These sources provide different perspectives and approaches to analyzing fiscal sustainability.

In summary, the literature on fiscal sustainability emphasizes the importance of analyzing the government's budget constraint and assessing whether the current budget deficit or debt stock can be met with future budget surpluses (Akduğan & Agun, 2018). Therefore, it is crucial for governments to continuously monitor and evaluate their fiscal positions, taking corrective steps when necessary to maintain sustainable levels of debt and ensure the long-term economic stability and growth.

In addition, the literature also suggests that a stable and consistent debt-to-GDP ratio is an important indicator of fiscal sustainability. In today's rapidly changing world, the significance of accurate weather forecasts cannot be overstated. Therefore, it is crucial for governments to continuously monitor and evaluate their fiscal positions, taking corrective steps when necessary to maintain sustainable levels of debt and ensure long term economic stability and growth. Through analyzing the level of government's budget constraint and assessing whether the current budget deficit or debt stock can be met with future budget surpluses (Akduğan & Agun, 2018, Ayyubi & Saputra, 2021, Priesmeier & Koester, 2014). The assessments should also consider environmental factors and can be achieved through effective fiscal planning, intergovernmental fiscal relations, and a strong institutional framework.

Therefore, ensuring fiscal sustainability is not only crucial for maintaining macroeconomic stability and managing public debt levels, but also for promoting long-term economic growth and development by fulfilling the responsibilities to stakeholders and the community through the sustainable provision of public services.

2.1.2 Climate change

Climate change is a long-term shift in global or regional climate patterns. These shifts may be a result of natural processes or human activities, such as the burning of fossil

fuels, which release greenhouse gases into the atmosphere. Greenhouse gases trap heat in the atmosphere, which causes the planet to warm. This warming can lead to a number of changes, including rising sea levels, more extreme weather events, such as droughts, floods, and storms, changes in agricultural yields, melting glaciers and ice sheets and loss of biodiversity

Over the past century, there has been a substantial evolution in the scientific understanding of climate change. The idea originated with the theories of Jean-Baptiste Fourier and Svante Arrhenius in the early 1800s. These theories described the greenhouse effect, which is the process by which certain gases in the Earth's atmosphere trap heat and cause the planet's surface to warm (Weart, 2008). Arrhenius (1896) was one of the first scientists to quantify the impact of carbon dioxide (CO_2) emissions on global temperatures, laying the groundwork for modern climate science. Furthermore the greenhouse effect is a fundamental concept in the field of climate science. It explains how greenhouse gases (GHGs) such as CO_2, methane (CH_4), and nitrous oxide (N_2O) collect and release infrared radiation, resulting in the warming of the Earth's surface. Over the years the Intergovernmental Panel on Climate Change (IPCC) has been instrumental in synthesizing scientific understanding on climate change. The IPCC annually publishes assessment reports (since 1990) that offer comprehensive evaluations of the scientific evidence about climate change, its consequences, and proposed strategies for mitigation. The Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC) in 2007 definitively stated that the climate system is undeniably warming. It also determined that the majority of the observed rise in global average temperatures since the mid-20th century is highly likely to be caused by the observed increase in human-induced greenhouse gas (GHG) concentrations.

The IPCC's Fifth Assessment Report (AR5) projected that, under a high-emission scenario (Representative Concentration Pathway 8.5), global temperatures could rise by up to 4.8°C by the end of the 21st century, with significant implications for ecosystems, human health, and economies (IPCC, 2013).

During the last century, there has been overwhelming scientific consensus that human activities are the primary drivers of recent climate change. The burning of fossil fuels (coal, oil, and natural gas) for energy production, transportation, and industry is the largest source of GHG emissions, accounting for approximately 76% of global GHG emissions in 2019 (IEA, 2020). Deforestation and land-use changes also contribute significantly to emissions by reducing the Earth's capacity to absorb CO_2 from the atmosphere (FAO, 2016).

In a nut shell, Climate change has emerged as one of the most critical global challenges of the 21st century, influencing a wide range of environmental, economic, and social systems. (Mukonza & Nhamo, 2017). It is widely recognized that climate change has the potential to disrupt economies at local, national, and global level hence affects various aspects of society (Jäger et al., 2023).

The impacts of climate change are already evident, with increasing incidences of extreme weather events and changes in ecosystems (Roesch et al., 2019). Its impact on the economy can be seen in multiple ways. One of the major effects is on agriculture, which is highly weather-dependent and therefore vulnerable to changes in climate patterns (Khamidov et al., 2022). These changes can lead to decreased crop yields, increased pest and disease prevalence, and reduced livestock productivity. As a result, food security may be compromised, leading to higher prices and potential shortages. Fluctuations in climate patterns can also lead to increased volatility in commodity

prices, affecting the values of currencies and creating challenges for international trade (IPCC, 2014, Lobell et al. 2008). The disruption of trade flows in turn leads to currency fluctuations and volatility in exchange rates which further increases debt burdens for countries that are affected (IMF, 2024). Moreover, climate change can also impact other key sectors of the economy such as tourism, energy, and infrastructure.

The tourism industry is a vital sector of global economies, contributing to job creation, economic development, and cultural exchange. However, climate change poses a significant threat to the sustainability and future growth of the tourism sector. According to (Higham & Cohen, 2011), climate change has both direct and indirect effects on the tourism industry. Direct effects on the tourism sector include the physical impacts on natural resources and tourist destinations (Tanoamchard & Limjirakan, 2012). These impacts can include increased temperatures, rising sea levels, changes in precipitation patterns, and extreme weather events such as hurricanes or droughts. These changes can lead to the degradation or loss of natural attractions, beaches, coral reefs, and wildlife habitats, reducing the appeal of tourist destinations. Indirect effects of climate change on the tourism sector include changes in tourist behavior and preferences. For example, as temperatures rise, tourists may seek cooler destinations or shift their travel plans to different seasons. In addition, tourists may become more environmentally conscious and prefer destinations that prioritize sustainability and climate action.

Climate change is already having a significant impact on the tourism sector in Sub-Saharan Africa. According to a study conducted by UNWTO and UNEP, rising temperatures and changing rainfall patterns are affecting the availability of water resources, which is crucial for tourism activities such as wildlife viewing, water-based

sports, and beach tourism. In addition, it is also leading to increased risks of extreme weather events such as droughts, floods, and storms, which can disrupt tourist activities and infrastructure in the region (Tanoamchard & Limjirakan, 2012). If climate change makes tourist destinations less attractive or increases the costs of travel, it could lead to a decline in tourism demand. This would reduce government revenue from tourism taxes and fees, and could also lead to job losses and a decline in economic activity. Moreover it could damage tourist infrastructure, which would require government spending to repair or rebuild. This could increase government debt and put a strain on fiscal sustainability (World Bank (2022), (IPCC 2021), (IMF 2022), (ACCAI 2022).

In the energy sector climate change also poses challenges for the supply of energy, particularly in regions that are heavily reliant on hydropower. As climate change alters rainfall patterns and decreases water availability, hydropower generation may be impacted, leading to potential energy shortages and the need for alternative sources of energy. Additionally, extreme weather events such as storms, hurricanes, and floods can damage energy infrastructure, disrupt power supply, and require costly repairs. According to a report from the Energy Transitions Commission (2020), an estimated annual investment of $1.475 to $1.8 trillion in green energy generation, transmission, and storage capacity, transportation infrastructure (including electric vehicle chargers), and industrial modifications (such as carbon capture) will be required globally to achieve net-zero emissions by 2050. This investment will come from both public and private sources.

Rainfall patterns play a significant role in determining agricultural production, which in turn influences government revenue from agricultural taxes and export earnings. Erratic rainfall patterns can lead to droughts, floods, and crop failures, resulting in

reduced agricultural output and lower tax revenues. This can strain government budgets and limit their ability to fund essential services and infrastructure projects (Burke & Lobell, 2015; World Bank 2014).

In countries with agriculture as a primary source of income, fluctuations in rainfall can directly affect tax collection. Reduced agricultural output due to insufficient rainfall can lead to lower incomes for farmers, reducing their tax liability. Additionally, disruptions in agricultural supply chains can impact the broader economy, affecting businesses and individuals, and potentially leading to lower tax revenues from other sectors (Wheeler & von Braun, 2013).

Droughts and floods often require government intervention to provide relief and support to affected communities. This can involve emergency food assistance, financial aid, and infrastructure repairs, all of which can strain government budgets. In severe cases, prolonged droughts or floods can necessitate large-scale infrastructure investments, such as irrigation systems or flood control measures, further increasing government expenditures (WFP 2017).

Developing countries with agriculture-dependent economies are particularly vulnerable to the fiscal impacts of rainfall variability. Their reliance on rain-fed agriculture makes them more susceptible to droughts and floods, and their limited financial resources make it more challenging to cope with the economic fallout of these events.

Carbon emissions and fiscal sustainability are interconnected issues that pose significant challenges for governments worldwide. The transition to a low-carbon economy requires substantial investments in clean energy technologies, infrastructure, and adaptation measures, which can strain government budgets and potentially impact fiscal sustainability. Carbon emissions contribute to climate change, which can have a

range of negative economic consequences that can strain government budgets and threaten fiscal sustainability **(**Stern, 2006)**.** These consequences include: droughts, floods, and natural disasters: Climate change exacerbates the frequency and intensity of extreme weather events, leading to increased spending on disaster relief, infrastructure repairs, and emergency services. For instance, Hurricane Katrina in 2005 resulted in over $125 billion in damages in the United States, much of which was covered by federal and state governments (Burby, 2006). Rising sea levels and coastal erosion threaten coastal communities and infrastructure, requiring costly investments in protection measures and relocation efforts (IMF 2020). Disrupted agricultural patterns and reduce crop yields, leading to lower tax revenues from agriculture and increased spending on food assistance and agricultural subsidies. It also exacerbates air pollution and increase the spread of vector-borne diseases, leading to higher healthcare costs and reduced economic productivity.

Addressing climate change requires a combination of mitigation and adaptation measures, both of which can have significant financial implications for governments. Mitigation measures, such as transitioning to renewable energy and improving energy efficiency, can involve upfront costs for investments in new technologies and infrastructure. Adaptation measures, such as building seawalls or relocating communities, can also be expensive and require long-term funding commitments (Stern 2006).

In order to mitigate the financial risks associated with climate change, governments are placing greater emphasis on the development of strategies and measures to adapt and build resilience. Adaptation policies have the objective of diminishing the susceptibility of economies to climate change by the allocation of resources towards infrastructure

development, the enhancement of agricultural methods, and the improvement of catastrophe readiness (UNFCCC, 2015). These investments, although essential, can be expensive, necessitating substantial initial public expenditure. Nevertheless, the literature highlights that the advantages of adaptation in the long run, such as decreased economic losses and improved fiscal stability, are greater than the associated expenses (Hallegatte et al., 2012).

Balancing these costs with the need for fiscal sustainability poses a challenge for governments. They need to find ways to finance climate action without undermining their ability to provide essential public services, manage debt obligations, and maintain economic stability (IPCC, 2014). Climate change can exacerbate debt dynamics by increasing the frequency and severity of economic shocks that necessitate borrowing. Governments in vulnerable regions often resort to borrowing to finance immediate disaster relief and recovery efforts, leading to an increase in public debt. Additionally, the long-term impacts of climate change on economic growth can reduce a country's capacity to service its debt, leading to concerns about debt sustainability (IMF, 2020). In low-income countries, where access to capital markets is limited, climate-related shocks can lead to unsustainable debt levels. For example, Mozambique, which was hit by Cyclone Idai in 2019, saw its debt-to-GDP ratio soar due to the costs of recovery and reconstruction, exacerbating an already precarious fiscal situation (World Bank, 2019).

A 2024 study by Monsod et al, examining fiscal sustainability in climate-vulnerable developing countries over the period 2010 to 2030 provides important insights into the growing fiscal pressures associated with climate change. The study introduces a novel approach by computing fiscal sustainability indices that compare a country’s actual tax

rate with the sustainable tax rate necessary to maintain a stable debt-to-GDP ratio. It distinguishes between short- and medium-term fiscal gap indices for the period 2010–2020 and a projected Climate Change Gap (CCG) for 2021–2030, which incorporates countries' reported climate-related financial needs. The findings reveal significant disparities among countries: approximately one-third of the sample face CCGs ranging from 10% to 99% of GDP, indicating severe fiscal stress, while another third exhibit negative CCGs, suggesting no immediate fiscal adjustment is required. However, the study cautions that these negative gaps may be misleading due to incomplete data, particularly on adaptation costs. The research underscores the urgent need for enhanced financial and technical assistance to enable vulnerable countries to accurately assess and finance their climate change adaptation requirements, ensuring fiscal sustainability in the face of escalating environmental challenges.

2.1.3 Institutional Quality

Effiom (2015) describes an institution as a process that arises from the entirety of a people's history, including the values they uphold and the traditions and culture they convey across generations. An institution is fundamentally a divine, moral, and spiritual framework that constitutes the subjective foundation of a people's societal and economic existence. On the other hand, North (2003) defines institutions as the formal and informal limitations limiting political, economic, and social relations. They constitute the regulations, enforcement procedures, and organizational structure.

Institutional quality refers to the effectiveness, efficiency, and integrity of the legal, regulatory, and administrative systems within a country. It encompasses a range of factors, including government effectiveness, rule of law, control of corruption, regulatory quality, and political stability (Kaufmann, Kraay, & Mastruzzi, 2010, World

Bank 2019). High-quality institutions are characterized by transparent and accountable governance, a well-functioning legal system, and competent public administration. It is an important concept in economics and public policy because it has a significant impact on a wide range of outcomes, including economic growth, poverty reduction, and fiscal sustainability.

There is a strong relationship between institutional quality and fiscal sustainability. Countries with strong institutions are better able to manage their finances and make sound fiscal decisions. This is because strong institutions are more likely to be independent of political interference and to be transparent and accountable (Acemoglu.et al. 2008). Institutional quality can promote fiscal sustainability in number of ways; first strong institutions can help to reduce corruption and tax evasion. This increases government revenue and reduces public debt. Secondly it can help to ensure that government spending is efficient and effective. This reduces the risk of government waste and overspending. Thirdly Strong institutions can help to build trust between the government and the public (Rodrik, D. 2004). This makes it easier for the government to borrow money at lower interest rates.

Conversely, weak institutions can lead to fiscal unsustainability. For example, countries with weak institutions are more likely to experience corruption and tax evasion, which reduces government revenue (Mauro, P. (1995). Weak institutions are also more likely to lead to inefficient and wasteful government spending. Institutions that are feeble or corrupt impede economic activity, perpetuate inequality, and erode social trust and cohesion.

Comprehensive reforms that are designed to enhance the rule of law, strengthen regulatory frameworks, and combat corruption are frequently necessary to enhance

institutional quality (World Bank, 2019). However, institutional reforms confront numerous challenges, including resistance from vested interests, capacity constraints, and political obstacles. Conversely, effective endeavors to enhance institutional quality can generate substantial benefits in terms of economic growth, poverty reduction, and general societal welfare.

Empirical studies have found that there is a positive relationship between institutional quality and fiscal sustainability. For example, a study by the World Bank (2018) found that countries with stronger institutions have lower debt-to-GDP ratios. Another study, by the IMF (2019), found that countries with stronger institutions are better able to adjust to shocks to their economies, such as natural disasters.

It is now widely acknowledged that controlling public debt is largely dependent on effective governance. Better financial risk management, lower borrowing costs, and improved growth of the domestic debt market are all possible with sound governance. Furthermore, improving domestic financial institutions and maintaining financial stability are possible with strong governance. Overall, institutional quality is an important factor in promoting fiscal sustainability. Governments should take steps to strengthen their institutions, such as by reducing corruption, improving transparency and accountability, and strengthening the rule of law.

Voice and accountability (VA) measures play a crucial role in fiscal sustainability by promoting transparency, participation, and oversight in government budgeting and spending (IMF 2018). Strong VA measures can help increase revenue collection by enhancing transparency and accountability in tax administration, which in turn reduces corruption and tax evasion, leading to higher revenue collection for the government (Grindle and Heckenberg 2016).

Additionally by fostering public participation and oversight, strong VA measures can encourage citizen engagement in monitoring government expenditures, preventing wasteful spending and misallocation of funds. Thus it promote efficient resource allocation by ensuring that government decisions are made in a transparent and accountable manner, as well as can help to prioritize investments in essential services and infrastructure, leading to more efficient resource allocation.

According to (Kaufmann and Kraay 2002) strong VA measures enhance debt management practices. It promotes public scrutiny of government borrowing, hence can encourage responsible debt management practices, preventing excessive borrowing and ensuring that debt levels remain sustainable. This in itself will strengthen public confidence in government and increase public trust in government institutions, leading to greater willingness to pay taxes and support government initiatives.

As it empowers citizens to hold the government accountable for its fiscal decisions, promoting sound financial management and long-term fiscal sustainability, improved economic growth and stability is enhanced. By enhancing fiscal transparency and accountability, a stable and predictable environment for businesses and investors is created, promoting economic growth and generating additional tax revenue.

It is truism that by addressing corruption, governments can create a more efficient and equitable allocation of resources, attract investment, and foster a more stable and prosperous society (Kumar et al. 2016, World Bank 2016). However many African leaders are reluctant to crack down on corruption because it is often a source of patronage and wealth for them and their supporters.

According to Transparency International's 2022 Corruption Perception Index, only 17 of the 54 African countries scored above 50 out of 100, indicating a high level of

corruption. Such information is detrimental to region progress as corruption diverts public resources away from essential services and investments, undermines investor confidence, and erodes public trust in government institutions. The statistics also insinuate that no or limited corruption measures are being undertaken by the majority of the African leaders. No greater commitment to fight corruption.

Corruption poses a significant threat to fiscal sustainability and economic prosperity, diverting resources away from essential services, hindering economic growth, and eroding public trust in government institutions. Addressing corruption is not merely a moral imperative; it is a crucial step towards achieving long-term fiscal sustainability and unlocking the full potential of African economies.

Corruption often manifests in the form of wasteful spending, as public officials divert funds for personal gain or engage in unnecessary or overpriced projects. This misallocation of resources undermines the effectiveness of public investments and hinders progress towards sustainable development goals. Additionally Irresponsible borrowing and debt accumulation, often driven by corrupt motives, can lead to unsustainable debt levels and jeopardize fiscal stability. Corruption can also distort debt management practices, leading to unfavorable terms and conditions for borrowing.

Further corruption creates an environment of uncertainty and risk, discouraging investment and hindering economic growth. Investors are less likely to invest in countries where corruption is rampant, as they perceive a higher risk of their investments being misappropriated or subject to unfair practices. It also erodes public trust in government institutions, making it more difficult to implement fiscal reforms and maintain public support for government programs. This lack of trust can undermine

the effectiveness of fiscal policies and hinder progress towards sustainable development.

Moreover it can lead to the misallocation of resources, as public officials prioritize projects that benefit their personal interests rather than the public good. This misallocation can result in inefficient use of public funds and hinder progress towards achieving development objectives. As a result corruption can hinder economic growth by creating an environment of inefficiency, uncertainty, and risk. It can discourage investment, stifle innovation, and lead to rent-seeking behavior that distorts market mechanisms.

Fiscal sustainability is the ability of a government to finance its current and future expenditures without jeopardizing long-term economic growth or imposing an undue burden on future generations. Achieving fiscal sustainability requires a combination of sound fiscal policies, economic growth, and efficient resource allocation (Mauro 1998). Institutional quality influences various aspects of development, shaping the distribution of resources, the efficiency of markets, and the effectiveness of public policies (Acemoglu & Robinson, 2019). Countries with well-functioning institutions tend to attract higher levels of investment, promote business confidence, and achieve more equitable distribution of wealth.

In addition to these traditional factors, the quality of regulations plays a crucial role in fiscal sustainability (Rose-Ackerman and Palifka 2016). High-quality regulations can promote economic growth, improve efficiency, and reduce risks, all of which contribute to long-term fiscal stability. Conversely, low-quality regulations can create uncertainty, hinder investment, and increase costs, potentially leading to fiscal instability (Tanzi 2012).

High-quality regulations can positively impact fiscal sustainability in several ways. They can foster a stable and predictable environment for businesses to operate, encouraging investment, innovation, and job creation, thus generating additional tax revenue for the government (Mauro 1998). Effective regulations can also reduce unnecessary administrative burdens on businesses, streamline processes, and promote competition, leading to increased productivity, lower costs, and better value for public funds (Rose-Ackerman and Palifka 2016). Additionally, sound regulations can mitigate risks associated with activities such as environmental damage, financial instability, or public safety hazards, preventing costly accidents, lawsuits, and disruptions that can strain government finances (Tanzi 2012). Furthermore, a strong regulatory framework fosters investor confidence, attracting both domestic and foreign investment, further stimulating economic growth and generating additional tax revenue (Wei 2000). Finally, well-crafted regulations can encourage environmentally sustainable practices and resource conservation, reducing long-term costs associated with environmental degradation and resource scarcity (Rose-Ackerman and Palifka 2016).

In contrast, low-quality regulations can have detrimental effects on fiscal sustainability. They can create uncertainty for businesses, discouraging investment and hindering economic growth, reducing tax revenue and limiting the government's ability to fund essential services (Rose-Ackerman and Palifka 2016). Excessive or poorly designed regulations can also lead to higher compliance costs for businesses, reducing their productivity and competitiveness, while also increasing the administrative burden on government agencies, diverting resources from other essential functions (Tanzi 2012). Inefficient regulations can distort markets, favoring certain industries or sectors at the expense of others, leading to misallocation of resources and economic inefficiencies, reducing overall productivity and tax revenue (Kaufmann and Kraay 2002). Low-

quality regulations that are perceived as unfair or ineffective can erode public trust in government institutions, making it more difficult to implement fiscal reforms and maintain public support for government programs (Rose-Ackerman and Palifka 2016). Unclear or poorly enforced regulations can create opportunities for rent-seeking behavior, where individuals or businesses seek to exploit loopholes or bribe officials for personal gain, diverting resources away from productive activities and undermining fiscal sustainability (Tanzi 2012).

2.1.4 Foreign exchange rate

The influence of foreign exchange rate fluctuations on fiscal sustainability is a complex and multifaceted issue (Krugman, 1999; Mussa, 2010). There are a number of channels through which exchange rate fluctuations can impact fiscal sustainability, and the specific effects can vary depending on a number of factors, including the country's economic structure (Kremers, 2004), its exchange rate regime (Rodrik, 2000), and its level of external debt (Obstfeld & Rogoff, 2000).

Exchange rate fluctuations can impact fiscal sustainability in a number of ways: Direct impact on the value of foreign-currency-denominated debt: When a country's currency depreciates, the value of its foreign-currency-denominated debt increases in terms of the local currency (Krugman, 1999). This can make it more difficult for the government to repay its debt and can increase the risk of default (Obstfeld & Rogoff, 2000).

Indirect impact on interest rates: Exchange rate fluctuations can also have an indirect impact on interest rates (Mussa, 2010). For example, a depreciation of the currency can lead to higher inflation (Kremers, 2004), which can in turn put upward pressure on interest rates (Rodrik, 2000). This can make it more expensive for the government to borrow money and can further strain its finances.

Impact on economic growth: Exchange rate fluctuations can also have an impact on economic growth (Krugman, 1999). For example, a depreciation of the currency can make exports more competitive and can therefore boost economic growth (Mussa, 2010). However, depreciation can also make imports more expensive, which can reduce consumer spending and investment (Kremers, 2004). The net impact of exchange rate fluctuations on economic growth is therefore uncertain (Rodrik, 2000).

However the impact of exchange rate fluctuations on fiscal sustainability will depend on a number of factors, including: The country's economic structure: Countries that are more reliant on exports will be more vulnerable to the effects of exchange rate fluctuations than countries that are more reliant on domestic consumption (Krugman, 1999). The country's exchange rate regime: Countries with fixed exchange rate regimes are generally less vulnerable to the effects of exchange rate fluctuations than countries with flexible exchange rate regimes (Mussa, 2010). The country's level of external debt: Countries with higher levels of external debt are more vulnerable to the effects of exchange rate fluctuations than countries with lower levels of external debt (Obstfeld and Rogoff, 2000).

In general, exchange rate volatility can have a significant impact on fiscal sustainability (Krugman, 1999; Mussa, 2010). Countries should therefore be aware of the potential risks and take steps to mitigate them (Rodrik, 2000).

Additionally country's foreign exchange reserves are essential for meeting its external financial obligations, such as servicing its foreign debt and importing essential goods and services. However a country's foreign exchange reserves can be depleted by a number of factors, including Current account deficits: When a country imports more goods and services than it exports, it runs a current account deficit. This leads to a net

outflow of foreign exchange. Through Capital flight which is the movement of money out of a country, often due to political or economic instability or If a country's currency devalues against other currencies, its foreign exchange reserves will be worth less in terms of foreign currency. Fiscal deficits can also lead to foreign exchange problems. When a government runs a fiscal deficit, it must borrow money to finance its spending. If the government borrows in foreign currency, it is exposed to foreign exchange risk. If the domestic currency devalues, the government will have to pay more to service its foreign debt (IMF 2019).

A depletion of foreign exchange reserves can have a number of negative consequences for fiscal sustainability. For example, a government with low foreign exchange reserves may have difficulty borrowing money to finance its budget deficit. This can lead to higher interest rates and a crowding out of private investment (Obstfeld and Rogoff 2019). In addition, a depletion of foreign exchange reserves can make a country more vulnerable to external shocks, such as a sudden stop in capital inflows. This can lead to a recession and a decline in government revenue, which can make it more difficult for the government to meet its financial obligations (Calvo (1999).

The relationship between foreign exchange reserves and fiscal sustainability seems complex but is one with a number of different factors. In general, higher foreign exchange reserves can help to improve fiscal sustainability by providing a buffer against external shocks, such as a depreciation of the currency or a sudden capital outflow (Dooley et al., 2003). However, the relationship is not always linear, and there are a number of factors that can influence the direction and magnitude of the effect (IMF, 2016).

One of the most important factors is the way in which foreign exchange reserves are managed (Rodrik, 2006). If reserves are managed in a sound and prudent manner, they can help to reduce the risk of a balance-of-payments crisis and can also help to stabilize the exchange rate (Obstfeld, 2004). However, if reserves are managed poorly, they can actually increase the risk of a crisis and can also lead to a loss of confidence in the country's currency (Habermeier, 2017).

Another important factor is the level of external debt (Reinhart et al., 2003). Countries with high levels of external debt are more vulnerable to the effects of external shocks, such as a depreciation of the currency (Rodrik, 2006). This is because depreciation can make it more difficult for the government to repay its debt, and can also lead to a higher cost of servicing the debt (IMF, 2016).

In general, the relationship between foreign exchange reserves and fiscal sustainability is positive (Obstfeld, 2004). However, the relationship is not always linear, and there are a number of factors that can influence the direction and magnitude of the effect (Krainer, 2017). Countries should therefore manage their foreign exchange reserves in a sound and prudent manner, and should also take steps to reduce their levels of external debt (Dooley et al., 2003).

Foreign exchange reserves can be used to defend the exchange rate from sudden depreciations (Obstfeld, 2004). This can help to reduce the risk of a balance-of-payments crisis, which can in turn help to improve fiscal sustainability (Reinhart et al., 2003). It can as well be used to provide a buffer against external shocks, such as a sudden capital outflow (Dooley et al., 2003). This can help to prevent the government from having to borrow large amounts of money in the short term, which can in turn help to reduce the cost of servicing the government's debt (IMF, 2016).

Foreign exchange reserves can be used to help to stabilize the exchange rate (Krainer, 2017). This can help to reduce uncertainty for businesses and investors, which can in turn help to boost economic growth (Habermeier, 2017). This can also help to reduce the risk of inflation, which can also help to improve fiscal sustainability (Rodrik, 2006).

However, it is important to note that foreign exchange reserves are not a panacea for all fiscal problems. Countries should also take other steps to improve fiscal sustainability, such as reducing their budget deficits and improving public debt management (Obstfeld, 2004).

2.1.5 Foreign Direct Investment

Foreign direct investment (FDI) refers to the total annual amount of money that foreign investors spend in a given economy through different sectors of activities (Dornean & Oanea, 2014). Foreign direct investment (FDI) is a crucial economic component of a nation's relations with the global community. One type of foreign investment known as FDI is the purchase of long-term assets in another nation (Malik, 2015). FDI is defined as an investment made by investors who possess at least 10% of the voting power in a foreign firm, according to Babu et al. (2020). FDI could take the form of opening a new location in the target nation, buying shares, growing a company's activities there, taking part in a joint venture or merger, or finishing the acquisition of a foreign business (Onuoha et al., 2018).

Every global economy aspires to achieve economic development, which is anticipated to have a knock-on effect of raising living standards and livelihoods. It is asserted that FDI significantly contributes to improving the macroeconomic conditions of the receiving country, fostering innovation, and strengthening the business climate (Agyemang et al., 2023). By accumulating wealth, advancing technology, and

advancing industry through the gathering and application of funds, FDI promotes economic sustainability (Samwel, 2016). When foreign companies invest and establish businesses in a host country, they generate corporate income tax revenue for the government. This can help improve the government's fiscal position and create more space for investment in essential services and infrastructure.

FDI can act as a catalyst for economic growth by creating jobs, increasing exports, and fostering technological advancements (Samwel, 2016). A growing economy typically leads to a rise in tax revenue, further strengthening fiscal sustainability. In some cases, foreign investors might invest in infrastructure projects like roads, power plants, or telecommunications. This not only benefits the overall economy but can also reduce the financial burden on the government, allowing them to focus resources on other areas.

However, FDI can be a double-edged sword for fiscal sustainability in any host country SSA included. Foreign companies may repatriate a significant portion of their profits back to their home countries, limiting the potential for reinvestment within the Sub-Saharan African nation. This reduces the long-term benefits of FDI for the host country's fiscal health. Moreover, FDI may lead to debt accumulation and deepen the budget deficit, contrary to Keynes’s perspectives (Wangui, 2019).

To attract FDI, Sub-Saharan African governments sometimes offer tax breaks and other incentives to foreign companies. While this can be beneficial in the short term, it can also lead to a temporary reduction in government revenue, potentially hindering fiscal sustainability. If FDI is heavily concentrated in resource extraction industries like mining or oil exploration, it can create a "resource curse." This can lead to Dutch Disease, where an appreciating currency due to resource exports harms other sectors of the economy, ultimately affecting tax revenue generation.

2.2 Theoretical Literature

2.2.1 Keynesian theory

In the context of Keynesian theory, fiscal sustainability refers to the ability of a government to maintain a sustainable level of public debt without endangering the long-term economic stability of the country. It is a key concept in Keynesian economics, as it emphasizes the role of government spending in stabilizing the economy during periods of economic downturn and promoting long-term growth.

Keynesian theory suggests that governments can play an active role in managing the economy through fiscal policy, which involves adjusting government spending and taxation to influence aggregate demand and economic activity. According to Keynes, during periods of economic recession, when private spending is low and businesses are hesitant to invest, governments can increase their spending on infrastructure, education, and other public goods and services to stimulate economic activity and create jobs (Blanchard, O. J. 2006, O'Connell, 2016,). According to Samuels and Medema (2019), monetary and fiscal policies are essential instruments available to public officials for promoting economic aggregate demand.

Keynes placed immense importance on interest rates and aggregate demand. He argued that interest rates significantly impact investment decisions businesses make. Higher interest rates make borrowing money for investment projects more expensive. This discourages businesses from borrowing and investing, leading to a decrease in overall economic activity and a potential slowdown. Conversely, lower interest rates make borrowing cheaper, incentivizing businesses to invest, which stimulates economic growth.

Keynes challenged the classical economic theory which believed that markets naturally self-correct towards full employment (everyone who wants to work has a job). He argued that aggregate demand, the total spending in an economy, is a key driver of economic activity. Factors like consumer spending, business investment and government spending all contribute to aggregate demand. Fluctuations in aggregate demand can lead to economic imbalances. When demand is low, businesses produce less, leading to layoffs and a downward economic spiral (recession).

However, Keynes also recognized that excessive government borrowing and debt accumulation, resulting from increased spending, could lead to economic instability and hinder long-term growth. He argued that governments should adopt a balanced approach to fiscal policy, ensuring that their debt levels remain manageable and do not crowd out private investment.

Keynesian theory is significant in the study of the interplay between climate change, institutional quality, foreign exchange rate, FDI, and fiscal sustainability in several ways; The theory emphasizes the role of government intervention in stabilizing the economy during times of crisis or shocks. Climate change presents a significant and long-term shock to economies worldwide, requiring government intervention to mitigate its impacts and promote sustainable development (Kumar and Lvov 2010, IMF 2018, ADB, 2019).

Keynesian fiscal policy measures, such as increased government spending on infrastructure investments and green technologies, can stimulate economic growth while addressing climate change mitigation and adaptation strategies. Additionally, Keynesian demand-side policies can help to reduce unemployment and poverty, which are often exacerbated by climate change impacts.

Keynesian theory highlights the importance of sound institutions, such as effective governance, transparent regulations, and well-functioning markets, for achieving economic stability and growth. Institutional quality plays a crucial role in ensuring that government interventions, including fiscal policies, are implemented effectively and efficiently (World Bank 2016).

Weak institutions can lead to corruption, rent-seeking behavior, and misallocation of resources, undermining the effectiveness of fiscal policies in addressing climate change and promoting fiscal sustainability. Conversely, strong institutions can enhance the effectiveness of fiscal policies, ensuring that resources are used effectively to mitigate climate change impacts and promote sustainable development (IMF 2017, ADB 2018).

Keynesian theory recognizes the impact of exchange rate fluctuations on economic stability and growth. In the context of climate change, exchange rate volatility can affect the cost of imported goods and services, particularly those related to renewable energy technologies and climate adaptation measures.

Fiscal policies can play a role in stabilizing the exchange rate and mitigating its impact on the economy. Additionally, Keynesian policies can help to diversify the economy and reduce reliance on trade, making it less vulnerable to exchange rate fluctuations (Reinhart and Rogoff 2009, IMF 2012, ADB 2014).

Keynesian theory provides a valuable framework for policymakers to analyze and address the complex interplay between climate change, institutional quality, foreign exchange rate, debt relief, and fiscal sustainability. By understanding the economic implications of these factors, policymakers can design effective policy responses to promote sustainable development and ensure long-term economic stability in the face of climate change challenges.

In conclusion, this theory offers a relevant and insightful lens through which to examine the interconnectedness of climate change, institutional quality, foreign exchange rate, debt relief, and fiscal sustainability. By integrating Keynesian principles into policymaking, governments can develop comprehensive strategies to address climate change effectively while promoting sustainable economic growth and long-term fiscal stability.

2.2.2 Debt Overhang Theory

A firm, bank, or nation's ability to grow and invest can be impeded by an excessive amount of debt, as explained by the debt overhang theory in economics. As per the theory, an entity may encounter challenges in securing fresh financing or pursuing profitable ventures if its debt level surpasses its projected income or repayment capacity. This is because there won't be much of an incentive for the company or its shareholders to invest in new projects because the current debt holders will receive a sizable portion of the future earnings. This will lead to underinvestment and stagnation for the organization, which will make it more difficult to lower its debt load.

In 1977, Stewart C. Myers first put forth the theory in his paper "Determinants of Corporate Borrowing" (Myers, 1977). By using the theory to corporate finance, he demonstrated how debt overhang can influence a company's choice of financing and investments. Additionally, he made recommendations for potential fixes, including debt forgiveness, debt restructuring, and the issuance of fresh equity.

Later, the theory was expanded to include situations involving banking crises and sovereign debt. When it came to developing nations with high levels of external debt and dim growth prospects, Paul Krugman applied the theory in 1988. He maintained that an excessive amount of debt can lead to a vicious cycle of low growth, low

investment, and high debt servicing, deterring both foreign and domestic investors from making loans to or investments in these nations. Additionally, in order to assist these nations in escaping the debt overhang trap, he promoted debt relief programs.

An additional application of the theory pertained to the 2007–2008 financial crisis, during which numerous banks and financial institutions encountered a substantial debt load and depreciating asset values. Some economists contended that even after receiving government bailouts or capital injections, these institutions' reluctance to lend money or invest in new ventures was partly due to their excessive debt load. Krugman (1988) and Myers (1977) proposed that the resolution of debt overhang could involve either a reduction in the debt level or an increase in the asset value of these institutions, which could be achieved through bankruptcy, restructuring, recapitalization, or asset sales.

It is evident Debt overhang, a situation where a country's debt level hinders investment and economic growth, has been extensively studied both theoretically and empirically. The negative effects of debt overhang include reduced investment, slower economic growth, and limited fiscal space. High debt burdens discourage both domestic and foreign investors, as they become less confident about the country's economic prospects and ability to repay its debts (Buiter & Panizza, 1996; Easterly et al., 1993). Lower investment levels lead to slower economic growth, creating a vicious cycle of debt and stagnation (Krugman, 1988; Sachs, 1989). Moreover, high debt service payments crowd out other essential government spending priorities such as education, healthcare, and infrastructure development, hindering long-term economic growth and development (D'Erasmo & Mendoza, 2018; Reinhart & Rogoff, 2010).

Debt overhang theory provides a useful framework for understanding the complex interactions between debt, economic development, and public policy. By considering the implications of debt overhang, policymakers can better design and implement strategies to address climate change, improve institutional quality, manage foreign exchange rates and promote fiscal sustainability.

Debt overhang is a major issue in Sub-Saharan Africa. According to the World Bank, the region's public debt-to-GDP ratio is at an all-time high of 77%, and is projected to reach 84% by 2024. This high debt burden is putting a strain on government budgets, crowding out spending on essential services such as education, healthcare, and infrastructure. It is also making it difficult for governments to invest in climate change mitigation and adaptation (Stiglitz, 2000), which are critical for the region's future prosperity.

The impact of debt overhang on public discontent is particularly acute in Sub-Saharan Africa. When people see their governments struggling to provide basic services and infrastructure, they become more likely to become dissatisfied with the government and to demand change. This can lead to social unrest, political instability, and even violence (Abanikanda, Dada & Ogunjumo, 2023).

In addition, debt overhang can undermine the ability of governments to implement sound economic policies. When the government is constantly scrambling to make debt payments, it is difficult to focus on long-term economic development (Sachs, 1989; Rodrik, 1998). This can lead to a vicious cycle of debt accumulation and economic stagnation, as the government is forced to borrow more and more money just to keep up with its existing debt obligations.

The situation in Sub-Saharan Africa is made more difficult by the fact that the region is highly reliant on external borrowing. This means that Sub-Saharan African countries are more vulnerable to changes in global economic conditions and interest rates. When these conditions worsen, it can make it more difficult for Sub-Saharan African countries to service their debts, which can further exacerbate the debt crisis (World Bank 2023).

2.2.3 Institutional Theory

Institutional theory (governance theory) has a rich history with contributions from various scholars across disciplines. Early thinkers like Thorstein Veblen (1857-1929) who examined the role of institutions in shaping economic behavior and social structures, Emile Durkheim (1858-1917): Studied the role of social institutions in maintaining social order and solidarity, Max Weber (1864-1920): Analyzed the influence of bureaucracy and other institutions on power and authority and Douglass North (1920-2010): Examined the role of institutions in economic development, including "Institutions, Institutional Change and Economic Performance". Their work highlighted the importance of institutions and set a foundation for modern economists like Dani Rodrik (1957-): An economist who explores the relationship between institutions and economic development, emphasizing the importance of good governance for sustainable growth.

Fiscal sustainability, the ability of a government to finance its spending obligations over the long term, is a critical issue for nations worldwide. Understanding the factors that contribute to sustainable fiscal practices is crucial for policymakers. Institutional theory offers a valuable framework for analyzing the relationship between institutional quality and fiscal health.

High-quality institutions, characterized by strong property rights, rule of law, and limited corruption, are conducive to sound fiscal policy (Besley & Persson, 2011). Clear and predictable rules (North, 1990) encourage efficient tax collection, discourage wasteful spending, and promote long-term economic growth (Acemoglu et al., 2008). This, in turn, generates a more sustainable fiscal environment.

Transparency and accountability are also hallmarks of strong institutions. Financial transparency allows citizens and stakeholders to monitor government spending and hold officials accountable (Alt et al., 1994). This fosters trust in government and encourages responsible fiscal policies (Guiso et al., 2004).

Furthermore, strong institutions facilitate long-term planning for fiscal sustainability. Weak institutions, often characterized by short-term political cycles, might prioritize immediate gains over long-term investments, leading to unsustainable debt levels (Alesina et al., 1996). Conversely, well-functioning institutions enable governments to take a long-term perspective when making fiscal decisions (Rodrik, 2003).

It is believed that Countries with strong institutions might influence others to adopt similar fiscal responsibility practices (DiMaggio & Powell, 1983). Regional integration and international organizations can also encourage convergence towards sound fiscal policies (Vogel, 1996). Besides governments with strong fiscal policies gain legitimacy from international organizations and credit rating agencies (Suchman, 1995). This legitimacy translates to access to financial resources and improved creditworthiness, further strengthening fiscal sustainability (Stone, 2004). From a rational perspective, governments with weak institutions might adopt best practices from countries with strong fiscal management (Scott, 2008). This can be seen as a way to improve economic performance and ensure long-term prosperity.

While institutional theory highlights the importance of strong institutions, there are challenges to consider. Path dependence, where countries struggle to break free from established, unsustainable practices due to historical institutional weaknesses, can be a significant obstacle (David, 2001). Additionally, even with strong institutions, political will is crucial for implementing sound fiscal policies (Brender &Drazen, 2003).

Institutional theory underscores the critical role of well-functioning institutions in achieving and maintaining fiscal sustainability. By promoting sound policies, transparency, and long-term planning, strong institutions create a foundation for responsible fiscal management.

2.2.4 Environmental Kuznets Curve Hypothesis

The Environmental Kuznets Curve (EKC) is a theoretical correlation between the deterioration of the environment and the progress of economic development. Essentially, it implies that as an economy expands, the deterioration of the environment escalates until a specific threshold, beyond which it starts to decline Stern (1998), Grossman and Krueger (1991). The EKC defines the trajectory of over time pollution levels and the economic growth of an economy Leal and Marques, (2022), Sarkodie and Ozturk (2020). The hypothesis posits an inverted-U correlation between environmental deterioration, as measured by pollution, and economic development, as measured by per capita income, as shown in the diagram below.

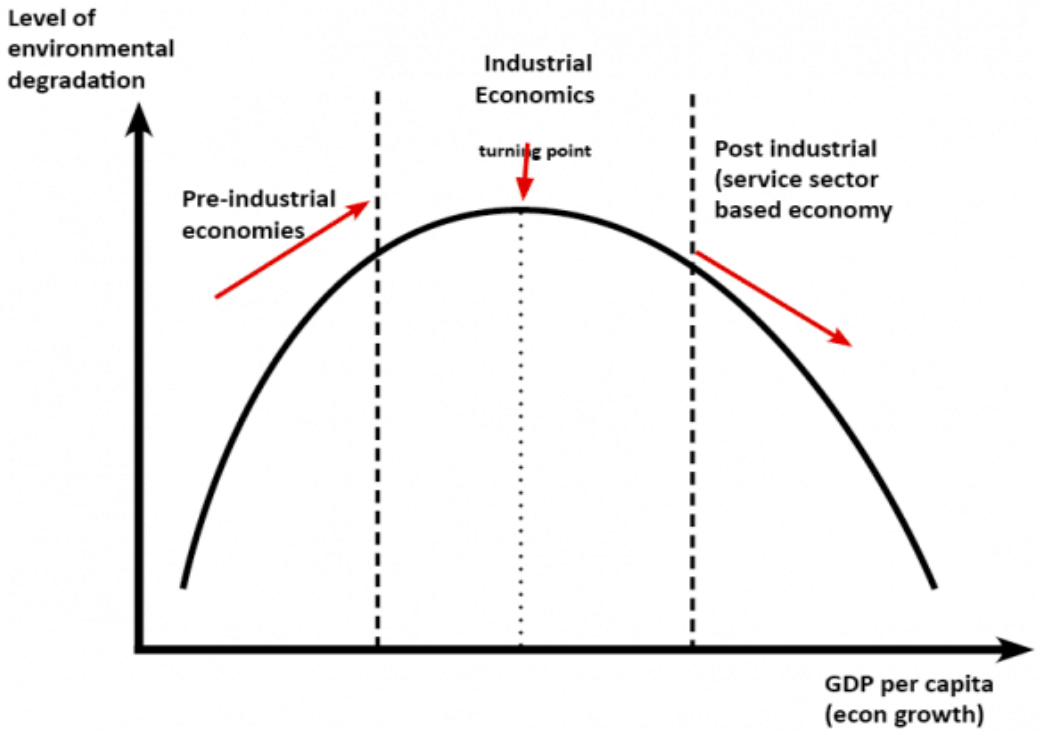

Figure 2. Environmental Kuznets curve

Typically, the Environmental Kuznets Curve (EKC) is categorized into three stages: the initial phases of economic growth, the pivotal moment, and the subsequent phases of economic growth. Concisely, while examining the progression of economic development, the initial stage is marked by a high utilization of resources and a swift escalation in environmental deterioration. The second stage, known as the turning point, is activated when a specific income level is attained, resulting in a shift in the pollution trajectory. This shift then triggers the third stage, which is marked by the mitigation of environmental degradation Grossman and Krueger (1995) Stern (2004), Dinda (2004), Luzzati and Orsini (2009), Halicioglu (2009), Acaravci and Ozturk (2010) and Al-Mulali et al. (2015).

During the pre-industrial era, the carbon cycle of the Earth was regarded to be in equilibrium. Nevertheless, as the industrial revolution commenced, the combustion of fossil fuels forced a significant surge in greenhouse gas (GHG) emissions Leal and Marques (2022). The vast reliance of society on fossil fuels sprang from the imperative

to satisfy the increasing energy requirements. Given this, the generation of wealth and energy consumption, namely the per capita income of a nation and the level of energy consumption, became inseparable entity UNDP (2015). As economic development depends on the escalation of energy consumption, it is closely linked to the increase of greenhouse gas emissions. Additionally economic growth creates a scale effect, as increasing output tends to raise emissions. Consequently, over decades, economic expansion has been attained at the expense of the environment, resulting in worldwide climate change, Alonso et al (2019).

Pollution and climate change are interrelated environmental issues that have garnered significant attention in recent decades due to their severe impact on ecosystems, human health, and global economies (Adger et al. 2005; Leal Filho et al. 2021; Feliciano et al. 2022 ; Malhi et al 2020; Shivanna 2022; UNDP 2023; Lee et al 2023). Planetary warming and climate change are predominantly the result of human activities. The increase in Green House Gas (GHG) emissions can be attributed to the expansion of industry, consumption, and population. Carbon dioxide emissions (CO2), the main greenhouse gas, are strongly linked to economic growth, human welfare, financial sector development, industrialization, and urbanization, all of which SSA aims to attain Sarkodie and Ozturk (2020), Menegaki (2013).

Climate change is a formidable environmental concern in the Sub-Saharan Africa (SSA) region. The performance of governments in mitigating environmental degradation unavoidably draws attention due to their limited fiscal capacity. Moreover, these countries exhibit significant variations in their industrial composition and urbanization levels, both of which are anticipated to worsen the correlation between

their economic growth rates and pollutant emissions, so endangering their profound economic progress Apergis and Ozturk (2015), Lau et al. (2014) Jiang et al., (2013).

In light of the swift economic growth, the issues of environmental pollution and carbon emissions are progressively escalating, and the prospects for pollution reduction and carbon reduction are bleak. An analysis by the International Energy Agency (IEA) reveals that in 2022, the worldwide emissions of greenhouse gases linked to energy amounted to 41.3 billion tons of CO2 equivalent. Among these, CO2 emissions surpassed 36.8 billion tons, representing almost 89% of the total energy-related greenhouse gas emissions. Global greenhouse gas emissions are projected to rise by 57% by 2030 compared to the present level, resulting in a 3 ℃ increase in the Earth's surface temperature. The global environmental pollution study conducted in 2022 revealed a highly severe global environmental pollution condition, whereby air pollution, water pollution, and soil contamination surpassed the safety criteria established by the United Nations.

The Paris accord, established in 2015, aims to enhance countries' capacity to address the impacts of climate change and synchronize financial resources with strategies that reduce greenhouse gas emissions and promote climate resilience (Shahbaz et al. 2019; Anwar et al. 2021; Usman et al. 2022a). Similarly according to the Global Risk Report (2022), the world is now in a condition of climate emergency, with climate action failures and extreme weather events ranking among the top ten most pressing dangers worldwide. Additionally, human environmental harm is identified as the seventh highest risk worldwide. Given the shared origin and core cause of these two issues, there has been a growing inclination towards joint emission reduction (Wang et al. 2022; Ali et al. 2023; Fahad et al. 2023a). To attain these ambitious aims, sufficient

financial resources must be collected and supplied, together with a new technological framework and enhanced capacity building, enabling developing countries and the most vulnerable countries to pursue their individual national aspirations (Sharma et al. 2020; Sharif et al. 2020; Chien et al. 2021).

2.3 Empirical Literature Review

2.3.1 Fiscal Sustainability

Governments have employed various strategies to mitigate economic downturns, including active fiscal policies such as government spending and tax exemptions, alongside monetary measures like quantitative easing (Jeong, 2014). However, the extensive use of expansionary fiscal policies has raised concerns due to escalating budget deficits and increasing public debt.

Afonso's (2005) research utilized cointegration tests, accounting for structural breaks, to evaluate fiscal sustainability in EU-15 nations from 1970 to 2003, focusing on the relationship between public expenditures and public revenues. The researcher determined that, with limited exceptions, fiscal policies in the EU-15 may have lacked sustainability. Although, debt-to-GDP ratios stabilized by the close of the 1990s, numerous countries faced the peril of accruing substantial debt.

Following the 2008 financial crisis, several Eurozone nations—Greece, Spain, Portugal, Italy, and Ireland—faced fiscal turmoil, prompting a shift away from expansionary measures by early 2010 (Krugman, 2010). To address rising debt levels, many European countries adopted fiscal austerity policies despite concerns about their potential negative impact on economic activity and employment (Baker, 2010). Over time, countries such as the UK, Denmark, and Ireland underscored the necessity of stabilizing public debt to foster long-term economic recovery (Jeong, 2014).

Economists like Alesina and Adagna (2010) argue that immediate deficit reduction is essential for sustained growth, emphasizing that unchecked deficits transform into future debt crises and potential government defaults. They contend that economic prosperity cannot be achieved without a balanced budget, underscoring the importance of prudent fiscal management

Adams et al. (2010) empirically examined fiscal sustainability in developing Asia by analyzing key fiscal indicators over time and across subregions. The study estimated fiscal policy response functions to measure the adjustment of the primary fiscal balance to public debt positions. The research found that public finances in developing Asia were generally in good shape due to responsible fiscal behavior. However, it warned that failure to withdraw the region's anticrisis fiscal stimulus in a timely manner would jeopardize fiscal sustainability. The study stressed the importance of developing strong medium-term fiscal policy frameworks to ensure long-term stability.

Pradhan's 2015 study provides a theoretical and empirical framework for assessing fiscal sustainability. It discusses the inter-temporal budget constraint (IBC) and applies time-series econometric techniques to analyze fiscal sustainability. The study also explores forward-looking fiscal projections and generational equity approaches. The research highlights that fiscal sustainability is a multidimensional concept, incorporating government solvency, stable tax regimes, macroeconomic stability, and inter-generational equity. It emphasizes that fiscal sustainability requires maintaining a balance between debt and future primary surpluses. The study also notes that short-term fiscal stability and long-term sustainability are interconnected through financial markets.

Clarke et al (2022) sought to investigate the long-term viability of Jamaica's public debt at a period characterized by significant instability. The authors employ a range of econometric techniques, such as unit root testing, cointegration testing, and calculating a fiscal reaction function. The authors accounted for structural breaks in the regression analysis and discovered that rescheduling in Jamaica could be a sign of cash-flow difficulties. However, the fiscal policy has efficiently responded by increasing the public debt, which has made the debt manageable in the long term. Despite the political and socioeconomic factors that existed before the pandemic, the consequences of increased debt levels (such as higher debt payments and less social spending) may render this fiscal policy and debt management method unworkable. Consequently, the authors advised that the government should adopt a proactive strategy to manage its debt position. This will enable the government to effectively respond to unexpected events and create an environment that allows for sustaining fiscal discipline.

Serju-Thomas (2020) evaluated the long-term viability of fiscal policy in Jamaica in relation to its significant public debt. Fiscal sustainability was evaluated using various models such as OLS, VAR, GMM, and VECM, by employing fiscal reaction functions. The vulnerability of the public debt stock was assessed using the IMF debt sustainability analysis (DSA) framework, which considered shocks to real GDP, primary balance, interest rate, real exchange rate, and a combined shock. Following the implementation of the nation's economic reform program, the outcomes indicated that fiscal policy in Jamaica was progressing towards achieving sustainability. Nevertheless, upon excluding the economic reform period, the results indicated that fiscal policy in Jamaica is not sustainable. Additionally, the findings showed that in the future, a primary surplus of 4.8 percent of GDP would be necessary in order to attain a public debt-to-GDP ratio of 60 percent. The risk assessment of Jamaica's public debt

has indicated that the debt is particularly susceptible to significant devaluations in the currency rate, and the overall risk to the total amount of public debt is considerable.

Brady and Magazzino (2017) conducted an analysis on the sustainability of Italian public finances using an exclusive database that encompasses the time frame from 1862 to 2013. Their primary focus was on conducting empirical studies to assess the sustainability and solvency of fiscal policies. A required but not sufficient requirement is that the growth rate of public debt must be smaller than the asymptotic rate of interest. Furthermore, it is imperative that the debt-to-GDP ratio reaches a condition of equilibrium and remains at a consistent level in the long run. The empirical study was performed for the full duration, as well as two specific time intervals (1862-1913 and 1947-2013). Cointegration tests were utilised to determine the presence of a long-term connection between public expenditure and income. The results indicated that such a relationship was observed solely during the initial sub-period from 1862 to 1913. Essentially, the findings indicated that Italy faced sustainability issues during the Republican era.

The significant decline in state revenues during the Great Recession and the resulting substantial budget deficits heightened worries regarding the long-term fiscal sustainability of states. In his study, S. Mahdavi (2014) utilised a model-based methodology suggested by Bohn (1998) to examine the concept of sustainability. Using a dataset consisting of 48 adjacent states from 1961 to 2008 and various model configurations, the researcher discovered strong evidence supporting the concept of sustainability. However, additional analysis indicated that the adjustment of the components of s to debt was not symmetrical, with the revenue side shouldering a greater weight than the spending side.

In order to evaluate the sustainability of debt in South Africa, Ruthira and Raputsoane (2015) employed a lengthy historical data set and took into account potential nonlinearities, such as threshold behaviour by fiscal authorities based on the frequency of financial crises and recent history of indebtedness. The findings indicate that fiscal consolidation remains in place after the debt-to-GDP ratio reaches approximately 56 percent. Below this threshold level, there is no meaningful evidence of fiscal consolidation. Secondly, the findings demonstrated that fiscal adjustment considered historical debt levels to facilitate more seamless remedial action. Furthermore, fiscal consolidation takes place at an elevated debt-to-GDP ratio in the midst of financial crises.

Serhan and Vibha (2020) utilised the model-based fiscal sustainability test to examine 16 Caribbean countries from 1980 to 2018. The findings revealed that the coefficient for lagged government debt is positive and has a substantial statistical impact. This suggests that fiscal policy in the Caribbean region implements measures to counterbalance an increase in the debt-to-GDP ratio. Nonlinear calculations revealed that the quadratic debt parameter is negative, indicating that the fiscal policy response is insufficient to guarantee sustainability when debt levels are high. Additionally, they discovered that the fiscal stance generally exhibits a countercyclical pattern on average across the observed time. These empirical findings support the need for growth-promoting structural changes and careful fiscal policy maintenance in order to create fiscal buffers and guarantee debt sustainability with a high likelihood even in the long run—even in the event of negative shocks.

Tran (2018) employed a panel threshold analysis to determine the debt limit for fiscal sustainability assessment in 14 emerging economies from 1999 to 2016. He examined

the non-linear relationship between government debt and sovereign risk premium, identifying a threshold beyond which default risk significantly increases. The research finds that non-Latin American economies maintain short-term fiscal sustainability with debt levels below 40–55% of GDP. However, long-term sustainability risks emerge due to continuous upward debt trends, necessitating fiscal buffers. Latin American economies face greater fiscal sustainability challenges, as their debt accumulation surpasses the threshold of approximately 35% of GDP, leading to heightened default risks. The study emphasizes the need for strict fiscal discipline to mitigate debt pressures.

Chemnyongoi and Kiriga (2020) used the Johansen cointegration technique, followed by the two-step Engle-Granger approach, to evaluate the sustainability of Kenyan fiscal policy. The study discovered that fiscal policy in Kenya is weakly sustainable, with the economy adapting swiftly in times of disequilibrium produced by numerous shocks. To ensure long-term fiscal sustainability, the study suggests a fiscal consolidation strategy that combines both spending and revenue initiatives. The study proposes decreasing the share of salaries and wages in recurrent costs and retiring short-term, high-cost commercial debt through increased concessional loans. Chapman (2022) conducted an analysis of fiscal sustainability by examining critical components, including debt, employee benefits, revenues, and expenditures. The study implements a theoretical framework that evaluates the sustainability of local governments in relation to structural, intergovernmental, and cyclical pressures. The present value approach to evaluating fiscal sustainability is also examined in the study. The research emphasizes that fiscal sustainability is a long-term concept that necessitates governments to guarantee equity, minimize economic distortions, and improve community welfare. It

identifies factors such as suburbanization, demographic shifts, and altering consumption patterns as critical influences on fiscal sustainability.

Economides et al. (2025) analyzed fiscal sustainability in the Euro Area from 2001 to 2023, using debt arithmetic and structural macroeconomic models. They evaluated the impact of the interest rate-growth rate variations on long-term fiscal sustainability and assessed the effectiveness of fiscal rules in stabilizing public debt, utilizing numerical simulations derived from data pertaining to the Euro Area. The study emphasized that conventional debt arithmetic may lack quantitative reliability due to the endogenous characteristics of sovereign interest rates, growth rates, and fiscal policy responses. It contends that fiscal sustainability necessitates debt-contingent fiscal regulations, wherein fiscal instruments consistently respond to public debt imbalances.

Saibu (2018) employed unit root tests, cointegration tests, and dynamic OLS (DOLS) regression to evaluate fiscal sustainability in Nigeria from 1961 to 2016. He applied the intertemporal budget constraint framework to formulate a fiscal sustainability equation and analyzed the prerequisites for achieving sustainability. The empirical findings demonstrate insufficient fiscal sustainability in Nigeria, especially as evidenced by the DOLS regression outcomes. The study also revealed that economic performance exhibits a limited response to fiscal sustainability, indicating that fluctuations in oil revenue greatly influence Nigeria's fiscal policy, resulting in heightened borrowing during times of falling oil prices.

Afonso & Jalles (2016) assessed fiscal sustainability in OECD countries using unit root and cointegration analysis, controlling for endogenous breaks. They examined the long-run relationship between government revenues and expenditures and evaluated fiscal regimes through primary balance adjustments. The research found that fiscal

sustainability is elusive in many OECD countries. There is a lack of cointegration—indicating the absence of sustainability—between government revenues and expenditures in most cases. However, several countries, such as Austria, Canada, France, Germany, Japan, the Netherlands, Sweden, and the UK, demonstrate fiscal sustainability. Australia, Belgium, Germany, Ireland, the Netherlands, and the UK observed improvements in primary balances following worsening debt ratios.

Bi and Leeper (2013) utilized a real business cycle (RBC) model to examine fiscal sustainability. It maps economic environments—comprising expected fiscal policies, external shocks, and the conduct of private agents—into a distribution for the maximum sustainable debt-to-GDP ratio. The model was calibrated using data from Greece and Sweden to analyze fiscal reforms in developed economies experiencing sovereign risk pressures. The research findings indicate that fiscal sustainability is dictated by a nation's fiscal limit, the threshold beyond which taxation and expenditure can no longer be modified to stabilize debt. Default may occur at any juncture within this fiscal limit distribution. The research indicates that credible fiscal reforms can mitigate sovereign risk, whereas weak or unclear reforms may not decrease debt-service expenses. The examination of Greece and Sweden demonstrates the impact of fiscal policy conduct on sovereign risk and fiscal sustainability.

The work by Afonso et al. (2024) utilized quantile regression analysis to evaluate fiscal sustainability coefficients in 22 OECD nations from 1950 to 2019. It analyzed the sensitivity of primary and global government balances to debt-to-GDP ratios and assessed the correlation between government revenues and expenditures. The study employed an expanding-window methodology to assess time-varying fiscal sustainability coefficients. The research indicated that the output gap positively

influences fiscal sustainability by enhancing the responsiveness of primary and global government balances. The responsiveness of government revenues to expenditures exhibited a negative correlation with fiscal sustainability coefficients, hence confirming a cross-relationship among fiscal sustainability indicators. The study emphasizes that fiscal sustainability is contingent upon the debt ratio, with varying impacts noted across quantiles.

Afonso and Jalles (2014) investigated fiscal sustainability in 19 nations from 1880 to 2009 using stationarity tests on first-differenced government debt levels. They utilized structural time series models to separate debt components and conducted panel analysis with numerous structural breakdowns to evaluate long-term fiscal sustainability. The study concluded that fiscal sustainability is often upheld, with the exception of Japan and Spain, where non-stationarity remains evident. The research found sovereign default episodes via endogenously established structural breaks, linking fiscal sustainability patterns with past economic crises.

Afonso & Coelho (2024) examined fiscal sustainability in 19 Eurozone countries from 1995 to 2020 using panel cointegration analysis, fiscal reaction functions, and time-varying coefficient modeling. They applied the Pesaran panel unit root test, Pedroni panel cointegration tests, and Granger non-causality tests to assess the long-term relationship between government revenues, expenditures, and debt sustainability. The research showed a long-term connection between government revenues and expenditures, the primary government balance and past public debt compared to GDP, and the public debt compared to GDP and past primary government balance. The estimated fiscal reaction functions suggest the existence of a Ricardian fiscal regime, although some evidence of non-Ricardian fiscal behavior is also observed. Fiscal

sustainability improves with the output gap, fiscal rules indices, and current account balances, while inflation and sovereign ratings produce mixed results.

Ko (2020) measured fiscal sustainability across 17 welfare states, covering a 28-year period by adapting the concept of fiscal space (the difference between the current level of public debt and the debt limit implied by a country's historical record of fiscal adjustment). The research employed a pooled time-series cross-sectional model to estimate fiscal reaction functions and a vector regression model to set the interest schedule. The study found that Southern European welfare states are fiscally unsustainable unless they immediately change their fiscal policies. In contrast, countries outside Southern Europe generally maintained financial sustainability. However, recent fiscal actions in the UK, the US, and France exacerbated their financial sustainability concerns. Social democratic states remained financially sound despite high levels of welfare spending, indicating that welfare expenditures do not necessarily weaken fiscal soundness.

Leith & Wren-Lewis (2013) employed a New Keynesian model to analyze fiscal sustainability, focusing on the time inconsistency of monetary and fiscal policy. They examined how governments adjust fiscal instruments in response to inflationary expectations and debt burdens. They also integrated numerical simulations to evaluate the influence of discretionary and commitment policies on fiscal stability. They found that when using discretionary policy, governments tend to stabilize debt more aggressively compared to commitment policies and that fiscal sustainability is influenced by the degree of nominal inertia and the size of the debt stock. The research also shows that welfare consequences of introducing debt are negligible under precommitment policies but significant under discretionary policy.

Asiama et al. (2014) examined fiscal sustainability in Ghana from 2000 to 2014 by estimating a fiscal reaction function. The researchers employed unit root tests, ARDL cointegration analysis, and debt dynamics modeling to assess the government's response to rising public debt accumulation. The research found that Ghana's fiscal behavior aligns with the intertemporal budget constraint, but fiscal adjustment remains weak. Persistent fiscal pressures, particularly during election cycles, contributed to expenditure overruns and rising debt levels.

Lee et al. (2018) evaluated fiscal sustainability across five regional groups in the EU using a dataset of 26 countries from 1950 to 2014. They estimated policy rules in which primary surpluses respond to public debt and examined whether these rules satisfy fiscal solvency conditions. The research applied baseline solvency tests with time-invariant marginal responses and more general solvency tests allowing time-varying responses. The study discovered that the Benelux, northern, and eastern groups meet fiscal solvency conditions, while the western and southern groups do not. After analyzing eurozone and non-eurozone countries separately, the research suggested that long-term fiscal sustainability is more questionable for eurozone countries. Non-eurozone countries in all regional groups exhibited significantly positive marginal responses, whereas eurozone countries in most groups did not. The generalized solvency tests revealed that only the southern group fails to meet solvency conditions, aligning with the fact that these countries had experienced severe fiscal crises.

Adrison (2024) investigated fiscal sustainability in Indonesia and compared it with Malaysia and Thailand. He evaluated fiscal rules, fiscal performance, and fiscal sustainability across these three countries. The analysis incorporated empirical assessments using data from 2010 to 2019, focusing on government revenue and

expenditure trends. The research found that, despite persistent fiscal deficits in Indonesia, Malaysia, and Thailand, all three countries maintain fiscal sustainability. The study highlights challenges in Indonesia's fiscal framework, particularly in revenue generation and expenditure management.

Magazzino & Forte (2019) studied fiscal sustainability in G-7 countries using panel data from 1980 to 2015. The study applied unit root tests for panel data to assess stationarity in government expenditures, revenues, debt, and primary deficit, as well as cointegration analysis to examine the long-run relationship between government debt and primary deficit. The study finds that government expenditures, revenues, debt, and primary deficit are non-stationary, but a clear cointegrating relationship exists between government debt and primary deficit. The study suggests that the G-7 countries need to maintain a careful balance between expenditures and revenues to prevent fiscal insolvency. Additionally, the research identifies bi-directional causality between government revenues and expenditures, as well as between primary deficit and debt, indicating that fiscal policy decisions are jointly made in G-7 countries.

Li & Du (2021) measured fiscal sustainability of local governments in China and analyzed the effects of vertical fiscal imbalance and transfer payments under the framework of Chinese-style fiscal decentralization. They employed nonlinear fiscal reaction functions and dynamic panel threshold models to assess fiscal sustainability. The researchers found that the current fiscal behaviors of local governments in China were unsustainable, but most local governments had sufficient space to establish a positive fiscal feedback mechanism through fiscal adjustment. The study highlighted that the effect of transfers from the central government on fiscal sustainability depended on the degree of vertical fiscal imbalance. When the vertical imbalance is low, transfers

have a negative impact, whereas when it is high, transfers contribute positively to fiscal sustainability.

Table 2. 1: Summary of Fiscal Sustainability Literature

Authors	Year	Methodology Used	Findings	Research Gap
Afonso	2005	Cointegration with structural breaks	EU-15 countries showed limited fiscal sustainability; some stabilized debt-to-GDP ratios.	Lacks SSA relevance; does not include climate, FDI, or institutional factors.
Adams et al.	2010	Fiscal response functions	Developing Asia generally showed responsible fiscal behavior; warned against prolonged stimulus.	Focused on Asia; excluded SSA and climate or institutional concerns.
Pradhan	2015	Time-series, IBC, forward-looking projections	Fiscal sustainability is multidimensional; includes generational equity and macro stability.	No SSA-specific application; lacks empirical analysis of external shocks like climate change or exchange rate.
Clarke et al.	2022	Unit root, cointegration, fiscal reaction function	Jamaica's fiscal policy is partially sustainable; debt management shows long-term viability.	Focus on a single Caribbean country; excludes SSA context and key external factors.
Prudence S.T	2020	OLS, VAR, GMM, VECM, IMF DSA model	Fiscal sustainability improved during reform; high exchange rate sensitivity noted.	Does not consider climate, FDI, or institutional quality in fiscal modeling.
Mahdavi	2014	Bohn model, panel of 48 U.S. states	Fiscal sustainability supported; stronger revenue-side adjustments.	U.S.-focused; not transferable to SSA or relevant external macro shocks.
Ruthira & Raputsoane	2015	Threshold models, long-term debt data	Fiscal consolidation in South Africa only happens above a debt threshold.	Only one SSA country analyzed; no FDI, governance, or climate integration.
Saibu	2018	DOLS, unit root, cointegration	Nigeria shows weak sustainability; oil revenue volatility influences fiscal behavior.	Does not assess institutional quality or climate-related pressures.
Asiama et al.	2014	ARDL, fiscal reaction function	Ghana adheres to IBC condition, but weak fiscal discipline noted during elections.	Political cycles noted but lacks FDI, institutional, or climate considerations.
Chemnyongoi & Kiriga	2020	Johansen cointegration, Engle-Granger	Kenya's fiscal policy weakly sustainable; rapid post-shock adjustments observed.	SSA country, but omits FDI, institutions, and environmental stressors.

Authors	Year	Methodology Used	Findings	Research Gap
Serhan & Vibha	2020	Non-linear fiscal reaction function	Positive debt response; insufficient for high debt levels; countercyclical stance prevalent.	No SSA countries analyzed; missing institutional and climate insights.
Tran	2018	Panel threshold model	Emerging markets face fiscal risk beyond specific debt thresholds.	Lacks SSA application; no institutional or environmental analysis.
Economides et al.	2025	Structural macro models, simulations	Emphasized debt-contingent fiscal rules; traditional debt arithmetic may mislead.	Focused on Euro Area; no coverage of SSA or non-traditional fiscal threats like climate change.
Afonso & Jalles	2016	Panel cointegration, unit root	Mixed sustainability in OECD; no cointegration in many countries.	No analysis of SSA; FDI and external shocks not included.
Bi & Leeper	2013	RBC model, fiscal limit framework	Fiscal limits vary; credible reforms reduce sovereign risk.	Theoretical; no SSA case, and omits exchange rate and climate variables.
Afonso et al.	2024	Quantile regression, time-varying coefficients	Sustainability depends on output gap and revenue-expenditure responsiveness.	OECD-focused; lacks SSA, climate change, or institutional dimension.
Afonso & Coelho	2024	Panel cointegration, fiscal reaction functions	Ricardian behavior observed; fiscal rules and output gap improve sustainability.	Focused on Eurozone; lacks SSA relevance and does not include FDI or climate effects.
Ko	2020	Pooled cross-section, fiscal space and vector models	Southern Europe unsustainable; welfare states maintain balance with strong fiscal rules.	Welfare state focus; lacks SSA coverage and ignores climate risks.
Leith & Wren-Lewis	2013	New Keynesian model with simulations	Debt more aggressively stabilized under discretionary policy.	Abstract modeling; no SSA, FDI, or climate integration.
Lee et al.	2018	Panel solvency tests	Solvency varies by EU region; eurozone more fragile.	Regional Europe focus; no SSA data or climate/institutional consideration.
Adrison	2024	Empirical fiscal trend analysis	Indonesia, Malaysia, Thailand maintain sustainability despite deficits.	Southeast Asia focused; lacks SSA and environmental/external shock perspectives.
Afonso	2005	Cointegration with structural breaks	EU-15 countries showed limited fiscal sustainability; some stabilized debt-to-GDP ratios.	Lacks SSA relevance; does not include climate, FDI, or institutional factors.

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2.3.2 Climate Change and Fiscal Sustainability

The empirical literature on the relationship between climate change and fiscal sustainability is still in its early stages of development, but a growing body of research suggests that climate change poses significant risks to government budgets in the medium and long term (Benson & Clay 2004). El-Morsy (2023) studied the relationship between climate change risks and macroeconomic policies, focusing on Egypt as a case study. He evaluates how climate-related risks affect financial stability, government budgets, and economic growth. The research concluded that climate change poses major threats to macro-financial stability, influencing government expenditures, debt sustainability, and financial asset valuation.

Bachner & Bednar (2019) employed a computable general equilibrium framework to systematically examine the effects of climate change on both the expenditure and revenue aspects of public budgets across 10 distinct impact areas in Austria by mid-century. The researchers subsequently examined various methods by which reductions in public service provision can be offset by fiscal instruments or foreign lending, together with the corresponding economy-wide impacts. The researchers discovered that in the absence of counterbalancing, the consequences of climate change on government budgets are magnified, as they account for both direct expenditure impacts and macroeconomic feedback effects that diminish the entire revenue base. Counterbalancing reveals substantial disparities in budgetary and macroeconomic effects among fiscal measures.

Lamberts & Georgaraki (2022) examined the impact of climate change and adaptation policies on debt sustainability, focusing on projections up to 2050. They utilized the Eurogreen macrosimulation model to compare economic scenarios with and without

climate damage, as well as rapid versus gradual adaptation strategies. Their finding suggests that while climate damage may have a limited impact on GDP by 2050, it significantly increases the debt-to-GDP ratio due to reduced government revenues. A rapid adaptation strategy was found to be more effective in offsetting the negative effects of climate change and maintaining debt sustainability compared to a slower, more gradual approach. The study also highlights that current fiscal rules may hinder effective responses to climate risks.

Cevik, S., & Nanda, V. (2020) argue that small economies with high debt and increased susceptibility to climate change face a significant and ongoing problem in maintaining fiscal sustainability. The model-based fiscal sustainability test was conducted in 16 Caribbean countries from 1980 to 2018. The findings revealed that the coefficient for previous government debt was positive and statistically significant, suggesting that fiscal policy in the Caribbean implements measures to offset a rise in the debt-to-GDP ratio. Nonlinear calculations revealed that the quadratic debt parameter had a negative value, indicating that the fiscal policy response was insufficient to guarantee sustainability when debt levels were higher. Similarly Cevik and Tovar-Jalles (2020) examine the bond yields of 98 economies from 1995 onwards and conclude that climate vulnerability and preparedness influence governments' borrowing costs. A 1% rise in climate sensitivity elevates the long-term government bond spreads of emerging nations by approximately 3%.

Binta et al. (2021) examined the effects of climate change on budget balance and forecasted its implications for fiscal policy in ECOWAS nations. The two-step dynamic GMM approach was utilized for a balanced panel dataset comprising 14 countries from 2008 to 2018. The research determined that rainfall is the sole climatic variable that

exacerbates budget shortfalls. Additional macroeconomic variables, including the debt-to-GDP ratio and inflation, contributed to the expansion of budget deficits. This analysis suggests that excessive and unexpected rainfall will disrupt the fiscal equilibrium of ECOWAS nations by diminishing revenue sources or increasing expenditures. This would result in more borrowing, exacerbating the current budget deficits due to debt payments, so causing the individual governments to allocate less attention to other sectors of the economy.

Physical risks from climate change, such as more extreme weather events, sea level rise, and damage to infrastructure, can lead to higher government spending on disaster relief and reconstruction. For example, a study by Giovanis and Ozdamar (2022) set out to look at how the Middle East and North Africa's countries' public debt and fiscal balance were affected by climate change. The empirical analysis uses a variety of models and panel data from 1990 to 2019. The results indicated that while temperature variations had no discernible effect on rainfall, they did have a negative influence on government debt and the budget. The average temperature raises debt by 1.87 percent and reduces fiscal balance by 0.3 percent. Under the assumption of a high greenhouse gas (GHG) emission scenario, they find a significant decrease in the fiscal balance at 7.3 percent and an increase in the public debt at 16 percent in 2060–2079 and 18 percent in 2080–2099 using temperature and rainfall projections for the years 2020 to 2099. Conversely, in the scenario with low greenhouse gas emissions, public debt increases by 6.3 percent in 2080–2099 and by 5.7 percent in 2020–2039, and the fiscal balance deteriorates by 1.7 percent in 2020–2039 and 2.2 percent in 2080–2099.

A study conducted by Nandini et al (2024) examined the impact of floods and cyclones on India's budget and economy at the subnational government level. This study

developed a physical catastrophe severity measure to assess the effect on fiscal sustainability following disasters. The study compiled a panel dataset of 25 Indian states by combining catastrophe intensity index and budgetary data from 1995 to 2018. The analysis, employing Panel Vector Autoregression, revealed that the total government spending of a state increases and its budget deficit deteriorates in the presence of floods and cyclones.

Several studies highlight the potential threat climate change poses to fiscal stability through its impact on debt dynamics and vulnerability. Agarwala et al. (2021) analyze the risks facing 138 countries, finding that low-income nations are particularly susceptible to climate-induced debt accumulation. A comparative study by S.A Zenios (2021) looked at the risks from climate change to sovereign debt using Italy as a case study. He established that it was difficult to make precise comparisons given that different study regions experience different climate conditions. However climate change had adverse effect on debt dynamics and he proposed an integrated framework for incorporating climate change impacts into debt sustainability analyses, emphasizing the need for proactive measures to mitigate potential risks.

Jorge M. Uribe (2023) analyzed fiscal stability and climate change in 171 countries from 1995-2020 using cox models. He found out that fiscal stability is contingent upon the debt burden, particularly the interest paid on debt and the potential trade-off between reducing vulnerability to climate change and maintaining fiscal stability lies within governance, as a measure of institutional quality a key determinant of both fiscal stability and climate change preparedness

Koenig and Schellenberg (2020) further emphasize the link between natural disasters and sovereign debt, suggesting that climate change may exacerbate existing

vulnerabilities. The paper by Iustina and Kamilla (2022) examines the influence of various climate change indicators (such as performance, exposure to extreme events, vulnerability, readiness, and climate debt) on the cost of government borrowing, measured by sovereign bond yields and sovereign risk premium. The study focuses on a panel of European Union countries from 2000 to 2020. Evidence indicates that countries that are susceptible to climate change, and have little capacity to effectively manage climate-related disasters, face increased costs in borrowing money through their sovereign debt.

In china it was depicted that fiscal cirisis was more likely to occur in both cold and dry climatic scenarios this was through Zhudeng Wei et al analysis of climate change and fiscal balance in china for a span of 10 years. Additionally studies like Yuanshuang Zhao et al. (2023) used temperature and precipitation to depict climate change by matching weather data with the data for all non-financial listed enterprises in China from 1990 to 2017. They created temperature bins and precipitation bins using daily temperature and precipitation data. The study offered a possible first empirical analysis that thoroughly examines the effects of daily temperature and daily precipitation on enterprises' debt financing costs using the risk perception theory. In contrast to an appropriate day, a day over 30 °C results in 0.2411% higher debt financing expenses for businesses. A day with torrential rain raises the financing expenses for businesses by 0.2697% when compared to a sunny day. In 2017, extra expenses totaling between $122.13 million and $20.49 million were incurred by all enterprises. After doing several heterogeneity tests, they discovered that companies that investors deem more vulnerable are more negatively impacted by climate change in terms of debt financing costs.

In their study, Zhongfei Chen et al. (2023) examined the influence of climate change on the financial burden faced by the government. They analyzed fiscal data from local governments in China spanning the years 2000 to 2020. Utilizing fiscal data at the county level in China, a thorough analysis of the financial consequences of extreme weather conditions revealed that each extra day of extreme temperatures in a year results in a CNY 0.002 billion rise in the general public budget deficit. The increase was equivalent to 0.1093% of the local fiscal deficit.

Similar findings are seen from Kunawotor, M et al (2022). They examine the impact of climate change and the occurrence of extreme weather events on fiscal balance and the overall implications for the development of fiscal policies in Africa. The researchers utilized the GMM method, as well as fixed-effects and random-effects estimation strategies, to analyze data from 1990 to 2017. Their findings indicate that higher temperature change anomalies, which indicate a warmer environment in a given meteorological year, have a negative impact on the fiscal balance in Africa. The data also indicated that weather-related disasters can have a substantial effect on fiscal balance, particularly when the resulting damage is extensive and serious.

The World Bank's review on climate change's impact on Caribbean tourism (2022) further highlight the sector-specific revenue losses that could exacerbate fiscal challenges. Addressing the fiscal implications of climate change necessitates a focus on adaptation and investment strategies. Barnett et al. (2022) estimate the global costs of coastal adaptation, highlighting the significant resource demands governments may face. The IMF (2021) report focuses on financial needs for climate change adaptation in low-income countries, outlining potential fiscal challenges and resource allocation strategies.

Monsod et al. (2023) analyzes fiscal capacity in climate-sensitive developing nations, focusing on long-term solvency and financial limitations. They implemented an endogenous debt limit metric, evaluating a nation's fiscal adjustment record to determine its ability to fund climate adaptation through evaluating the gap between anticipated debt ratios and country-specific debt thresholds. The research indicates that numerous climate-vulnerable nations have significant fiscal capacity, suggesting they are not on the brink of insolvency; however, they face liquidity limitations due to inefficiencies within the financial system. The research indicates that international financial institutions ought to reevaluate debt thresholds to facilitate increased adaptation financing. The study also underscores the potential risk of a financial trap, in which solvent governments may find it difficult to secure the necessary climate funding.

Examining the specific impacts of climate change on fiscal sustainability within regions and sectors provides valuable insights for policymakers. The Maldives Monetary Authority (2022) study assesses the unique fiscal risks posed by climate change for the Maldives, emphasizing potential impacts on tourism and infrastructure. The Alpine Climate Change Adaptation Initiative (2022) research focuses on the economic implications of climate change for Alpine tourism, revealing potential fiscal ramifications for countries in the region. The World Bank's review on climate change and the energy sector (2022) further emphasizes the sector-specific disruptions and fiscal risks that governments reliant on energy resources may face.

Using a combination of macroeconomic data and detailed ground and satellite catastrophe indicators spanning the past three decades across 164 countries, IMF study in 2023 examined the macro-fiscal consequences of three common climate disasters

(droughts, storms, and floods). Within emerging market and developing economies (EMDEs), where agriculture is the primary industry, a drought diminishes production growth by 1.4 percentage points and government revenue by 0.7 percent of GDP due to the erosion of tax bases in the afflicted countries.

Sudsawasd & Puapan's (2014) study examined fiscal policy responses to climate variability in Thailand over multiple economic cycles. Using regression-based measures to analyze discretionary fiscal policy changes in response to climate variability, it evaluated government budget formulation and spending patterns across different ministries. The study found that Thailand's discretionary fiscal policy is generally pro-cyclical, which means that government spending tends to increase during economic booms and decrease during downturns. The effects of climate variability on fiscal policy were limited, with only minor impacts on budget formulation at the ministry level.

However the adaptation and mitigation of climate change cannot be realized without understanding the root cause. This is to say that any comprehensive discussion on climate change must inherently incorporate the inseparable variables of rainfall patterns and carbon emissions. It is evident that both rainfall patterns and carbon emissions play significant roles in the broader context of climate change. Therefore understanding the feedback mechanism of the two variables is crucial for effective climate change mitigation and adaptations efforts. The empirical evidence indicates that rainfall patterns can have a significant impact on fiscal sustainability, both directly and indirectly. Rainfall variability poses significant challenges to government revenue streams. Studies by Burke et al. (2015), World Bank (2018) and Dell et al. (2014) demonstrate the negative correlation between rainfall fluctuations and agricultural

output, particularly in developing countries. This translates to reduced tax revenue from agricultural production, potentially impacting government budgets and fiscal stability. Further research by IMF (2022) emphasizes the vulnerability of hydroelectricity generation to rainfall patterns, highlighting potential revenue losses for governments reliant on this energy source. Another study, by the IMF (2019), found that extreme weather events can increase government debt by up to 2% of GDP in developed countries.

The fiscal impacts of rainfall variability extend beyond revenue losses. Droughts and floods associated with erratic rainfall patterns often necessitate increased government expenditure on disaster relief, infrastructure repair, and social safety nets. Studies by World Bank (2020) and Heltberg et al. (2009) quantify these expenditure pressures, highlighting the financial strain placed on governments during extreme weather events. Additionally, long-term adaptation strategies, such as investing in drought-resistant crops or water management infrastructure, require significant upfront investment, further adding to fiscal pressures. Moreover the global pursuit of mitigating climate change through carbon emission reduction poses both environmental and fiscal challenges.

Transitioning to a low-carbon economy necessitates significant upfront investments in clean energy infrastructure, research and development, and social safety nets to support workers in transitioning sectors. The IEA (2021) and IPCC (2022) reports quantify these investment needs, highlighting the potential strain on government budgets. Additionally, adapting to the economic and social impacts of climate change, such as rising sea levels and extreme weather events, also entails substantial expenditure pressures. Hence it is critical for policy makers to come up with policies putting in mind

the strains on government budgets. Research by Coady et al. (2017) and Gillingham et al. (2016) provide valuable insights into effective policy design to minimize adverse impacts while maximizing economic and environmental benefits.

In their 2011 paper, Paul Ekins and Stefan Speck analyze the fiscal sustainability difficulties presented by climate change and the requisite policy solutions to mitigate them. The article presents a framework to evaluate fiscal sustainability in the context of climate change, emphasizing the application of economic instruments including carbon taxes, emissions trading systems, and subsidies. The authors demonstrate that climate change mitigation and adaptation measures have substantial fiscal repercussions by examining their impact on government revenues and expenditures. Although measures like both carbon taxes and auctioned emissions permits can provide significant revenue, adaption initiatives frequently require substantial public investment. The study highlights the significance of long-term fiscal planning to ensure economic stability while addressing the financial requirements of a climate-resilient transition.

Catalano, et al. (2022) utilized an Integrated Assessment Model (IAM) featuring a multi-country overlapping generation's framework and a climate module to examine fiscal policy instruments for climate change mitigation across different economic regions. Their analysis indicated that relying solely on carbon pricing or green investments is insufficient for a sustainable transition to a low-carbon economy. Carbon pricing alone would lead to rapid energy price increases, causing economic downturns. Likewise, excessive public green investment without carbon pricing could threaten debt sustainability. The study concludes that a mix of carbon pricing and deficit-financed

green public investment is necessary to achieve climate objectives while maintaining fiscal stability.

Avgousti et al. (2023) analyzed fiscal policies across EU member states, assessing the impact of extreme weather events, debt sustainability, green investment gaps, and the distributional effects of climate policies. The research employed empirical analysis and policy evaluation frameworks. The research showed that using the right mix of revenue policies (like carbon taxes) and spending policies (like subsidies and investments) is crucial for meeting greenhouse gas emissions goals, along with addressing the financial challenges of adapting to and reducing climate change in the EU.

Seghini (2024) examined the long-term fiscal implications of climate change, focusing on sovereign debt sustainability across different economic scenarios. Employing an economic modeling approach to assess how climate mitigation efforts and rising temperatures affect government debt limits, the study found that climate change mitigation costs can push government debt into unsustainable territory, particularly for countries like Italy. Thus it emphasized on the importance of global coordination in transition policies, showing that a collaborative approach stabilizes debt limits and supports sustainable public finance.

Barrage (2020) examined the long-term fiscal consequences of climate change, focusing on government expenditures and taxation by integrating climate change impacts into the Climate Optimization Model of the Economy and Taxation (COMET), a dynamic general equilibrium model. The research indicated that climate change increases the cost of government services (e.g., disaster assistance, healthcare) and necessitates higher tax rates. It estimated that accounting for fiscal impacts could increase the welfare benefits of efficient climate policy by up to 30%.

Beirne et al. (2024) examined fiscal space and climate risk in 199 economies from 1990 to 2022. They utilized panel local projections to examine the impact of political stability and financial development on the relationship between climatic risk and fiscal space. Their research confirmed that climate threats adversely influence fiscal space, particularly affecting the most vulnerable economies to a greater extent. Nonetheless, political stability and socioeconomic prosperity can alleviate these impacts. The research indicates that fiscal consolidation is essential for mitigating the negative impacts of climate threats on fiscal capacity. Similar results are reported by Cheeseman,et al. 2024. They examined fiscal risks associated with climate change, focusing on public financial management strategies. The research highlights that climate change poses significant fiscal risks, affecting government expenditures, infrastructure investments, and financial planning.

Brändle, et al (2022) analyzed the long-term fiscal sustainability of Switzerland, focusing on the effects of the COVID-19 crisis, demographic ageing, and climate change. The research highlights that Switzerland's ageing population significantly affects public finances, particularly in pension and healthcare systems. The COVID-19 crisis exacerbated fiscal pressures, requiring long-term policy adjustments. Additionally, climate change presents an emerging challenge, necessitating proactive fiscal strategies to ensure sustainability. Le, Park, and others (2024) conducted a detailed panel data analysis to examine the impact of disaster risks on government debt and fiscal stability, utilizing a New Keynesian Dynamic Stochastic General Equilibrium (NK-DSGE) model that incorporates various types of households and a government to assess how disaster risk influences different groups. The research found that rising climate-related disaster risks increase government debt and threaten fiscal sustainability. The adverse effects of disaster risks disproportionately impact low-

income households, exacerbating inequality. The study also found that sovereign debt rises significantly due to disaster risk, posing challenges for policymakers.

Another study by Afonso, et al. (2025) offers a detailed examination of fiscal and external sustainability across 134 economies over the period 1980 to 2023, with a particular emphasis on the effects of climate-related shocks. The researchers employ a two-step methodology: first, they estimate country-specific, time-varying sustainability coefficients; second, they analyze the factors influencing these coefficients using Weighted Least Squares (WLS) panel regressions with fixed effects. To better understand short-term responses to climate shocks, the study also incorporates local projection techniques, focusing on the impacts of disaster-related mortality, vulnerability, and resilience. The findings reveal that natural disasters significantly undermine fiscal sustainability, especially in emerging and climate-vulnerable economies. Countries with higher levels of vulnerability experience greater fiscal and external fragility, while those with stronger resilience are better able to absorb shocks and maintain fiscal stability. Local projections show that fiscal sustainability tends to deteriorate markedly in the medium term following climate-related disasters, while external sustainability responses are more varied and less pronounced. The study highlights the need for a combined short- and long-term analytical approach to fully capture how climate shocks influence macroeconomic conditions and to guide the design of adaptive, risk-informed fiscal policies.

D'Orazio (2025) investigated the fiscal challenges and opportunities facing Emerging Markets and Developing Economies (EMDEs) as they confront climate risks and pursue a transition to low-carbon development. The study analyzes fiscal policy responses to both physical and transition climate risks, examining government spending

patterns, efforts to diversify revenue sources, and the role of institutional capacity. Specific focus is given to initiatives such as fossil fuel subsidy reforms and the issuance of green bonds. The findings reveal that EMDEs are particularly vulnerable to climate-related disruptions, often requiring substantial public investment in disaster recovery and climate-resilient infrastructure. Additionally, economies heavily reliant on fossil fuels face significant transition risks, including declining revenues and the potential for stranded assets. The study underscores the urgent need for EMDEs to diversify their fiscal base, strengthen institutional frameworks, and access international climate finance in order to build resilience and achieve long-term fiscal and environmental sustainability.

In her 2024 study, Shuqin Gao examines the fiscal and financial sustainability difficulties posed by climate-related physical risks and the expenses associated with adaptation. The research assesses the macroeconomic effects of climate disasters on output, tax income, and public expenditures through binary and multinomial logistic regression analysis, dynamic stochastic general equilibrium (DSGE) modelling, and Bayesian estimation. The results indicate that climate-related occurrences disturb fiscal-financial stability, frequently leading to budget deficits and fiscal crises that burden public finance systems. Gao investigates alternative policy approaches, such as the environmental enhancement of fiscal-financial institutions, to provide climate fiscal space and bolster long-term resilience. The study indicates that governments often underestimate the financial burden of climate disasters, leading to structural financial instability and highlighting the necessity for cohesive climate-conscious fiscal planning.

In 2023, Peter S. Heller explored the fiscal challenges associated with climate change adaptation, with a particular focus on government policy responses and financial constraints. He examined the macroeconomic implications of climate hazards and emphasizes the critical role of governments in enabling private sector adaptation while distinguishing between mitigation—efforts to reduce greenhouse gas emissions—and adaptation, which aims to lessen vulnerability to climate risks. Heller found that many developing and emerging market economies face significant fiscal limitations that hinder their ability to implement effective adaptation strategies. He warned that delaying adaptation in hopes of mitigation success could result in substantial economic and social losses. The study also highlighted recent initiatives by the International Monetary Fund (IMF) to enhance economic policy surveillance as a means of supporting national efforts to strengthen climate resilience.

2.3.3 Institutional Quality and Fiscal sustainability

Institutional quality encompasses a complex set of factors, including the rule of law, government effectiveness, control of corruption, and regulatory quality. Empirical studies reveal a positive correlation between institutional quality and fiscal sustainability. Ahmad (2007) and Alt & Lassen (2006) demonstrate that stronger rule of law and government effectiveness is associated with lower budget deficits and public debt levels. Additionally, research by Alesina and Perotti (1996) suggests that countries with higher control of corruption tend to exhibit greater fiscal discipline and transparency. These findings indicate that robust institutions facilitate sound fiscal management by reducing wasteful spending, improving tax compliance, and enhancing long-term fiscal planning.

Rose's (2010) study consolidates empirical literature on fiscal sustainability, analyzing several political and fiscal structures, including direct democracy and balanced budget regulations. This analysis evaluates existing studies to determine the efficacy of various fiscal policies in fostering financial accountability among state and local governments. The analysis indicates that governments have employed several fiscal strategies to curtail spending growth and improve financial stability. Although many regulations and procedures have demonstrated efficacy, deficiencies persist in comprehending their enduring effects on fiscal sustainability. The research underscores the necessity for additional empirical investigation to identify the optimal institutional structures for sustaining fiscal health.

Abdullahi & Jibril (2024) analyze the threshold effects of the rule of law and corruption on public debt sustainability in Nigeria, using annual data from 1993 to 2022 and applying a threshold regression model for their research. The study's findings indicate that when corruption above a specific threshold, it significantly exacerbates public debt, suggesting that corruption intensifies the nation's financial load. The findings demonstrate that a stronger rule of law correlates with reduced public debt levels, highlighting the essential importance of institutional quality in efficient fiscal management.

Nguyen & Luong (2021) empirically modeled the effects of fiscal policy and institutional quality on public debt in 27 transition nations from 2000 to 2018, examining the economic implications of these characteristics. Using two-step GMM, random effects, and Ordinary Least Squares (OLS) techniques, they discovered that institutional quality influences public debt. In particular, inadequate governance in preventing corruption contributes to a greater amount of public debt accumulation,

while funding to enhance institutional quality in terms of government efficacy, regulatory quality, and rule of law following regime changes in those nations increases the amount of public debt.

Lee et al (2023) conducted a study to examine the impact of institutional quality on debt sustainability in a panel of 82 nations. The study specifically focused on identifying threshold effects at different income levels. The study included nations classified by the World Bank as high income (HI), upper middle income (UMI), and lower-middle and low income (LMLI). The results of the dynamic threshold panel regression showed that there is a threshold influence of institutional quality on the fiscal reaction function, which includes debt sustainability and cyclical fiscal policy, in all countries with varying income levels. Fiscal adjustment in HI countries is hampered when the level of institutional quality exceeds a certain threshold. The budgetary adjustment in UMI nations was comparable to that in HI countries, but it was not statistically significant. In contrast, governments in low and middle-income countries (LMLI) have the potential to encourage sustainable debt if their institutional quality surpasses a certain threshold.

Aduma et al. (2022) analyzed the influence of institutions on external debt in ECOWAS nations over a decade (2008-2018), encompassing 16 West African countries. The study employed the System Generalized Method of Moments for data analysis and assessed institutions using six proxies: Government Effectiveness, Rule of Law, Control of Corruption, Political Stability, Regulatory Quality, and Voice and Accountability. The findings indicated that the rule of law and regulatory quality exerted no significant positive effect on the management of external debts in the ECOWAS sub region, whereas political stability and government effectiveness had a significant positive

impact on external debts. Conversely, control of corruption negatively affected external debt, and voice and accountability significantly hindered external debt management during the reviewed period. The researchers advocated for uphold of rule of law and enhanced governmental oversight of corruption, the alleviation of administrative impediments, and the reduction of redundant governmental agencies that have caused unwarranted delays in the execution of government policies.

In their study, Cahyadin et al (2022) calculated the threshold levels of the public debt-to-gross domestic product (GDP) ratio and the budget deficit for a total of 106 developing nations and 36 developed countries, covering the period from 1996 to 2018. A fiscal sustainability indicator based on Principal Component Analysis (PCA) was created, and a dynamic panel threshold regression was used. The primary discoveries indicated a threshold effect in the relationship between the public debt-to-GDP ratio and budget deficit fiscal sustainability. The public debt-to-GDP ratio and budget deficit played a positive role in ensuring fiscal sustainability within various institutional measures, whether at lower or upper threshold levels. The maximum criterion for the public debt-to-GDP ratio was 59.56% for affluent countries and 64.87% for developing countries. Developed countries had a maximum budget deficit-to-GDP ratio of 0.41%, while underdeveloped countries had a maximum ratio of 3.34%. Three institutional factors, namely regulatory quality, the rule of law, and control of corruption, have a substantial impact on the calculation of the threshold.

Fagbemi (2020) examined the immediate and long-term correlation between institutional quality and fiscal success in 12 West African nations from 1984 to 2016. This analysis employed the Pooled Mean Group and Mean Group estimator methods. The findings indicated that enhanced governance had a consistent effect of reducing

deficits, both in the short term and in the long term. When compared to other variables, the democratic accountability factor had the most substantial impact on the fiscal performance of West Africa in the long term. Nevertheless, the empirical data also shows that, in the near term, the institutional aspects are not significant in predicting the budgetary performance of West Africa. Therefore, the study proposed that in order to improve fiscal prudence and sustainability in West Africa, it is important to encourage the establishment of strong institutions and ensure effective governance. This is because a higher level of public debt has the potential to negatively impact the effectiveness of sustainable fiscal policies.

Ibukun et al (2018) investigated the impact of institutions on fiscal performance in 15 West African nations from 1996 to 2012. The researchers utilized the Feasible Generalized Least Squares (FGLS) estimator to examine the relationship between institutions and fiscal performance in West Africa. They focused on institutional indicators such as government effectiveness, political stability, rule of law, regulatory quality, and control of corruption. Their main finding was that institutions played a significant role in influencing fiscal performance in the region, among other factors. Additionally, the quality of regulations had the greatest impact on enhancing fiscal performance, and hence, development. The observed association is attributed to the fact that high-quality institutions limit the likelihood of public agents engaging in political capture. This, in turn, reduces reckless expenditure that contributes to the debt accumulation in respective countries. The study's findings were crucial because a weak institutional framework can allow governments to manipulate public spending in order to gain political support, resulting in significant fiscal deficits and ultimately hindering the development of these economies.

Bleaney, Michael (2010) created an index that measures the effectiveness of the institutions, regulations, and processes that control the budget process in 46 African countries. The index encompassed the three phases of the budget process: bargaining, legislative endorsement, and execution. The quality of the budget process is assessed based on five criteria: centralization, rules and controls, sustainability and credibility, comprehensiveness, and openness. Significant variation in the quality of institutions was seen throughout the continent. Moreover, a data-driven examination utilizing Ordinary Least Squares (OLS) estimations revealed a correlation between improved budget institutions and reduced public external debt, as well as an increase in the main budget balance.

The 2023 study by Ahmed et al. discovered that institutional quality has a positive effect on economic sustainability in 65 emerging economies from 1984 to 2019. Nonetheless, it also disclosed an adverse correlation between quality and CO2 emissions, as well as ineffectiveness non deforestation efforts. The research indicated that political stability, administrative capability, and accountability within the political system contribute to sustainable development; nevertheless, these factors do not account for deforestation.

Digdowiseiso, K. (2023) contends that the diverse institutional frameworks of fiscal decentralization in developing nations are dependent on the quality of institutions. Additional incentives may motivate policymakers to alter the levels of budgetary authority. An analysis utilizing a five-year average of data from 34 developing nations spanning 1990 to 2014, employing the Generalized Method of Moments (GMM), revealed a robust nonlinear correlation between institutional quality and fiscal decentralization indicators. In this framework, as democracy (polity), participatory democracy, bureaucratic quality, law and order, and fiscal decentralization originate

from low development levels, an enhancement in these institutional quality factors will further diminish fiscal autonomy.

The Okine et al. (2023) study looked at how fiscal policy affected financial development in Sub-Saharan African countries. Spanning 23 countries from 2000 to 2021, the study reveals that improvements in institutional quality and fiscal policy reduce long-term financial development. Nonetheless, an escalation in government revenue and expenditure positively influences financial development. The study also showed no causal link between fiscal policy, foreign capital, industrialization, and financial development with respect to institutional quality. Hence SSA countries ought to give the creation of strong fiscal policy systems top priority for efficient fiscal policy development. Effective fiscal policy creation depends on institutional consistency both inside SSA countries and among them.

The study conducted by Fayzullokh et al. (2023) sought to investigate the impact of public debt on poverty alleviation, taking into account additional parameters such as economic growth, population, inflation, human development index, and institutional quality. The study employed a panel data methodology to examine the relationship between public debt and poverty alleviation in developing nations. The panel dataset spanned a 21-year timeframe, specifically from 2000 to 2021, and included of data from 20 developing nations. The study demonstrated a notable and favorable association between public debt and poverty, suggesting that elevated levels of public debt can result in a rise in poverty within developing nations. The analysis emphasized the intricate correlation between public debt and the alleviation of poverty in developing nations. Despite the varied outcomes, the findings underscore the necessity for policymakers to implement a holistic strategy for alleviating poverty. This strategy

should encompass not just the reduction of public debt, but also the promotion of economic growth, improvement of institutional quality, and addressing other issues that contribute to poverty.

In their study, Ritzen et al (2017) examined the institutional attributes of the 19 Euro countries, including factors like Government efficiency, undue influence, and business ethics. They found that these qualities have varied between the years 2006 and 2015. It was discovered that the overall disparity in the quality of institutions across the EMU, as quantified by the Gini coefficient, rose. The institutional changes observed in Euro area nations were influenced by both the varying severity of the financial and economic crises (which likely had a reciprocal relationship) and the fiscal consolidation measures implemented as policy responses.

In her study, Dimitra (2020) examined the influence of fiscal frameworks, such as fiscal regulations and fiscal councils, on fiscal performance. Additionally, she explored the effects of other institutions, including the Worldwide Governance Indicators, on the primary balance. The empirical analysis utilized a reaction function proposed by Bohn (1998), employing fixed effect panel data estimation and dynamic panel data estimation methods developed by Arellano-Bover and Blundell-Bond. The primary findings indicate that political stability, government effectiveness, fiscal rules, and fiscal councils have a significant impact on enhancing fiscal performance. Nevertheless, the impact of fiscal institutions on the primary balance varied depending on the specific type of fiscal regulations (such as debt rules, expenditure rules, and budget balanced standards) and whether fiscal councils were independent or had access to information.

The primary objective of Calderón & Nguyen (2016) was to record the cyclical characteristics of fiscal policy in SSA and examine whether the cyclical stance could

be affected by structural and policy aspects of the economy, such as institutional quality, policy space, resource abundance, and state fragility, among others. By analyzing annual data from 1970 to 2013 for 128 countries, it was discovered that countries with stronger institutions and more policy flexibility are able to decrease the extent to which fiscal policy is influenced by economic cycles in the majority of countries in the region. Their research suggests that African policymakers should prioritize two actions: (i) implement comprehensive institutional reforms to ensure durable and countercyclical responses, and (ii) build up liquidity and policy buffers during favorable economic conditions to be better prepared for unfavorable ones.

While strong institutions generally promote fiscal sustainability, certain challenges can undermine their effectiveness. Studies by Rodrik and Weldon (2002) and Robinson and Rodrik (2001) highlight the potential influence of vested interests and elite capture, which can lead to policy decisions that prioritize short-term political gains over long-term fiscal stability. Christelle M & Joel H (2023) conducted a study on the correlation between fiscal policy and economic growth in CFA countries. They also analyzed the influence of institutions and debt on this correlation. Through the utilization of panel data from thirteen countries spanning the years 1995 to 2017, the system GMM estimates have determined that, in contrast to the Keynesian perspective which suggests a positive correlation between fiscal policy and economic growth, there exists compelling evidence of a negative correlation between fiscal policy and economic growth. The economic rationale for this outcome may be attributed to the fact that many developing countries, including CFA countries, do not allocate sufficient resources to invest in productive sectors of their economies. Additionally, weak accountability mechanisms within institutions can enable mismanagement and corruption, posing risks to sound fiscal practices.

Kpegba et al. (2024) undertook a study to empirically examine the moderating effect of institutional quality on the link between public expenditure and economic sustainability in Sub-Saharan African nations. The study employed a quantitative and explanatory design, examining a longitudinal dataset covering 20 years (2003-2022) from 48 Sub-Saharan African nations, obtained from the World Development Indicators and World Governance Indicators databases. The application of Pooled OLS and System GMM econometric methods indicated that public expenditure and institutional quality positively and significantly influence economic sustainability. Nonetheless, it was discovered that institutional quality negatively and significantly moderates this link, suggesting a potential trade-off for nations between preserving institutional quality and attaining long-term economic sustainability..

Understanding the empirical evidence on institutional quality and fiscal sustainability informs effective policy choices. Governments can prioritize strengthening key institutions to foster responsible fiscal management. This includes efforts to combat corruption, improve transparency, enhance the rule of law, and strengthen democratic processes.

2.3.4 Foreign Exchange Rate and Fiscal Sustainability

The interconnectedness of global economies makes national financial health susceptible to international financial currents. Fluctuations in foreign exchange rates (FX) pose a significant challenge to fiscal sustainability, influencing government revenue, expenditure, and debt dynamics.

Studies by Edwards (1989) and Obstfeld and Rogoff (2000) demonstrate that export-oriented economies tend to benefit from a depreciating currency, as it makes their exports more competitive in international markets. However, a depreciating currency

can also increase the cost of imported goods and services, leading to potential inflation and reduced domestic consumption, ultimately impacting tax revenue. Additionally, research by IMF (2020) highlights the vulnerability of commodity-exporting countries to FX fluctuations, as their revenue streams are directly tied to global commodity prices, which can be volatile and susceptible to currency movements.

In his study of Jamaica, Prudence Serju-Thomas (2020) employed Fiscal reaction functions to evaluate fiscal sustainability using various models such as OLS, VAR, GMM, and VECM. The vulnerability of the public debt stock was assessed using the IMF debt sustainability analysis (DSA) framework, which considered shocks to real GDP, primary balance, interest rate, real exchange rate, and a combined shock. Following the completion of the nation's economic reform program, the outcomes indicated that fiscal policy in Jamaica is progressing towards achieving sustainability. Nevertheless, when excluding the economic reform period from the sample, the results indicated that fiscal policy in Jamaica was not viable in the long run. Additionally, the findings suggested that a primary surplus of 4.8 percent of GDP would be necessary in the future to attain a public debt-to-GDP ratio of 60 percent. The risk assessment of Jamaica's public debt indicated that it is very susceptible to significant decreases in the exchange rate, making it particularly vulnerable. Overall, the risk to the country's public debt stock is deemed to be high.

Unver et al (2015) conducted an empirical study to examine the factors that contribute to fragility in terms of long-term fiscal sustainability and sovereign ratings for Brazil, India, Indonesia, South Africa, and Turkey. They utilized the Fully Modified Ordinary Least Square (FMOLS) approach developed by Phillips and Hansen (1990). The dataset encompassed the time span from 1980 to 2012 for fiscal sustainability and from 1990

to 2012 for sovereign ratings in these nations. The study found a significant correlation between fiscal sustainability and various economic factors, including current account balance, gross domestic product (GDP), total reserves, energy imports, exchange rate, external debt, and credit to the private sector. Additionally, the study showed that sovereign ratings are primarily influenced by exchange rates, total reserves, energy imports, foreign direct investment (FDI) net inflows, current account balance, GDP, and external debt stocks.

A depreciating currency can increase the cost of servicing foreign debt, as the domestic currency buys fewer units of foreign currency to make debt payments. Studies by Reinhart and Rogoff (2010) and Blanchard (2005) emphasize the risk of debt traps for countries with significant foreign-denominated debt, particularly during prolonged periods of depreciation. Additionally, imported goods and services used for public infrastructure or social programs can become more expensive due to FX fluctuations, potentially necessitating adjustments to budgetary allocations.

The relationship between debt dynamics and foreign exchange fluctuations further muddies the image of fiscal sustainability. Research by Alesina and Hausmann (2005) and Tornell and Velasco (2000) indicate that FX volatility may increase risk premiums and deter long-term investment, which could result in higher borrowing costs and more debt. Additionally, currency depreciations can erode the value of government assets denominated in domestic currency, potentially reducing the government's capacity to handle potential future shocks.

From 1980 to 2017, Israel et al. (2018) looked at Nigeria's external debt, foreign exchange, and sustainable debt. The Augmented Dickey Fuller Unit Root Test Techniques, the Co-integration Test, and Ordinary Least Square Techniques were

employed. The results of the econometric techniques of Ordinary Least Squares (OLS) revealed that, in both the short and long run, the exchange rate had a significant relationship with sustainable debt management, while external debt had a positive but insignificant relationship with the same over the same periods.

In their study, Nazamuddin et al. (2022) investigated the immediate and lasting impacts of foreign exchange on Indonesia's external indebtedness. By utilizing an autoregressive distributed lag (ARDL) bounds testing method on quarterly data spanning from 2010 to 2019, and examining the presence of impact asymmetry, the researchers discovered a long-term cointegrating link between the two variables. Additionally, they discovered a gradual adaptation to a condition of balance after a disturbance. Foreign exchange has a favorable impact on Indonesia's external debt in the long term, but has a detrimental effect in the short term, a lack of symmetry in the responsiveness of external debt to changes in the exchange rate between the rupiah and the US dollar.

Futtwiler (2007) examined the relationship between interest rates and fiscal sustainability using empirical analysis of government debt and macroeconomic indicators. Using econometric modeling, he assessed how fluctuations in interest rates impact fiscal stability and long-term debt sustainability. The researcher highlights that rising interest rates can significantly affect fiscal sustainability by increasing debt-servicing costs. He asserts that governments with high debt levels are more vulnerable to interest rate shocks, which can lead to fiscal instability.

Martínez & Vergara (2012) employed a dynamic panel model to analyze the impact of real exchange rate shocks on fiscal sustainability in five Latin American countries (Brazil, Chile, Colombia, Mexico, and Peru) from 1999-2007. They estimated the effect

of public debt on interest rates and GDP growth, incorporating valuation effects into fiscal sustainability analysis. The research finds that currency devaluation significantly affects fiscal sustainability, not only by increasing the value of foreign-currency-denominated debt but also by raising interest rates and reducing GDP growth. The required fiscal adjustment after a devaluation depends on the size of the devaluation, the adjustment period, and the share of public debt in foreign currency. The study concludes that ignoring valuation effects can lead to misleading conclusions about fiscal sustainability, emphasizing the need for policymakers to account for exchange rate fluctuations when designing fiscal strategies.

2.3.5 Foreign Direct Investment and fiscal sustainability

Foreign Direct Investment (FDI) holds the potential to be a powerful tool for promoting fiscal sustainability. By bringing in new capital, technology, and skills, FDI can stimulate economic growth, a key driver of government tax revenue. However, the relationship between FDI and fiscal health is not always straightforward.

Several studies have documented the positive influence of FDI on economic growth. Lenka and Sharma (2014) and Balasubramanyam et al. (1996) analyzed data from various countries and found a positive correlation between FDI inflows and economic growth. This growth typically translates into increased government revenue from various taxes, such as income tax, corporate tax, and value-added tax (VAT). The impact of foreign direct investment (FDI) on corporate tax payments was examined by Balikcioglu et al. (2016) in Turkey between 2004 and 2012. They discovered that FDI increased corporate tax payments. The same results was painted by Binha (2021). FDI significantly boosts Zimbabwe's growth in tax revenue. The correlation between foreign direct investment (FDI) and tax revenue suggests that FDI may have led to some

beneficial technology spillovers that increased domestic firms' productivity, boosting government revenue in Zimbabwe. Ahiakpor et al. (2017) uses the Bayesian Model Selection (BMS) to identify the relationship between Foreign Direct Investment (FDI) and export performance in Ghana. The study found that while FDI had a favorable impact on export performance, it was not a key exporter growth driver in Ghana.

Asiedu (2006) analyzed the effects of macroeconomic instability, investment constraints, corruption, and political instability on foreign direct investment (FDI) in Africa. Analysis of panel data from 22 countries spanning 1984 to 2000 revealed that natural resources and expansive markets facilitate foreign direct investment (FDI). Additionally, factors such as reduced inflation, robust infrastructure, an educated workforce, receptiveness to FDI, diminished corruption, political stability, and a dependable legal framework also exert a favorable influence. The study indicated that nations with limited or absent natural resources might draw foreign direct investment by enhancing their institutional frameworks and policy environments.

Akinlo (2004) examined the influence of foreign direct investment (FDI) on economic growth in Nigeria from 1970 to 2001. The ECM results indicated that both private capital and lagged foreign capital exert minimal and statistically insignificant effects on economic growth. The findings appear to support the assertion that extractive foreign direct investment may not be equally beneficial to growth as manufacturing foreign direct investment. Although foreign direct investment (FDI) significantly impacts GDP, its direct relationship with fiscal sustainability is dependent upon institutional capability and macroeconomic policies.

In their study, Liliana and Dumitrescu (2017) examined the influence of remittances on fiscal sustainability, which is a component of economic development, private

consumption, private investments, and government tax revenue in low and upper middle-income nations. Based on a panel data set collected from 74 developing countries between 1989 and 2015, their research revealed a favourable correlation between migrants' remittances and both economic growth and private consumption expenditure. Moreover, their findings indicated that the remittances of migrants are linked to government tax income and the real interest rate, particularly when instrumental factors were employed.

Chukwuma Okolo (2017) conducted a study to determine the impact of remittances on budgetary sustainability in Nigeria. The Johansen cointegration test was utilised to examine the presence of a long-term link. The analysis utilised annual time series data spanning from 1977 to 2014, acquired from the Central Bank of Nigeria and the World Bank. The study utilised the Ordinary Least Squares (OLS) estimate technique in the context of error correction models. The findings suggest that remittances have a substantial effect on fiscal sustainability over a prolonged period, but not in the short term. The delay of remittances by one year resulted in an average annual improvement of fiscal sustainability, reducing the ratio of debt to GDP plus remittances by approximately 1.28%.

Kaur et al (2012) investigated the relationship between Foreign Direct Investment (FDI) and current account deficit in the context of India. Using the Toda-Yamamoto (T-Y) granger causality technique for the period 1975-2009, their results indicated that FDI and current account are co-integrated in the long run. There is evidence of unidirectional causality from FDI to current account.

Diallo et al. (2021) analyze the influence of Foreign Direct Investment (FDI) inflows on private domestic investment in Sub-Saharan African nations from 1980 to 2017.

Findings indicate that FDI inflows exert significant crowding-in effects over the long term, whereby a 1% rise in FDI relative to GDP leads to a 0.3% increase in private domestic investment. In the short term, competitive impacts predominate, whereas in the long run, beneficial effects prevail. The study also seeks to clarify the impacts of foreign direct investment on both private and state domestic investment. It indicates that foreign direct investment, when coupled with increased public expenditure, could support private domestic investment over the long term; however, this potential may be compromised by crowding-out effects resulting from elevated budget deficits, debt, political instability, and corruption. The study highlights the significance of economic diversification and resource endowments in evaluating the effects of FDI on private investment.

In her study, Oriana I. Fuentes (2012) investigated the potential correlation between the sustainable economic expansion in Latin America and the significant influx of foreign direct investment into the region, particularly during the last two decades. The researcher analysed the relationship between the ratio of total debt to gross domestic product (GDP) and three distinct indicators for foreign direct investment (FDI). The first measure is derived from the actual amount of foreign direct investment (FDI) that enters a country. The second and third measures are indexes that focus on exceptional periods of FDI inflow, such as significant growth from one quarter to another or large individual FDI transactions within a quarter. The regressions indicated an inverse correlation between nominal foreign direct investment (FDI) and the natural logarithm of the debt to GDP ratio. Across order to decrease the debt to GDP ratio from the present average of 29% across the South American and Caribbean areas to 21%, an increase of approximately $2.34 billion in foreign direct investment (FDI) inflows is necessary.

While FDI can be beneficial, there are also potential downsides to consider. Pournarakis and Varsakelis (2002) point out that FDI tends to be concentrated in developed economies, potentially limiting the tax revenue benefits for developing nations. This raises concerns about unequal distribution of the gains from FDI. Benedikt and Laura (2019) by analysing a dataset of bilateral foreign direct investment (FDI) stocks for over 150 countries from 2001 to 2011, the study examined the influence of fiscal discipline on FDI. The analysis centers on two key indicators of fiscal discipline that form the foundation of the convergence criteria outlined in the Maastricht Treaty: budget balance, which assesses short-term fiscal discipline, and the public debt-to-GDP ratio, which evaluates long-term fiscal discipline. The researchers introduced a novel approach that combines domestic investment data with bilateral foreign direct investment (FDI) data to analyse the influence of country-specific variables on FDI. Furthermore, it was shown that the stocks of inward foreign direct investment (FDI) are closely associated with sustained budgetary discipline over a significant period of time. Nevertheless, the decline in Foreign Direct Investment (FDI) in GIIPS countries was not caused by fiscally unsustainable policies.

Alfaro et al. (2004) investigated the correlation between superior financial systems in countries and their capacity to utilize foreign direct investment (FDI) more effectively. Empirical investigation of cross-country data from 1975 to 1995 demonstrated that foreign direct investment (FDI) alone had a vague impact on economic growth. Nevertheless, nations with advanced financial markets derive substantial benefits from foreign direct investment (FDI).

Wako (2018) examined the correlation between Foreign Direct Investment (FDI), economic development, institutional quality, and industrial value addition. He

employed dynamic panel data methodologies to demonstrate that economic growth, institutional quality, and natural resources favorably impact the attraction of foreign direct investment (FDI). Institutional quality is not merely an environmental variable; it also influences both variables. Economic growth improves institutional quality, whereas foreign direct investment increases corruption and weakens the rule of law. The research additionally uncovers an institutional resource curse stemming from both natural resources and foreign direct investment (FDI). The study indicates that nations ought to be discerning in their approach to foreign direct investment, weighing its beneficial growth impact against its deindustrializing and detrimental institutional consequences.

Kubaje et al. (2024) employed a fixed effects model and discovered that foreign direct investments considerably impact economic growth, although tax revenue as a percentage of GDP did not. Utilizing a dynamic threshold model, they determined that tax income exerts a minimal influence on economic growth, as the average tax rate of the tested countries remains below a threshold sufficient to catalyze economic expansion. The model suggests that a tax rate below 15% positively influences economic growth through tax revenue, however over this threshold renders taxes harmful to economic growth. Based on the findings, it is advised that African developing nations should not just depend on foreign direct investments but also enhance their tax systems, which will complement FDIs in the nation's economic progress.

Furthermore, Eluwole et al. (2019) highlight the issue of tax avoidance by multinational corporations, who may utilize tax havens to reduce their tax burden in the host country. This can significantly impact government revenue and undermine efforts towards fiscal

sustainability. Chukwuma Okolo (2017) conducted a study to determine the impact of remittances on budgetary sustainability in Nigeria. The Johansen cointegration test was utilised to examine the presence of a long-term link. The analysis utilised annual time series data spanning from 1977 to 2014, acquired from the Central Bank of Nigeria and the World Bank and the Ordinary Least Squares (OLS) estimate technique in the context of error correction models. The findings suggest that remittances have a substantial effect on fiscal sustainability over a prolonged period, but not in the short term. The delay of remittances by one year resulted in an average annual improvement of fiscal sustainability, reducing the ratio of debt to GDP plus remittances by approximately 1.28%.

Other studies like that by Chen et al. (2020) examining China's regions suggest that a country's level of financial development plays a crucial role. The positive impact of FDI on fiscal sustainability might only be evident after reaching a certain threshold of financial maturity. Additionally, Asamoah et al. (2016) emphasize the importance of sound macroeconomic policies, including fiscal sustainability itself, to attract beneficial FDI. A stable economic environment is crucial for attracting the right kind of foreign investment.

2.4 Control variables

A control variable is a variable that remains constant during a research investigation. The variables in question, that is population, inflation, human capital and economic growth are not the primary focus of this investigation, but they are being controlled since they have the potential of affecting the results.

2.4.1 Population and Fiscal sustainability

Clarke et al (2022) explored the sustainability of Jamaica's public debt over a highly volatile period of time using a suite of econometric tools, including, unit root testing, cointegration testing and estimating a fiscal reaction function. The authors found that whilst rescheduling might be indicative of cash-flow problems in Jamaica, fiscal policy has responded effectively to increase the public debt, thereby making the debt sustainable. However they noted that political economy and social demands of the population might make this approach to fiscal policy and debt management infeasible. As a result, the authors recommend that the government will need to take an active approach in managing its debt position to facilitate responses to societal demands, shocks and provide conditions within which maintaining fiscal discipline is feasible.

Brandle et al. (2022) employed a cohort simulation methodology to examine the impact of demographic changes on the sustainability of Switzerland's state finances. To assess the long-term fiscal implications of population ageing, they forecasted the age-related public expenditure on ageing, disability, education, health, and long-term care. The Federal Statistical Office's (FSO) standard population forecast for 2020-2050 serves as the basis for these projections (FSO, 2020). Excluding the COVID-19 crisis and interest expenses, non-demographic public expenditures and public revenues are often expected to rise in proportion to GDP. It was determined that state budgets will experience considerable pressure due to the aging population during the next thirty years. The effects of aging will be most evident until 2035 as baby boomers enter retirement.

Kalbarczyk and Mackiewicz-Łyziak (2019) examined the anticipated effects of heightened physical activity among the elderly on the long-term fiscal sustainability in

Poland. Utilizing the European Commission's S2 indicator to evaluate the ageing-related costs aspect of fiscal sustainability, they estimate the anticipated ageing-related expenses in Poland under two distinct levels of physical activity: vigorous activity and inactivity. Their findings indicated that the budgetary sustainability index might decrease by 0.7 relative to the baseline scenario, assuming robust physical activity among the elderly. Of the reduction, 0.5 is attributable to the LTC component and 0.2 to the HC component. Given the absence of physical activity, the computed S2 indicator is somewhat elevated compared to the baseline scenario. The present level of physical activity among elderly Poles is comparatively low. Their findings indicate that, for Poland, the enhancement of the long-term fiscal condition due to elevated physical activity levels could be substantial.

Liu and Yang (2018) investigated the impact pathway and mechanism of population aging on budgetary sustainability in China, employing generational accounting methods for numerical simulation of the extent of this influence. The aging population diminishes the tax base and increases fiscal expenditures by decreasing labor quantity and productivity, altering residents' consumption levels and structures, lowering the savings rate, and expanding the disparity between social security revenues and expenditures, thereby jeopardizing the fiscal system's equilibrium. The empirical findings indicate that the issue of intergenerational disparity regarding fiscal burdens is significantly pronounced, and the per capita tax burden varies markedly under different birth rate assumptions. Due to the pressures of an aging population, the future per capita tax burden may grow by up to 55.9% to sustain fiscal balance. While enhancing productivity and lowering interest rates may contribute to narrowing that gap, their significance is somewhat overshadowed by the impact of fertility. To address aging, the fiscal system must enhance revenue, decrease expenditures, and restructure

allocations. Simultaneously, the tax system should be refined and the tax base expanded, while also optimizing the expenditure structure.

Liu and Zhao (2023) developed fiscal sustainability indicators utilizing data from four municipalities directly governed by the central government, eight provincial capitals, and eighty-eight prefecture-level cities in China from 2010 to 2019. They examined the influence of population aging on fiscal sustainability across eastern, central, western, and multi-level cities in China, employing methodologies such as two-way fixed-effects models. The study revealed that fiscal sustainability is considerably undermined by population aging; specifically, an increase in aging correlates with a decrease in fiscal sustainability. The impact of population aging on budgetary sustainability is more pronounced in industrialized regions than in underdeveloped regions. Provincial cities, encompassing municipalities and provincial capitals, experience a far greater adverse effect from population aging on fiscal sustainability than prefecture-level cities. Population aging undermines fiscal sustainability through healthcare costs and social security employment expenses. The report advocated for policies to enhance the reproduction rate, safeguard fiscal spending in developed regions and provincial capitals to address population aging, and improve the efficacy of fund utilization for medical, health, and social security employment expenses.

Cho and Kim (2021) stated in their analysis that unfavorable demographics in Korea affect its growth potential and budgetary outlook. This paper analyzes the present demographic conditions and recent forecasts concerning the effects of population aging in Korea, especially with the impending fiscal imbalance. The primary finding is that a bidirectional effect arises from population aging. The primary concern is the expected strain on government resources resulting from rising welfare expenditures for the

elderly. The second issue is poor economic growth, resulting in inadequate government revenue collection. The likelihood of substantial and escalating deficits is thus immediate and perhaps enduring, as governments will encounter increasing expenditure demands and stagnant tax receipts concurrently due to an aging population.

Andersen (2012) in his study, he examined fiscal sustainability in OECD countries in the context of demographic shifts. He applied sustainability metrics to assess the impact of increasing dependency ratios driven by fertility changes and longevity. The research explored the trade-off between fiscal consolidation and increasing retirement ages, arguing that longevity should be addressed through policy adjustments rather than pre-saving. The study found that demographic changes, particularly increasing longevity, pose significant fiscal sustainability challenges. It argues that while pre-funding may be appropriate for fertility-driven dependency ratio changes, longevity-related shifts should be managed by linking statutory retirement ages to life expectancy. The research highlights the importance of distinguishing between different demographic drivers when formulating fiscal policy strategies.

2.4.2 Inflation and Fiscal sustainability

The rapid increase in government spending and public debt in both developed and emerging nations has raised apprehensions regarding the medium-term viability of fiscal policies. Should these trends continue, nations may encounter a juncture in the forthcoming decades where fiscal supremacy is contested, limiting the central bank's capacity to address inflation via elevated interest rates due to the potential threat to fiscal sustainability. Experts have often indicated that, under these circumstances, the central bank may be compelled to relinquish inflation targeting and assume a more passive role. Avakyan and Kuznetsova (2024) proposed an alternative scenario by

suggesting that the central bank's mandate be modified to align with the changing economic situation, particularly by integrating the level of real public debt. This modification to the central bank's mandate indicates that the ideal monetary policy rule will be contingent upon the fiscal policy framework. The analysis performed with a New Keynesian DSGE model, illustrates, that the proposed alteration in the mandate would enhance the resilience of central bank policy against shifts in the fiscal policy regime and promote equilibrium among stabilized inflation, output, and public debt levels. Moreover, incorporating debt into the central bank's mandate would allow the institution to maintain its proactive stance in combating inflation in reaction to an assertive fiscal policy. The paper suggests that a fiscal dominance regime does not inherently compel the central bank to forfeit its autonomy in determining monetary policy or to relinquish the fundamental tenets of inflation targeting.

Afonso, Alves, and Tkačevs (2023) investigated the correlation between inflation and fiscal sustainability utilizing a two-step methodology. Initially, they calculate a country-specific, time-varying metric of fiscal sustainability utilizing the fiscal reaction function. This function measures the response of the primary balance to variations in the public debt ratio. In the subsequent phase, they analyze the impact of different inflation metrics, including headline inflation, core inflation, energy inflation, and food inflation, on the previously determined estimate of fiscal sustainability. Their findings suggest that elevated inflation rates favorably influence the assessment of fiscal sustainability.

Carvalho (2024) investigates the correlation between expectations of fiscal sustainability and inflation in Brazil, employing Vector Autoregressions (VAR) to analyze inflation dynamics and generate impulse responses utilizing empirical data

from 2001 to 2019. The researcher incorporates sovereign Credit Default Swaps (CDS) as an indicator of anticipated future fiscal sustainability and identifies a correlation between CDS premia and unexpected inflation, thereby endorsing a fiscal theory interpretation of inflation.

2.4.3 Human Capital and Fiscal Sustainability

The escalating healthcare cost poses a significant threat to the sustainability of state budgets. Colombier, C. (2018) formulated a novel series of healthcare expenditure forecasts for the notably intriguing instance of Switzerland. Projections till 2045 indicate that population aging increasingly strains public resources and compulsory healthcare insurance. Healthcare expense is influenced not just by demographic changes but also by non-demographic factors, including rising national income, medical advancements, and Baumol's cost disease. Long-term care is more adversely impacted than healthcare excluding long-term care. This research indicates that population aging impacts public finances more significantly than mandated healthcare insurance.

Christopoulos (2019) posits that health care expenses are anticipated to further strain budgetary sustainability in the forthcoming years. He analyzed the correlation and spillover effects between Health Care Expenditures and health, as defined by Potential Years of Life Lost, together with their marginal influence on state finances. He employed spatial health econometrics models and a fixed-effects model utilizing data from 29 OECD nations spanning the years 1990 to 2017. To calculate the marginal impact, he included the coefficient from our spatial model into a fiscal analytical framework comprising averaged tax revenues and government expenditures. He identified a favorable correlation between healthcare expenditures and health, along

with substantial spillover effects, resulting in a fiscal return of $2,551.45 for each dollar spent per capita.

Licchetta & Stelmach's (2016) study reviewed demographic and non-demographic determinants of health spending in the UK from 1978 to 2016 and their implications for long-term fiscal sustainability. It analyzes historical trends in public health expenditures and assesses the impact of income effects, technological advancements, and cost pressures on fiscal sustainability. The research found that demographic factors have played a relatively small role in increasing health spending over past decades, though they are expected to grow in importance. Income effects significantly drive real health spending, but not necessarily spending as a share of GDP. The study highlights that other cost pressures, such as rising healthcare costs and technological advancements, have been the dominant contributors to increased health expenditures. It emphasized the importance of recognizing and quantifying non-demographic cost pressures in long-term fiscal projections.

Imrohoroğlu and Tomoaki (2019) devised an accounting model featuring overlapping generations of persons and meticulously integrate social insurance policies. Recent estimates of Japanese microdata and government demographic projections were utilized to refine the wages and labor supply profiles of different agents. The model forecasts future trajectories of fiscal and macroeconomic indicators to evaluate Japan's fiscal sustainability, concentrating on long-term projections from 2015 to 2100. The study reveals that Japan confronts significant fiscal burden stemming from population aging and escalating costs associated with pensions, healthcare, and long-term care. In the absence of policy modifications, the debt-to-GDP ratio will persist in its upward trajectory. The research indicates that a multifaceted approach—comprising the

extension of the retirement age to 67, a 10% reduction in pensions, an increase in healthcare copays to 20%, boost of female employment and wages, and an increase of the consumption tax rate to 15%—could attain fiscal sustainability. With these modifications, Japan's debt-to-GDP ratio in 2050 would be lowered compared to 2020.

2.4.4 Economic growth and Fiscal sustainability

Marín-Rodríguez et al. (2023) analyzed 324 studies from the Scopus and Web of Science databases using tools like VOSviewer and Bibliometrix to find patterns, methods, and important works in fiscal sustainability research. The research finding identified three key trends in fiscal sustainability: its relationship with economic growth, methodologies for assessing fiscal sustainability, and demographic concerns affecting fiscal sustainability. The research showed how useful advanced methods like panel data analysis, multicointegration, probabilistic debt analysis, Markov-switching models, and wavelet analysis are for assessing fiscal sustainability.

Checherita-Westphal et al.'s study (2014) developed a theoretical model to derive growth-maximizing public debt ratios. It estimates optimal debt targets based on the productivity of public capital and applies empirical analysis to OECD, EU, and Euro Area countries. The research incorporated forward-looking budget reaction functions within a debt-targeting framework. The findings of the study suggested that the Euro Area should target debt levels of around 50% of GDP to maximize economic growth. This was approximately 15 percentage points lower than the estimated growth-maximizing debt ratio for OECD countries. The findings indicate that governments should contract debt only to finance public investment, following the golden rule of financing.

Magazzino & Mutascu (2022) employed wavelet analysis to examine the relationship between government expenditures and revenues in Italy from 1862 to 2013. They utilized frequency-domain techniques to assess fiscal sustainability and explore the impact of economic crises on government financial stability. The research highlights that fiscal sustainability in Italy has been a persistent challenge due to high public debt, low productivity, and economic disparities between northern and southern regions. The study found that fiscal sustainability depends on the interaction between government revenues and expenditures, with economic growth playing a crucial role in stabilizing public finances. The analysis suggests that Italy's fiscal sustainability has been affected by major economic crises, including the 2008 financial crisis and the European sovereign debt crisis.

Abdullah et al. (2012) employed Vector Autoregression (VAR) analysis and Multivariate Cointegration Test methodology to assess fiscal sustainability in Malaysia. They examined the co-integrating relationship between fiscal sustainability indicators and Gross Domestic Product (GDP) to determine long-term fiscal stability. The researchers found that fiscal sustainability indicators and GDP are co-integrated, suggesting that Malaysia’s fiscal sustainability is stable in the long run, and recommend improving the presentation of fiscal policy sustainability, reviewing sustainability indicators, and strengthening long-term estimates in short-term fiscal policy design.

Rajakaruna & Suardi 2022 employed a fiscal reaction function (FRF) model, based on the Bohn (1998) framework, to examine fiscal sustainability in Sri Lanka, India, and Pakistan from 1960–2019. Researchers conduct various tests, including a Markov-switching model and a time-varying parameter model, to analyze fiscal policy regimes. They also apply a threshold regression model to assess the impact of fiscal debt on

economic growth. The results indicate that fiscal sustainability exists in all three countries, with governments responding positively to rising debt levels. However, when accounting for nonlinearity, fiscal policies oscillate between sustainable and unsustainable periods. Additionally, the study identifies critical debt thresholds beyond which economic growth declines: 78% of GDP for Sri Lanka, 67% for India, and 58% for Pakistan. The authors recommend maintaining fiscal debt below these levels to support economic expansion.

Fadhal & Kubaisi (2024) applied Multiple Regression Model (ARDL) to examine the relationship between fiscal sustainability indicators—such as budget deficit and public debt—and economic growth from 2004–2021. The research identifies an inverse relationship between the budget deficit and economic growth, with Iraq's budget deficit reaching 59% of GDP, far exceeding the 3% threshold set by the Maastricht Treaty. Additionally, the study finds that Iraq's public debt negatively impacts economic growth due to improper allocation—favoring consumptive spending over investment

Méndez-Marcano & Pineda (2014) used a Structural Vector Autoregression (SVAR) model with specific long-term rules to study how fiscal sustainability issues affected Bolivia. The authors used macroeconomic indicators such as GDP, inflation, and debt-to-GDP ratio to assess the impact of fiscal policy on economic growth. The research found that Bolivia experienced significant economic downturns due to adverse fiscal sustainability shocks, particularly in the late 1970s, early 1980s, and late 1990s. These shocks negatively affected GDP levels and contributed to inflationary pressures, including the hyperinflation of 1985. The study concludes that while fiscal sustainability shocks do not have a permanent effect on Bolivia's economic growth, their recurrence has hindered long-term economic stability.

Yousuo & Okrinya (2023) used the Autoregressive Distributed Lag (ARDL) model in their study because the unit root tests showed different levels of integration. They examined the impact of primary balance, domestic debt, external debt, and trade balance on Nigeria's economic growth from 1981–2021. The research establishes a long-run relationship between fiscal sustainability and economic growth. Domestic and external debts, as proxies for fiscal sustainability, along with trade balance as a control variable, have positive and significant effects on Nigeria's economic growth. The study also finds that economic growth adjusts to stability from short-run errors at a rate of 65.12% per trade cycle. However, the negative and insignificant effects of the fiscal primary balance suggest that government spending should be reduced to 45% of annual GDP to promote economic growth.

Odetayo & Adeyemi (2017) used descriptive analysis to examine trends in fiscal policy variables and econometric techniques to assess fiscal sustainability in Nigeria from 1980–2015. It utilizes Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests to check stationarity, Autoregressive Distributed Lag (ARDL) model to test long-run relationships, and Error Correction Model (ECM) to evaluate the impact of fiscal policy on economic growth. The results indicated that government revenue, expenditure, and fiscal deficit increased significantly over the study period. The ARDL model, subjected to a Wald test, reveals that fiscal policy in Nigeria was weakly sustainable. Additionally, fiscal policy variables exhibit a long-run relationship with economic growth, emphasizing the need for stricter compliance with policies that enhance revenue and reduce expenditure.

Kuncoro (2011) explored fiscal sustainability in Indonesia by analyzing the impact of public debt on economic growth from 1999 to 2009. He developed a fiscal model and

employs quarterly data analysis to assess the relationship between domestic and external debt with economic performance. The research finds that domestic debt does not contribute to economic growth, whereas external public debt negatively impacts growth because of high debt service costs and inefficient use of the debt. The study concludes that Indonesia should prioritize internal loans and only borrow externally for productive projects. Additionally, mobilizing alternative domestic financial resources could help secure cheaper debt and improve fiscal sustainability.

Sasmal & Sasmal (2020) examined fiscal sustainability in India over multiple economic cycles. The research employed time series analysis to assess the impact of public expenditure on economic growth and fiscal balance and used co-integration tests to analyze the relationship between gross fiscal deficit (GFD) and net national product (NNP), alongside evaluating the effects of revenue expenditure and interest payments on fiscal sustainability.

The study found that the share of revenue expenditure (RE) has significantly increased with many components being non-developmental in nature. The ratio of GFD to NNP is co-integrated, showing that fiscal balance deteriorates a NNP increases. Additionally, rising government expenditure has led to an increase in the ratio of revenue deficit to total spending, while interest payments on public debt have contributed to fiscal instability. The authors conclude that India's fiscal policy is non-viable in the short run, emphasizing the need for structural reforms to improve fiscal sustainability.

2.5 Research Gaps

While fiscal sustainability has been widely examined in the context of advanced economies and emerging markets, research focused specifically on Sub-Saharan Africa (SSA) remains relatively limited. Existing studies on SSA often emphasize traditional

determinants such as debt ratios, budget deficits, and revenue mobilization, while paying insufficient attention to broader structural and external factors that are increasingly important in today's fiscal environment.

One critical gap in the literature is the limited exploration of how climate change affects fiscal sustainability in SSA. Despite the region's high vulnerability to climate shocks—such as droughts, floods, and rising temperatures—these risks are rarely integrated into fiscal analyses. Climate-related events can significantly erode government revenues, particularly from agriculture and natural resources, increase public expenditure requirements (e.g., for disaster response and infrastructure repair), and hinder long-term economic growth. Yet these channels are often overlooked in conventional assessments of fiscal sustainability.

Additionally, while there is a substantial body of research examining the individual relationships between climate change, institutional quality, foreign exchange dynamics, foreign direct investment (FDI), and fiscal sustainability, few studies adopt a comprehensive framework that captures how these variables interact in an interconnected way—especially within the SSA context. Much of the existing literature focuses on developed or emerging economies outside the region. For example, Zhang et al. (2023) analyzed countries such as China, India, Bangladesh, Japan, South Korea, and Singapore; Zenios (2021) focused on Italy; and Ritzen et al. (2017) examined institutional factors in 19 Eurozone countries.

While these studies offer valuable insights, they do not reflect the unique economic, institutional, and environmental conditions of SSA. The region faces distinct challenges, including extreme climate events, political instability, and fragile financial institutions, all of which influence the design and effectiveness of fiscal policy and

adaptation strategies. This study aims to address this gap by providing an integrated analysis tailored to the SSA context.

Most prior research on fiscal sustainability has relied on fiscal reaction functions and cointegration techniques focused on macroeconomic variables. However, such studies often fail to holistically incorporate governance, environmental, and economic dimensions. To overcome this limitation, the present study adopts a more comprehensive methodological approach by integrating governance indicators, environmental variables, and macroeconomic factors. Specifically, the study employs both the Fixed Effects Model (FEM) and the Generalized Method of Moments (GMM). The FEM controls for unobservable heterogeneity across countries—a key issue in panel data analysis—while the GMM addresses endogeneity concerns stemming from potential reverse causality among variables. This methodological combination provides more robust estimates and has not been widely applied in prior studies on fiscal sustainability in SSA, making this research both novel and policy-relevant.

2.6 Conceptual Framework

According to Robert, Yu, and Lewis (2021) a conceptual framework is a diagrammatical representation of the relationship between the research concepts and their influence on the phenomenon under investigation. According to Huberman and Miles (1994), a conceptual framework presents the aspects that will be studied in a narrative or graphic format. The independent variables in this study are climate change, institutional quality, foreign exchange rate and foreign direct investment while the dependent variable is fiscal sustainability.

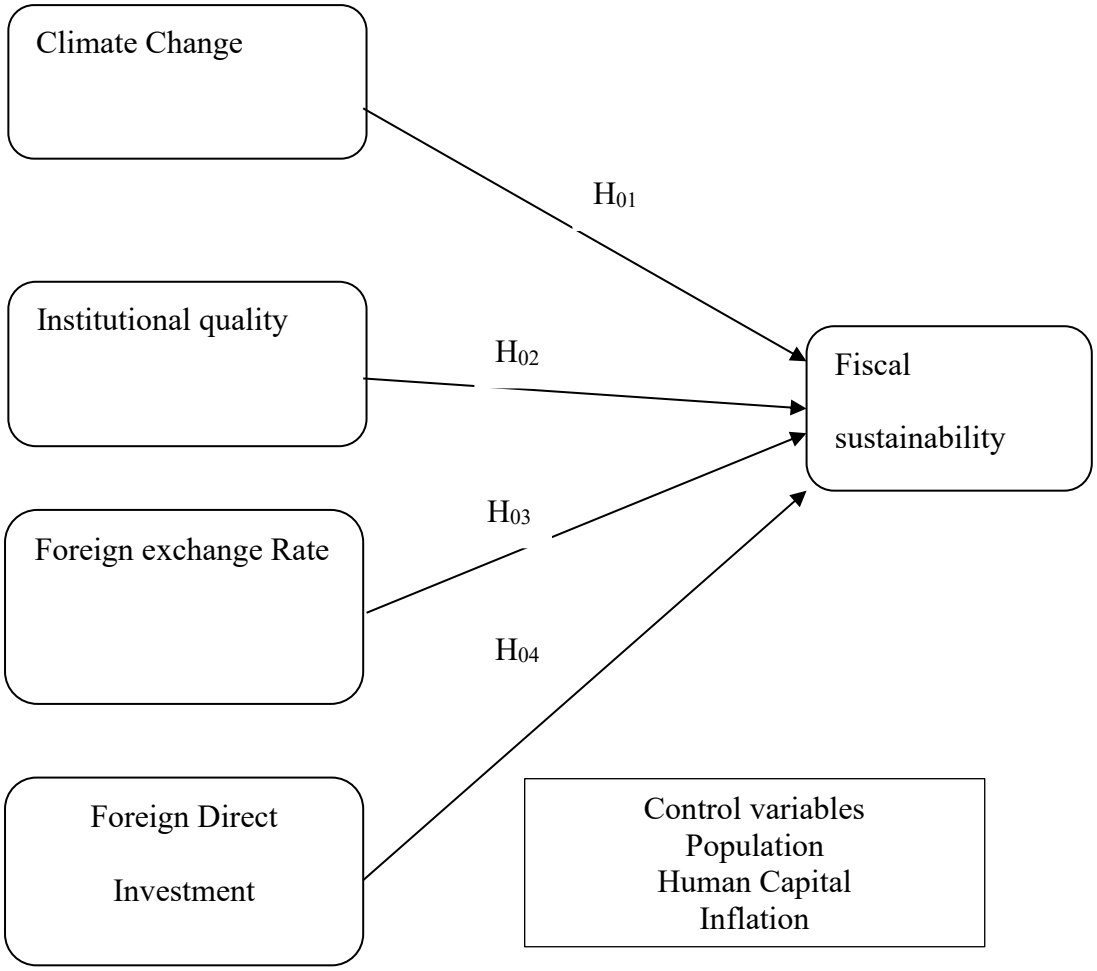

Figure 3 Conceptual Framework

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

This chapter presents the research paradigm and the research design that was adopted by the researcher. It's organized as follows; Research paradigm, Study setting, research design, data collection & measurement, panel models, data processing and ethical consideration.

3.2 Research Paradigm

A research paradigm according to Creswell (1998) can be defined as a 'basic set of beliefs or assumptions that guide research. A research paradigm as asserted by other researchers (Mertens, 2007) affects every stage of the research from deciding on the research problem to analyzing and interpreting the data. According to Ogula and Onsongo (2019), a research paradigm provides guidance and obliges the researcher to adhere to a particular methodology, data representation, and interpretation of results as a framework for contemplating the concept of truth. A researcher's ontological and epistemological perspectives are revealed by the paradigm that they choose to use in their research. As stated by Rubin and Rubin (2015), it functions as a lens through which one can view the world, it investigates the topic that is being investigated, and it offers directions on who should conduct research and the length of their investigations.

This study adopts a positivist research paradigm, which assumes that reality exists independently of human perception and can be measured objectively using statistical and econometric techniques. Furthermore, the positivism paradigm, often associated with quantitative and objective research, particularly when dealing with pre-established and meticulously organized data, is relevant to this research context (Scotland, 2012).

Scotland asserts that the production of precise and significant data depends on procedures that are both observable and quantifiable. The research utilizes quantitative secondary data about climate change indicators, institutional quality indices, exchange rates, foreign direct investment inflows, and fiscal sustainability measurements, rendering it appropriate for a positivist methodology (Bryman, 2016).

3.3 Research Design

Research design is a master plan that specifies the methods and the procedures for collecting and analyzing needed information to answer research questions (Zikmund, 2010). It provides a framework or action plan for research. It acts as a blueprint that helps to structure the collection, analysis and interpretation of data. There are a number of design approaches including exploratory, explanatory and descriptive (Zikmund et al., 2010).

This study used both explanatory and longitudinal research design, as the study sought to establish the effect of the relationship between climate change, institution quality, foreign exchange, FDI and fiscal sustainability in Sub- Saharan Africa. The research design was used to explore and understand the cause-effect relationship between the independent variables (climate change, institution quality, foreign exchange, FDI and fiscal sustainability) under the study. According to Saunders *et al.,* (2011), studies that establish causal relationships between variables use explanatory design. In terms of time horizons, this study is longitudinal in nature. Longitudinal research design utilized panel data covering the period from 2000 to 2023

The goal of longitudinal research was to improve the validity of one's inferences in ways that cross-sectional research cannot (Shadish, Cook, & Campbell, 2002). Longitudinal research has the potential to improve inferences concerning measurement,

causality, generalizability and the quality of effect size estimates and hypothesis tests. Another clear construct validity improvement gained from longitudinal research is when measuring change. Assessing rate of change is a more precise version of change measurement. Time is an important variable in determining the rate. To assess a rate, only two repeated measurements of the variable of interest are required, though these measurements should be taken from multiple units (e.g., individuals, groups, organizations) if measurement and sampling errors exist, and possibly under different conditions if systematic measurement error is possible (e.g., testing effect). Furthermore, Ployhart and Vandenberg (2010) advocate at least three repeated measures because most change rates are not constant, necessitating more than two observations to determine whether and how the rate changes (i.e., the shape of the growth curves). Indeed, three is insufficient given measurement noise and the commonality of complex processes. With certain precautions, longitudinal research designs can increase one's confidence in causal inferences. Time does not need to be measured or included as a variable in the analysis when this is the case, but the interval between measurements should be reported because rate of change and cause are related.

3.4 Study Setting

The study setting refers to the geographical, economic, and institutional context within which research is conducted (Creswell & Creswell, 2018). This study focused on Sub-Saharan Africa (SSA), a region consisting of 49 countries as classified by the World Bank for the period 2000 to 2023. SSA presents a unique context for analyzing the interplay between climate change, institutional quality, foreign exchange rates, foreign direct investment (FDI), and fiscal sustainability due to its economic structure, governance challenges, vulnerability to climate change, and external economic dependencies. Fiscal sustainability remains a major concern for SSA economies, given

the prevalence of budget deficits, rising public debt levels, and weak revenue generation mechanisms (World Bank, 2023).

3.5 Inclusion and Exclusion Criteria

The inclusion and exclusion criterion was based on two criteria's, first is whether the country has been operating over the study period of 2000 to 2023, secondly the country should have complete data. Upon applying the inclusion/exclusion criteria the final sample was 43 countries over a period of 22 years that yielded 989 number observations. The following countries were omitted due to incomplete data; Djibouti, Equatorial Guinea, Namibia, Seychelles, Somalia and South Sudan.

3.6 Data Collection

For the purpose of answering research questions or putting research hypotheses to the test, "the process of collecting evidence" is what Byers (1995) defines as "data collection." Similarly Arun et al. (2022) define it as the process of collecting, measuring, and analyzing accurate research data using standardized method. It serves as the foundation of empirical research by ensuring that relevant, accurate, and reliable data is obtained for meaningful analysis.

A data collecting schedule was utilized in order to obtain secondary data, which was employed in the study. According to Sekaran and Bougie (2019) and Vartanian (2010), researchers contend that secondary data is more reliable and objective than primary data.The study utilized secondary data which was obtained by document and content analysis of published materials, sourced from World Bank, IMF, and Transparency International.

3.7 Measurement of Variables

3.7.1 Dependent Variable

3.7.1.1 Fiscal Sustainability

Fiscal sustainability is the dependent variable. Essentially, fiscal sustainability refers to a government's ability to maintain a balanced budget and effectively handle its debt, so preventing future generations from being burdened with an overwhelming amount of debt. The unit of measurement is Debt to GDP ratio. A high ratio indicates potential fiscal problems (IMF 2023)

3.7.2 Independent Variables

3.7.2.1 Climate Change

Climate change refers to the gradual and persistent alterations in temperatures and weather patterns over an extended period of time. These fluctuations may occur naturally, but since the 1800s, human actions have been the primary catalyst for climate change, chiefly through the combustion of fossil fuels that emit greenhouse gases into the atmosphere. The unit of measurement is carbon emissions in kt (kiloton) (Boden, Marland & Andres, 2017). One of the main strengths of using carbon emissions as a measure of climate change is the direct and quantifiable relationship between emissions and global warming. Emissions data provide a clear target for climate policy, enabling governments and organizations to set specific goals for reducing CO_2 emissions, such as those outlined in the Paris Agreement (UNFCCC, 2015).

3.7.2.2 Institution Quality

The study utilized the Institutional Quality index, which was created by the world governance indicators. This index includes various factors such as political stability, control of corruption, regulatory quality, the rule of law, voice and accountability, and

government effectiveness (Easterly 2002, Al-Marhubi (2004), Méon and Weill (2005), Bjørnskov (2006), Kaufmann et al. (2009), and Langbein and Knack 2010).

3.7.2.3 Foreign Exchange rate

The foreign exchange rate (FX rate) denotes the value of one nation's currency in relation to another currency. It denotes the quantity of home currency necessary to acquire one unit of foreign currency (Krugman & Obstfeld, 2020). The foreign exchange rate was considered in terms of the local currency to USD exchange rate, which indicates how much of a country's domestic currency is needed to obtain one U.S. dollar (USD). This measure is commonly used in economic research and policy analysis because the USD serves as the global reserve currency and a standard benchmark for international transactions (IMF, 2023).

3.7.2.4 Foreign Direct Investment

Usually by ownership of assets, establishment of operations, or acquisition of a significant share, foreign direct investment (FDI) is the investment made by an entity (individuals, businesses, or governments) from one country into business interests in another country. FDI is a crucial component of the global economy, influencing economic growth, balance of payments, and trade patterns. FDI is the measure of investment inflows by the ratio of GDP (Pattayat, 2016).

3.7.3 Control variable

3.7.3.1 Population

The population of a given area is the number of people usually living in that country (Gu, Andreev & Dupre, 2021). Changes in the population age structure can impact both government revenue and spending (Bova et al, 2021, Sang et al 2016). Population is measured by the annual growth rate which is often used to assess how rapidly the

population is increasing and the subsequent pressure it places on public resources and fiscal policy.

3.7.3.2 Inflation

Inflation is the rate at which the general level of prices for goods and services is rising, eroding purchasing power. Persistent high inflation can undermine fiscal sustainability by increasing the cost of borrowing and reducing the real value of tax revenues (IMF 2023). Consumer Price Index is the most common indicator of inflation (Forbes et al 2022, Moench et al 2017).

3.7.3.3 Gross Domestic Product

It serves as a comprehensive indicator of the overall economic activity and plays a crucial role in determining fiscal sustainability (OECD, 2023). The metric used is annual growth

3.7.3.4 Human Capital

It is a critical factor in determining the productivity of labor and, consequently, economic growth and fiscal sustainability. Human capital has two major components; education and health. This study employed the health component by looking at health expenditure which fosters equality and social justice, as well as resulting in a more robust workforce, heightened productivity, and diminished expenses (Tandon and Cashin, 2010). Government expenditure has a beneficial role in the development of human capital. However, the sustainability of such expenditure becomes uncertain, especially in countries facing fiscal constraints (Kgakge-Tabengwa, 2014).

Table 3.1: Measurement of variable

Variable	Category	Symbol	Data source	Measurement
Fiscal sustainability	Dependent Variable	FS	World Bank	Debt to GDP ratio
Climate change	Independent variable	CC	/IMF/World Bank	CO_2 Emission metric tons to GDP ratio
Institutional Quality	Independent variable	IQ	World Bank/ Transparency International	Governance - composite Index
Foreign exchange rate	Independent Variable	FX	World Bank/ IMF	Local currency to USD Rate
Foreign Direct Investment	Independent variable	FDI	IMF	Net inflows to GDP ratio
Human Capital	Control variable	HC	World Bank	Health expenditure to GDP ratio
Population	Control Variable	PP	World Bank	Annual Growth
Inflation	Control Variable	INF	World Bank	CPI
Gross Domestic Product	Control Variable	GDP	World Bank	Annual growth

Source: Researcher 2024

3.8 Model Specification

The study utilized panel data from the years 2000 to 2023 and multiple regression model (Baron & Kenny, 1986) to analyze the direct impacts. The fiscal sustainability model follows the overall structure of the econometric model introduced by Bohn (1998). The information is presented in the following manner:

$$FS_{i,t} = F(CC_{i,t}, IQ_{i,t}, FX_{i,t}, FDI_{i.t})$$

Where $FS_{i,t}$ is used for fiscal sustainability at time t and for a specific country i.

$$FS_{it} = \beta_{it} + \beta_1 CC_{it} + \beta_2 IQ_{it} + \beta_3 FX_{it} + \beta_4 FDI_{it} + \mu_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 3.0$$

Model 1. Testing the effect of control variables on Fiscal sustainability.

$$FS_{it} = \beta_{it} + \beta_1 POP_{it} + \beta_2 INF_{it} + \beta_3 GDP_{it} + \beta_4 HC_{it} + \mu_{it}$$

Model 2. Testing the effect of independent variable on fiscal sustainability.

$$FS_{it} = \beta_{it} + \beta_1 POP_{it} + \beta_2 INF_{it} + \beta_3 GDP_{it} + \beta_4 HC_{it} + \beta_5 CC_{it} + \beta_6 IQ_{it} + \beta_7 FX_{it} + \beta_8 FDI_{it} + \mu_{it}$$

- Where FS_{it}Fiscal sustainability; β_0 is the coefficient for the intercept; $IQ_{it}$is Institution quality; CC_{it} is Climate change; $FX_{it}$is Foreign exchange; $FDI_{it}$is Foreign Direct Investment; PP is population; INF is inflation; GDP is Gross Domestic Product; HC is human capital and μ_{it} are random stochastic error terms (disturbance or the usual disturbance in the regression model) and $\beta_1 \ldots \beta 8$ are estimated parameters for the explanatory variables in the model. The subscript *i,t* a cross section data for the country at a predefined time (time series) for country t.

3.9 Panel Multiple Regression Analysis

Panel data analysis depends on building two OLS models: Fixed Effects Model and Random Effects Model. Using Hausman test the study chose Fixed Effects Model as most suitable for the data.

3.10 Regression Assumptions and Diagnostic Tests

Regression analysis is a fundamental statistical technique used to examine relationships between independent and dependent variables. However, to ensure the reliability and validity of regression results, certain assumptions must be met. Violations of these assumptions can lead to biased, inefficient, or inconsistent estimates (Baltagi 2008).

Diagnostic tests are performed to check for these violations and apply necessary corrections if needed. Some of these assumptions are homoscedasticity, multivariate normality, linearity, and multicollinearity. In the same way, diagnostic tests on panel data were done to see if the data were good enough to use before the chosen panel data estimate model was used. To be more specific, the study looked for autocorrelation, multicollinearity, heteroskedasticity, and unit root.

3.10.1 Unit Root

Stationarity is an essential need in panel data regression, as non-stationary variables may result in false regression outcomes and erroneous conclusions. A variable is deemed stationary if its statistical features, including mean and variance, stay invariant over time and the value of the covariance between the two time periods depends only on the distance or lags between the two time periods (Gujarati & Porter, 2010). The use of a unit root test for a pooled time series and panel data can significantly increase the power of the test (Levin, Lin, & Chu, 2002). It is necessary to test for unit root because regressing time or panel series variables that are not stationary leads to spurious regression. If the series are nonstationary, they are differenced until they become integrated. This study utilizes the Levin, Lin & Chu (LLC) Test and the Harris-Tsavalis Test to assess stationarity.

The Levin, Lin & Chu (LLC) Test (Levin, Lin, & Chu, 2002) is a widely utilized panel unit root test that presumes a uniform autoregressive parameter across all cross-sectional units. The null hypothesis (H_0) posits that all panels exhibit a unit root (i.e., the variable is non-stationary), whereas the alternative hypothesis (H_1) asserts that the variable is stationary throughout all cross-sections.

This study used the Harris-Tsavalis Test (Harris & Tsavalis, 1999), in conjunction with the LLC test, as it is particularly appropriate for fixed-effects models in panel data. In contrast to the LLC test, which presumes a uniform unit root process, the Harris-Tsavalis test allows for heterogeneity within units while still assessing stationarity. Greene (2012) recommends use of different panel unit root tests to check for consistency and robustness.

The hypothesis tested:

Null hypothesis (H_o): Panel data contains unit root [non-stationary].

Alternative hypothesis (H_a): Panel data is stationary.

If the p-values are below the conventional significance levels of 0.05 then it implied that all variables are stationary

3.10.2 Multicollinearity

Multicollinearity arises when two or more independent variables in the regression model are highly correlated, making it difficult to isolate their individual effects. Severe multicollinearity inflates standard errors, reduces the statistical significance of individual predictors, and leads to unreliable coefficient estimates. According to Murray (2006), multicollinearity makes it hard to differentiate the individual effects of the explanatory variables and regression estimators may be biased in that they tend to have huge variances. Additionally, if there is a perfect linear relationship among the explanatory variables, the approximations for a regression model can-not be exceptionally calculated. The possible existence of multicollinearity is established based on the correlation matrix including all the independent and control variables

To detect multicollinearity, this study employed the Variance Inflation Factor (VIF). The VIF measures how much the variance of a regression coefficient is inflated due to multicollinearity. A VIF value greater than 10 is generally considered indicative of high multicollinearity (Gujarati & Porter, 2009).

$$VIF = \frac{1}{1 - R^2}$$

Where:

R^2: R squared

The multicollinearity test was performed as below:

Ho: data contains no multicollinearity

Ha: data contains multicollinearity

3.10.3 Heteroscedasticity

In many cross-sectional datasets, the variance for each of the panels differs. It is common to have data on countries, states, or other units that have variation of scale. Heteroscedasticity occurs when the variance of the error terms is not constant across all observations, leading to inefficient estimates and incorrect hypothesis testing results. In the presence of heteroscedasticity, standard errors become biased, which can distort statistical inferences.

To test for heteroscedasticity, this study applied the Breusch-Pagan / Cook-Weisberg Test (Breusch & Pagan, 1979; Cook & Weisberg, 1983). The null hypothesis (H_0) assumed that the variance of the residuals is constant (homoscedasticity), while the

alternative hypothesis (H_1) suggests that heteroscedasticity is present. If the p-value of the test is less than 0.05, the null hypothesis is rejected, indicating the presence of heteroscedasticity.

The null hypothesis stated that the variance of the disturbance terms is homoscedastic meaning that the variance of the error terms was constant. The hypothesis tested was:

H0: Error variance is homogeneous

H1: Error variance is not homogeneous

3.10.4 Autocorrelation

Autocorrelation occurs when the residuals of the regression model are correlated across time. Brooks (2010) identified that a key assumption of the Linear Regression Model is that the covariance between the error terms over time is zero, indicating that the error terms are uncorrelated with one another. When the error terms exhibit correlation, it results in the issue of autocorrelation or serial correlation, which in turn causes the standard error to become biased. In panel data, this issue is particularly problematic because it violates the assumption of independence of errors, leading to biased and inefficient estimates Gujarati (2012).

To detect autocorrelation, the Wooldridge Test for Autocorrelation (Wooldridge, 2002) is employed. This test is widely used in panel data settings due to its robustness and simplicity. The null hypothesis (H_0) states that there is no first-order autocorrelation, while the alternative hypothesis (H_1) suggests the presence of serial correlation in the residuals. If the p-value exceeds 0.05, the null hypothesis is not rejected, indicating that serial correlation is missing.

3.10.5 Model Specification Error Test

Model specification is an important part of econometric analysis that makes sure a regression model is put together properly. A well-specified model shows the correct link between independent and dependent variables without leaving out important variables, adding variables that aren't needed, or getting the functional form wrong (Gujarati & Porter, 2020). A misspecified model can lead to biased estimates and incorrect inferences (Ramsey 1969).

To test for specification errors, this study employs the Ramsey RESET Test (Ramsey, 1969). This test helps identify whether the regression model has omitted variables or if the functional form is incorrectly specified. If a model is misspecified, the estimated coefficients may be biased and inefficient, leading to misleading conclusions in empirical research (Wooldridge, 2010) The test also evaluates whether additional nonlinear combinations of the independent variables should be included in the model. The null hypothesis (H_0) assumes that the model is correctly specified, while the alternative hypothesis (H_1) suggests that the model is misspecified. Therefore, we fail to reject the null hypothesis if the p-value of the test is greater than 0.05.

The hypotheses for the test are:

Null Hypothesis (H_0): The model has no omitted variables or specification errors.

Alternative Hypothesis (H_1): The model has omitted variables or incorrect functional form.

3.10.6 Random and Fixed Effects

In the random effects model, the individual-specific effect is a random variable that is uncorrelated with the explanatory variables.

RE1: Unrelated effects

$SE(c_i|X_i, z_i) = 0$

RE1 assumes that the individual-specific effect is a random variable that is uncorrelated with the explanatory variables of all past, current and future time periods of the same individual.

RE2: Effect Variance

$V(c_i|X_i, z_i) = \delta_c^2 < \infty$ (homoscedastic)

$V(c_i|X_i, z_i) = \delta_{c,i}^2(X_i, z_i) < \infty$ (heteroscedastic)

RE2a assumes constant variance of the individual specific effect.

In the fixed effects model, the individual-specific effect is a random variable allowed to be correlated with the explanatory variables.

FE1: Related effects

FE1 explicitly states the absence of the unrelatedness assumption in *RE1.*

FE2: Effect Variance

FE2 explicitly states the absence of the assumption in *RE2.*

FE3: Identifiability

$rank\,(\ddot{X}) = K < NT$ and $E(\ddot{x}_i'\ddot{x}_i)$ is probabilistic density and finite where the typical element $\ddot{x}_{it} = x_{it} - \bar{x}_i$ and $\bar{x}_i = 1/T\sum_t x_{it}$

FE3 assumes that the time-varying explanatory variables are not perfectly collinear, that they have non-zero within–variance (i.e. variation over time for a given individual) and not too many extreme values. Hence, x_{it} cannot include a constant or any time-invariant variables.

3.10.7 Hausman Test

In order to decide between fixed or random effects, Hausman test is needed (Green, 2008). It test whether the unique errors (μ_i) are correlated with the regressor. Hausman test null hypothesis is that the random effect is appropriate versus the alternative that fixed effect is appropriate. If the probability of the Hausman test is more than 5 percent significance level, random effect is used otherwise fixed effect is used.

The hypothesis tested was:

Ho: Random effect model is appropriate

H1: Fixed effect model is appropriate

Decision criteria: Reject H_o if the p-values obtained are less than the level of significance 0.05.

3.11 Data Analysis

Sharma (2008) describes data analysis as the method of deriving responses to queries through examination and interpretation of data. Data interpretation was executed via both descriptive and inferential statistics with the help of STATA software. The hypothesis was evaluated by interpreting the beta coefficients and p-values of the multivariate regression estimation equations

The findings of the study were presented in tabular forms where interpretation and discussion of results were made based on specific research objectives. Conclusions and recommendations were derived appropriately from regression results.

3.12 Ethical Considerations

It is pertinent to consider the ethical implications of the research process; however, there were no major ethical issues with this study simply because it used publicly available information and data suggesting that neither respondent nor questionnaire was used. However, since the study relied on secondary data, ethical concerns primarily involve proper attribution and responsible data use. All datasets are sourced from credible institutions (World Bank), ensuring accuracy and reliability.

Ethical guidelines for data use, including adherence to citation requirements, are strictly followed. Furthermore, the study followed all the required procedures in carrying out such a study. This include, prior to data collection, the researcher sought approval from Moi University to proceed to the field and collect research data. Additionally, consent was requested through research permission from the national Commission for Science, Technology, and Innovation (NACOSTI).

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Overview

This chapter presents the findings of the research study. Specifically, the chapter discusses the results of the diagnostic tests, the descriptive statistics, the correlation analysis and the regression results used for hypotheses testing.

4.2 Descriptive Statistics

Table 4.1: Descriptive statistics for all the variables

Variable	Obs	Mean	Std. Dev.	Min	Max
FS	989	3.122617	5.056503	.004773	59.6714
CC	989	47061.11	154676.7	53.5	833713.8
IQ	989	-.7820688	.6682469	-2.224527	1.044383
FX	989	1.38e+07	2.24e+08	.0444684	6.72e+09
FDI	989	-76086.46	1704399	-4.23e+07	103.3374
GDP	989	6.06e+10	2.24e+11	7.60e+07	2.06e+12
HE	989	5.262397	2.318729	1.465947	22.19721
PP	989	2.08e+07	3.05e+07	143714	2.19e+08
INF	989	10.26286	33.60457	-16.85969	557.2018

Source: Researcher 2024

Table 4.1 shows the descriptive statistics for all the variables used in the study. The table indicates that the mean FS was 3.122617 (minimum= 0.004773 and maximum = 59.6714; standard deviation 5.056503). This indicates a low level of fiscal health across countries in SSA. The extensive range, spanning from a low of 0.004773 to a maximum of 59.6714, indicates notable discrepancies in fiscal sustainability while the relatively high standard deviation of 5.056503 points indicates a significant amount of variability in fiscal sustainability. This variability can be attributed to changes in debt levels, revenue generation, and expenditure management, which result in various fiscal

circumstances Baldacci and Kumar (2010). The mean value of fiscal sustainability is 3.12, with a standard deviation of 5.06, implying that the observations vary substantially around the mean. There is a wide range in fiscal sustainability scores among the SSA countries, indicating varying levels of fiscal health and stability. Fiscal sustainability is important for long-term economic stability because high fiscal deficits can prevent a country from meeting its debt obligations and cause a financial crisis (Nandelenga, 2021). For instance, before the 2008 financial crisis, Botswana experienced impressive economic performance and maintained fiscal surpluses (Chea, 2011). In recent years, Botswana has faced fiscal deficits due to various economic challenges. The 2023/24 fiscal deficit widened to 2.5% of GDP, driven by lower-than-expected mineral earnings, higher-than-planned recurrent spending and drought conditions (IMF2023). As one of the most advanced economies in Sub-Saharan Africa, South Africa may exhibit improved fiscal sustainability metrics; nonetheless, it confronts escalating debt levels and budgetary deficits. The budget deficit increased to 4.9% of GDP in the 2023/24 fiscal year, driven by declining revenues and persistent low economic growth. The fiscal sustainability of Angola is significantly affected by oil revenues, leading to considerable fluctuations in its fiscal health due to oil price volatility. On the other hand, Mauritius has demonstrated strong fiscal sustainability. Its public finances have improved and the budget deficit reduced to 6.1% of GDP in 2022 from 10.4% in 2021 (ADB 2023). In contrast, Zimbabwe has faced fiscal instability characterized by high inflation, currency volatility, and external debt burdens. Additionally, a less developed nation such as Burundi is at high risk of external and overall debt distress due to inadequate public sector management, leading to a diminished fiscal sustainability score (World Bank 2022).

Further, climate change had a mean of 47061.11 (minimum= 53.5 and maximum = 833713.8; standard deviation = 154676.7). An average of 47,061 and a high standard deviation of 154,676 indicate wide variability in the measurement of climate change. Some regions are more heavily impacted by climate change, with a minimum value of 53.5 and a maximum value of 833,713 suggesting that these have severe economic and social consequences. Sub Saharan Africa is highly vulnerable to climate change impacts, particularly in countries like Somalia**,** Ethiopia**,** and Malawi, where droughts, floods, and desertification are increasing. These effects disrupt agricultural productivity, which is central to fiscal revenue in many SSA countries (Adekola & Njoku, 2021). Extreme weather events can also lead to higher government spending on disaster relief, putting pressure on fiscal sustainability. These results align well with a recent study by Diffenbaugh and Burke (2019). They found that the economic impacts of climate change are highly variable across different regions, particularly in SSA, where climate-related risks such as droughts and floods have disproportionately large effects.

Institutional quality had a mean of -0.7657887 (minimum= -2.224527and maximum = 1.044383; standard deviation = 0.6615381). The negative mean value for institutional quality (-0.7657887) suggests that, on average, the institutions in the panel are below a neutral or positive benchmark (possibly indicating challenges in institutional environments, governance, rule of law, or corruption control). The range from -2.224527 to 1.044383 shows that while some countries perform significantly better, many are struggling with poor institutional quality that hampers development Acemoglu and Robinson (2019). Countries like Mauritius and Botswana score higher on institutional quality, benefiting from effective governance. Conversely, nations such as Kenya and DRC face governance challenges that undermine fiscal discipline and

economic growth. In a nutshell, lack of institutional capital in the region is a major impediment to sustainable growth in the long run.

The average foreign exchange rate can be estimated at 13.8 million (in local currency per USD) with the highly significant standard deviation of 224 million which signifies that the exchange rate values vary a lot across the region. The minimum of 0.0445 indicates that some countries have stable or even stronger currencies while the maximum of 6.72 billion may be due to the Zimbabwean experience of hyperinflation and currency devaluation. Such a wide fluctuation shows the differences in the stability of currency in different countries due to severe devaluations and exchange rate risks especially during economic turmoil. The results echoes the findings of Ghosh and Ostry (2017) that substantial fluctuations in exchange rates, potentially impacts trade balances, inflation, and fiscal sustainability For instance countries like South Africa have relatively stable exchange rates, fostering investment and fiscal predictability. In contrast, nations such as Sudan experience extreme volatility, which destabilizes trade and increases external debt burdens (IMF, 2023).

The mean of foreign direct investment (FDI) is a negative -76,086.46 with a very high standard deviation of 1,704,399. Foreign Direct Investment inflows ranges from -4.23e+07 to 103.34 indicating a great deal of variation with some countries experiencing large capital flight and others receiving large investments. For instance countries receiving large investments includes; Nigeria (US$5.3 billion), South Africa (US$4.4 billion), Angola (US$2.2 billion), Liberia (US$2 billion) and Ghana (US$0.61 billion) (World Bank, 2022), while others experience large disinvestment such as Central Africa Republic, Eritrea, Burundi and Comoros. The irony is that Ghana receives large inflows but currently is among countries in distress. The above variability

may be attributed to capital outflows or extremely low inflows experienced by certain countries, which could be indicative of factors such as political instability, unfavorable investment conditions, or external economic disruptions (Bevan & Estrin 2022, Okara, 2023).

The mean economic growth was 6.06e+10 (or 60.6 billion) and a very high standard deviation of 2.24e+11 (or 224 billion), again revealing the variation in economic sizes in the sample, with countries such as Niger, Senegal, Libya, Rwanda, Cote d'Ivoire, Ethiopia, Benin, Djibouti, Tanzania, Togo and Uganda registering higher economic growth while countries such as Equatorial Guinea, Sudan, São Tomé and Príncipe registering lower economic growth. That the range is from 7.60e+07 (or 76 million) to 2.06e+12 (or 2.06 trillion) shows that some economies are large and developed more than others, which corresponds with global economic inequality (Piketty, 2014). The disparity in economic growth has significant implications for fiscal sustainability. Economic downturns can exacerbate fiscal challenges by reducing tax revenues and increasing debt levels (Baharumshah .et al 2017). These results are consistent with recent findings by Page & Shimeles (2015), who note that many SSA countries have experienced robust growth over the last two decades, driven by improvements in macroeconomic policies and increased investment. However, they also caution that this growth is uneven across the region. Economic stability might boost government revenues and reduce fiscal deficits, improving fiscal sustainability.

Human capital, defined by the education, health, and skills of the workforce, is a key determinant of economic growth and fiscal sustainability. The mean of health expenditure is 5.262397, with a small standard deviation of 2.318729, which suggests that countries are clustered around the mean. That is, some countries have much more

developed health expenditure, a critical factor in driving economic growth and innovation (Li, Chang, Wang & Zhou, 2022), and the minimum value of 1.465947 and maximum value of 22.19721 reflect this. A study by Anyanwu and Erhijakpor (2009) found substantial variability in health expenditure across SSA. Countries like Botswana and Mauritius have relatively high human capital, which contributes to better economic performance and greater fiscal resilience. Conversely, countries with lower levels of human capital, such as Burundi or Chad, face greater challenges in achieving sustained fiscal policies. These countries often require larger investments in education and healthcare, which can strain government budgets (World Bank, 2017).

Besides, the average population was at 2.8 million (minimum= 143714 and maximum = 2.19 million; standard deviation 3.05). The large standard deviation indicates that the sample covers both least populated countries such as Seychelles, Comoros, Sao Tome and Principe and highly populated countries such as Nigeria (15.4%) · Ethiopia (8.7%) · Egypt (7.7%) · DR Congo (7.1%) · Tanzania (4.5%) · South Africa (4.3%) · Kenya (3.7%), as is typical in global datasets (Zhang & Tan, 2016). The high variation in population within the panel reflects findings from studies such as those conducted by Bloom and Canning (2011), which revealed that population growth rates in Sub-Saharan Africa (SSA) are generally high but rather uniform across most nations. This consistent pattern of population increase contributes to persistent economic and social difficulties in the region (Dimnwobi, et al., 2021). Large populations require more government expenditure on infrastructure, health, and education, which can challenge fiscal sustainability (Alesina & Perotti, 1996). However, countries with smaller populations, such as Lesotho and Sao Tome, may have lower growth rates but also face challenges in sustaining fiscal resources for a smaller workforce.

Finally, the mean inflation was 10.26 (minimum= -16.86 and maximum = 557.20; standard deviation 33.60). The mean inflation rate of 10.26 indicates a generally high level of inflation across the sample, which could be concerning for fiscal stability and economic growth. The high standard deviation of 33.60 reveals that inflation rates are highly volatile and diverse across the entities. The extreme variability in inflation observed here is consistent with findings by Ha, Kose, and Ohnsorge (2019), who report that inflation in SSA is highly volatile, driven by external shocks, currency fluctuations, and commodity price changes. A hyperinflationary episode, such as those observed in Zimbabwe (557.2%), undermines fiscal sustainability by eroding the real value of government revenues, increasing borrowing costs, and discouraging investment. When inflation is high, purchasing power erodes and this can cause economic turmoil, especially in developing countries (Ali, Khokhar & Sulehri, 2023). Conversely, low or negative inflation, as observed in economies such as Comoros, may result in stagnation and diminished tax revenues, hence exacerbating fiscal pressures (Fosu, 2019).

4.3 Diagnostic Tests

Before conducting the regression analysis, several diagnostic tests were performed to ensure the validity and reliability of the model. First, a unit root test was conducted to determine the stationarity of the data, preventing spurious regression results. Multicollinearity was examined to identify highly correlated independent variables that could distort coefficient estimates. The heteroscedasticity test checked for unequal variance in residuals, which could affect standard errors and inference. Autocorrelation was tested to detect serial correlation in residuals, ensuring model efficiency. Lastly, a specification error test was conducted to verify if the model was correctly specified and free from omitted variable bias. These diagnostic tests enhanced the robustness and accuracy of the regression model.

4.3.1 Unit Root Test

Non-stationary data refers to a data series that does not have a constant mean, variance, and auto-covariance at various lags over time. Testing for stationarity means that the mean and variance of variables are time-invariant. This study used Levin- Lin Chu and Harris-Tzavalis unit-root. The two tests have the following hypotheses;

Null hypothesis (Ho): Panel data contains unit root [non-stationary].

The alternative hypothesis (Ha): Panel data is stationary.

The results presented in Table 4.4, the null hypothesis can be rejected at all conventional significance levels for all the study variables, which mean that there is no unit root in our data.

Table 4.2: Results of unit root test

	Levin-Lin-Chu	**HarrisTzavalis**
FS	-2.2181	-11.8297
p.value	0.0133	0.0000
CC	-3.4913	-30.7690
p value	0.0002	0.0000
IQ	-5.8562	-1.7293
p value	0.0000	0.0419
FX	-14.8840	-22.6736
p value	0.0000	0.0000
FDI	-4.6880	-17.3505
p value	0.0000	0.0000
PP	-17.3080	-44.0024
p value	0.0000	0.0000
HC	-1.5980	-12.2129
p value	0.030	0.0000
INF	-24.8402	-12.2129
p value	0.00	0.0000
GDP	-7.7477	-49.3551
p value	0.0000	0.0000

Source: Researcher 2024

4.3.2 Multicollinearity

Multicollinearity is a statistical effect that happens in regression analysis when two or more independent variables are strongly linked to each other. This can change the expected coefficients and make the statistical conclusions less reliable (Gujarati & Porter, 2020). It's hard to separate the effect of each predictor on the dependent variable when multicollinearity is present, which leads to large standard errors and unstable coefficient values (Wooldridge, 2019). The Variance Inflation Factor (VIF) is a popular way to find multicollinearity. It measures how much the variance of a regression coefficient is inflated because it is linked to other predictors. Tolerance can be seen in the reciprocal of VIF (1/VIF); lower numbers mean more collinearity (Maddala & Lahiri, 2021). A VIF above 10 usually means that there is serious multicollinearity, while a VIF between 5 and 10 usually means that there is moderate multicollinearity (Gujarati & Porter, 2020). A VIF lower than 5 is good enough.

The results of the VIF test are shown in Table 4.3. The values range between 3.67 and 1.04; which, are less than 10, implying the research variables do not suffer from multicollinearity.

Table 4.3: Multicollinearity

Variable	VIF	1/VIF
GDP	3.67	0.272231
CC	2.43	0.411618
PP	2.03	0.491427
FX	1.16	0.858526
HC	1.15	0.871027
IQ	1.08	0.925724
INF	1.05	0.953471
FDI	1.04	0.959797
Mean VIF	1.70	

Source: Researcher 2024

4.3.3 Test for Heteroskedasticity

Heteroscedasticity is a condition in regression analysis where the variance of the error terms is not constant across observations. In ordinary least squares (OLS) regression, one of the key assumptions is homoscedasticity, meaning that the residuals should have a constant variance. When this assumption is violated, the estimated standard errors become unreliable, leading to inefficient parameter estimates and invalid statistical inferences (Gujarati & Porter, 2020).

The Breusch-Pagan/ Cook-Weisberg test was used to test for heteroskedasticity, and the results are presented in Table 4.4. The heteroscedasticity test evaluates whether the variance of residuals is constant across observations. The hypotheses for the test are:

Null Hypothesis (H_0): The residuals have constant variance (Homoscedasticity).

Alternative Hypothesis (H_1): The residuals have non-constant variance (Heteroscedasticity is present).

The findings indicate that the Chi2 (1) value is 2.43 *and p-value of 0.1194 implying* that the null hypothesis cannot be rejected (Since the p-value (0.1194) is greater than 0.05**,** we fail to reject the null hypothesis). Thus, the assumption of constant variance was not violated.

Table 4.4: Breusch-Pagan test for heteroscedasticity/ Cook-Weisberg

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of FS
chi2(1) = 2.43
Prob > chi2 = 0.1194

Source: Researcher 2024

4.3.4 Autocorrelation Test

The correlation of a variable with its previous values measured over a period of time is referred to as autocorrelation, which is also referred to as serial correlation. The phenomenon of autocorrelation occurs in the setting of panel data, which is characterized by the collection of observations from a number of different entities throughout a variety of time periods. This occurs when the error terms in one period are associated with those in earlier periods. According to Gujarati & Porter (2020), the presence of autocorrelation is a violation of the assumption of the independence of residuals, which is essential for getting estimators that are both unbiased and efficient using regression analysis.

The study used the Wooldridge to test for autocorrelation. Developed by Wooldridge (2002), this test is based on the assumption that if autocorrelation exists, then the residuals from the regression model will exhibit a systematic pattern over time rather than being randomly distributed. The test is particularly advantageous as it does not require strict assumptions about the distribution of errors and is applicable to both fixed and random effects models (Baltagi, 2021).

The Wooldridge test for autocorrelation in panel data is conducted under the following hypotheses:

Null Hypothesis (H_0): There is no first-order autocorrelation in the panel data residuals. This implies that the errors are independently distributed across time, which is desirable for ensuring the validity of statistical inferences.

Alternative Hypothesis (H_1): There is first-order autocorrelation in the panel data residuals, meaning that past errors significantly influence current errors, which could lead to inefficient parameter estimates.

The test's results presented in Table 4.5 indicate that the null hypothesis cannot be rejected at a 5% significance level since the p-value of 0.2512 is above the conventional significance threshold. Therefore, there is no autocorrelation in the panel data.

Table 4.5: Wooldridge test for autocorrelation in panel data

Wooldridge test for autocorrelation in panel data
H0: no first order autocorrelation
F(1, 42) = 1.353
Prob > F = 0.2512

Source: Researcher 2024

4.3.5 Specification Error Test

A well-specified model accurately captures the relationship between independent and dependent variables without omitting relevant variables, including unnecessary variables, or misspecifying the functional form (Gujarati & Porter, 2020). One of the most commonly used tests for detecting model specification errors is the Ramsey RESET (Regression Specification Error Test). This test helps identify whether the regression model has omitted variables or if the functional form is incorrectly specified. If a model is misspecified, the estimated coefficients may be biased and inefficient, leading to misleading conclusions in empirical research (Wooldridge, 2010).

The Ramsey RESET test evaluates whether the model is correctly specified. The hypotheses for the test are:

Null Hypothesis (H_0): The model has no omitted variables or specification errors.

Alternative Hypothesis (H_1): The model has omitted variables or incorrect functional form.

The results of the Ramsey RESET test are presented in table 4.6. From the findings in the table, the p-value of the Ramsey RESET test are more than the threshold value of 0.05; implying that the model has no omitted variables; indicating that we fail to reject the null hypothesis. This suggests that there is no significant evidence of model misspecification, meaning that the regression model used to estimate fiscal sustainability is correctly specified (Ramsey, 1969).

Table 4.6: Ramsey RESET (test using powers of the fitted values of FS)

Ramsey	RESET test using powers of the fitted values of FS
Ho: model has no omitted variables	
F (3, 977) = 1.65	
Prob > F = 0.1770	

Source: Researcher 2024

4.3.6 Hausman Test

The Hausman test is conducted to determine whether a fixed effects (FE) or random effects (RE) model is more appropriate for panel data analysis (Hausman, 1978). The null hypothesis (H_0) assumes that the difference in coefficients between the fixed and random effects models is not systematic, meaning that the RE model is efficient and consistent. The alternative hypothesis (H_1) suggests that the FE model is preferred because the RE estimates are inconsistent. In this case, the Hausman test statistic is $\chi^2(8) = 24.62$ with a p-value of 0.0018, which is highly significant. This result strongly

rejects the null hypothesis, indicating that the fixed effects model is the appropriate choice for the analysis (Wooldridge, 2010).

Examining the coefficient differences (b - B), we observe some notable variations between the FE and RE estimates. For instance, population has a relatively large difference (0.1495) with a standard error of 0.1215, suggesting that its effect varies significantly between the models. Similarly, climate change has a notable coefficient difference of 0.0587, with a standard error of 0.0279, implying potential bias in the RE estimation. On the other hand, variables such as foreign direct investment (FDI) Institutional quality (IQ) and foreign exchange rate (FX) show minimal coefficient differences (-0.0255, -0.0065 and -0.0403, respectively), suggesting that their estimates are relatively stable across both models.

The coefficient estimates indicate that change climate (0.410 in FE, 0.351 in RE) and Foreign exchange (0.777 in FE, 0.818 in RE) positively influence the dependent variable, suggesting their crucial role in the model. Contrary, institutional quality (-0.063 in FE, -0.057 in RE) and FDI (-0.538 in FE, -0.513 in RE) exhibit negative effects, implying that weak institutions and negative FDI outflows hinder fiscal sustainability. The rejection of the RE model in favor of the FE model underscores the presence of individual-specific effects that must be accounted for to obtain consistent estimations (Baltagi, 2021).

Table 4.7: Hausman test results

	---- Coefficients ----			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	Fe	Re	Difference	S.E.
Economic growth	-.3991105	-.3610553	-.0380552	.00222781
Inflation	-.121281	-.1279239	.0066429	.00208693
Human Capital	.0126945	.0130897	-.0003952	.0014182
Population	.5375872	.3881299	-.1494573	.12149
Climate change	.4097996	.3511136	-.0586869	.0279125
Institutional quality	-.0630974	.0565754	-.006522	.0082834
Foreign exchange	.7772738	.8175482	-.0402744	.008152
Foreign Direct investment	-.5381266	-.5126753	.0254513	.008033

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 24.62

Prob>chi2 = 0.0018

Source: Researcher 2024

4.4 Correlation Analysis

A correlation test is a statistical instrument employed to assess the degree and direction of the linear relationship between two variables (Gujarati & Porter, 2020). The correlation coefficient, represented as r, varies from -1 to 1. The goal of pairwise correlation is to ascertain the nature and extent of the relationship between study variables. The correlation coefficients between pairs of variables are displayed in Table 4.8.

The table show that FDI was negatively correlated with FS (*r= -0.0737; ρ< 0.05*). This might be due to tax exemptions for foreign investors, capital flight, or limited reinvestment into the domestic economy. It also suggests that in SSA, some FDI might not translate to fiscal gains due to poor tax regimes or revenue leakage.

The table further shows that GDP and FS are positively correlated (*r* =0.0369*; ρ< 0.*05). There is a slight positive relationship between GDP and fiscal sustainability — meaning as GDP increases, fiscal sustainability might improve but this relationship is weak and not statistically significant**.** Also, the correlation results indicated that CC and FS are positively correlated (*r* = 0.2412*; ρ> 0.05*). This might reflect increased climate-related investments, financing or that governments are engaging in fiscal reforms in response to climate risk. The association between IQ and FS are negatively correlated (*r* = -0.2291*; ρ< 0.05*) indicating that better governance is associated with high fiscal health. Strong institutions enforce environmental regulations, promote accountability, and encourage sustainable development, leading to reduced fiscal imbalances (Acemoglu & Robinson, 2012).

Foreign Exchange (FX) and FS are strongly, positively and significantly correlated (*r* = 0.4620*; ρ> 0.05*). It suggests that a stable or favorable exchange rate is linked with better fiscal sustainability. Currency stability may help reduce the burden of foreign debt and improve budget planning in SSA countries. The correlation matrix further indicates a positive but not significant correlation between Human capital and FS (*r* = 0.0075*; ρ< 0.05*) However, it has a positive correlation with FX (0.1444*) and FDI (0.1306*), Suggesting that investment in human capital may attract foreign investment or support currency stability, even if the direct fiscal impact is not yet strong. Also, the correlation between population and FS is positive and significant (*r* = 0.1199*; ρ< 0.05*),

Indicating that higher population levels are associated with better fiscal sustainability. It could suggest that a growing population leads to a larger tax base or labor force, supporting revenue generation. Finally, the correlation between inflation and FS is positive (r = 0.2432*; $\rho < 0.05$*). Its significance suggests that moderate levels of inflation may support fiscal sustainability, potentially by reducing the real value of debt or increasing nominal tax revenues. The matrix shows that the highest correlation coefficient occurs between FX and INF. According to Gujarati (1995), if correlations reach 0.8, it can result in multicollinearity among the variables. Hence, it can be argued that this problem is not present in the regression models of the present study.

Table 4.8: Correlation analysis

	FSS	FDI	GDP	CC	IQ	FX	HC	PP	INF
FSS	1.0000								
FDI	-0.0737*	1.0000							
GDP	0.0369	-0.0874*	1.0000						
CC	0.2412*	-0.0738*	0.7284*	1.0000					
IQ	-0.2291*	-0.0650*	-0.0787*	-0.1969*	1.0000				
FX	0.4620*	-0.0197	-0.0037	0.1811*	-0.1493*	1.0000			
HC	0.0075	0.1306*	-0.3048*	-0.1660*	-0.0270	0.1444*	1.0000		
PP	0.1199*	-0.1115*	0.6886*	0.4641*	-0.1264*	0.1206*	-0.1836*	1.0000	
INF	0.2432*	-0.0918*	0.0608	0.1046*	-0.0499	0.1651*	0.0333	0.1129*	1.0000

Source: Researcher 2024

4.5 Results of the Regression Analysis

4.5.1 Testing the Effect of the Control Variables

Prior to analyzing the influence of the predictor variables on the outcome variable, the study assessed the influence of the control variables: GDP, population, health spending, and inflation. Fixed-effects regression is a statistical technique that is employed to analyze panel data by adjusting for unobserved heterogeneity across groups, such as countries or years that may affect the dependent variable. It eliminates time-invariant characteristics, guaranteeing that only within-group variations are examined

(Wooldridge, 2019). This approach is beneficial for evaluating the long-term influence of independent variables on a dependent variable while accounting for individual-specific characteristics. The influence of control variables is investigated in this analysis using fixed-effects regression. The fixed effect results are presented in table 4.8.

The GDP coefficient is -0.453, with a p-value of 0.000, demonstrating a statistically significant negative correlation between economic growth and fiscal sustainability. Economic growth, usually quantified by the rise in a nation's GDP, is commonly anticipated to improve fiscal sustainability through the augmentation of tax revenues and the mitigation of borrowing requirements. Nevertheless, the study's findings indicate that an increase in economic growth is associated with more fiscal expenditures or borrowing, potentially as a result of heightened investments in infrastructure, social services, or other expenses related to growth as well as corruption. This has the potential to put a burden on financial resources, therefore diminishing financial stability. The p-value's significance confirms the robustness of this negative association, ruling out the possibility of it being caused by random variation.

The coefficient for inflation (INF) is 0.1976, with a p-value of 0.000, indicating a statistically significant positive relationship between inflation and fiscal sustainability. A 1-unit increase in INF is associated with an increase of approximately 0.1976 units in FSS. Inflation can have complex effects on fiscal sustainability. On one hand, moderate inflation can erode the real value of debt, reducing the burden of existing liabilities and potentially improving fiscal sustainability. On the other hand, high or volatile inflation can increase the cost of borrowing and create economic instability, which might undermine fiscal sustainability. The positive coefficient in this study

suggests that, within the observed range, inflation may help improve fiscal sustainability by reducing the real value of debt.

The human capital (HC), proxied by health expenditure, coefficient is 0.0257, with a p-value of 0.000, indicating a statistically significant positive relationship between human capital and fiscal sustainability. A 1-unit increase in HC is associated with an increase of approximately 0.0257units in FSS. Investment in human capital, particularly through health expenditure, is crucial for long-term economic growth and fiscal sustainability. Improved health outcomes enhance productivity, reduce healthcare costs, and foster a more robust labor force, which in turn strengthens the economy and the fiscal position of the state. The positive coefficient suggests that higher investments in human capital contribute to improving fiscal sustainability, and the p-value indicates that this effect is statistically significant

The study found also Population had a statistically significant positive relationship with fiscal sustainability. A growing working population can positively impact fiscal sustainability by expanding the tax base, increasing productivity, and boosting economic growth. A larger working-age population contributes more to government revenues through taxes and supports higher levels of economic activity, which strengthens the fiscal position of the government. The large positive coefficient suggests a strong link between a growing working population and improved fiscal sustainability.

Sigma_u (0.43347404) represents the standard deviation of the unobserved individual effects, indicating the variation in fiscal sustainability that remains unexplained by the model across different countries. Sigma_e (0.3117869) is the standard deviation of the error term, showing the level of unexplained variation in fiscal stability within the

model. Rho (0.6590411) indicates that only 65.9% of the total variance is due to unobserved individual effects. Highlighting the need for control. The model provides three R-squared values, which indicate how well the control variables explain variations in fiscal sustainability. The within R-squared value (0.1161) shows that 11.61% of the variation in fiscal sustainability within each country is explained by GDP, population, human capital and inflation. The between R-squared value (0.0205) suggests that 2.05% of the variation between different countries is captured by the model, indicating a weak explanatory power across countries. The overall R-squared value (0.0314) implies that 3.14 % of the total variation in fiscal sustainability is accounted for by the independent (control) variables. Additionally, the F-statistic (30.94) and its p-value (0.0000) confirm the model's statistical significance. Since the p-value is below the 1% significance level, it indicates that at least one of the independent variables significantly influences fiscal sustainability (Gujarati & Porter, 2020).

Table 4.9: Regression of FS on control variables

Fixed-effects (within) regression		Number of obs	=	989		
Group variable: CountryID		Number of groups	=	43		
R-sq: within= 0.1161		Obs per group: min	=	23		
between = 0.0205		Avg	=	23.0		
overall = 0.0314		Max	=	23		
		F(4,942)	=	30.94		
corr(u_i, Xb) = -0.5645		Prob > F	=	0.0000		
FSS	Coef.	Std. Err.	T	P>t	[95% Conf.	Interval]
GDP	-0.4533051	.0609881	-7.43	0.000	-.5729934	-.3336167
HC	0.0257404	.0067181	3.83	0.000	.0125563	.0389245
PPL	1.41158	.1927732	7.32	0.000	1.033266	1.789895
INF	0.1976045	.0322417	6.13	0.000	.1343305	.2608785
_cons	-5.335704	.9829813	-5.43	0.000	-7.264791	-3.406618
sigma_u	.43347404					
sigma_e	.3117869					
Rho	.6590411	(fraction of variance due to u_i)				

Source: Researcher 2024

4.5.2 Testing the Direct Effect

The regression model is used for the empirical statistics to analyze predictor variables, as shown in Table 4.10. In this analysis, four direct hypotheses were evaluated by regressing the outcome variable (FS) against all of the explanatory factors (institutional quality, foreign exchange, foreign direct investment, and climatic change), as well as the controls. The study performed both the fixed effect (FE) and the random effect (RE) regression and the results of the Hausman test (Chi2 (8) =24.62; p=0.0018), shown in table 4.7 and appendix, supported the use of FE to test the direct hypotheses.

The model provides three R-squared values, which indicate how well the independent variables explain variations in fiscal sustainability. The within R-squared value (0.3465) shows that 34.65% of the variation in fiscal sustainability within each country is explained by the independent and control variables. The between R-squared value (0.1741) suggests that 17.41% of the variation in fiscal sustainability is accounted for by the model. Additionally, the overall R-squared value (0.2244) suggests that 22.44% of the total variation in fiscal sustainability is explained by the selected variables.

The F-statistic (62.17) and the corresponding p-value (0.0000) confirm that the model is statistically significant. This indicates that at least one of the independent variables has a significant impact on fiscal sustainability. An analysis of the variance components provides further insight into the model's robustness. The sigma_u value (0.35376094) represents the standard deviation of the unobserved individual effects related to each country. This suggests that while country-specific factors influence fiscal stability, their impact is not relatively small. The sigma_e value (0.26866371) represents the standard deviation of the error term, capturing unexplained variations in fiscal sustainability that are not accounted for by the included variables.

Table 4.10: Regression results for Fixed Effect

xtreg FS CC GDP FDI FX HC IQ PP INF, fe

Group variable: Country ID	Number of groups	=	43
R-sq: within = 0.3465	Obs per group: min	=	23
between = 0.1741	Avg	=	23.0
overall = 0.2244	Max	=	23
	F(8,938)	=	62.17
corr(u_i, Xb) = -0.3663	Prob > F	=	0.0000

FSS	Coef.	Std. Err.	T	P>t	[95% Conf.	Interval]
CC	.4097996	.0509084	8.05	0.000	.3098921	.5097071
IQ	-.0630974	.0239384	-2.64	0.009	-.1100763	-.0161184
FX	.7772738	.0644117	12.07	0.000	.6508661	.9036816
FDI	-.5381266	.1361471	-3.95	0.000	-.8053147	-.2709385
GDP	-.3991105	.0540719	-7.38	0.000	-.5052263	-.2929947
HC	.0126945	.0058744	2.16	0.031	.001166	.024223
PP	.5375872	.1816255	2.96	0.003	.1811477	.8940267
INF	.121281	.0281132	4.31	0.000	.0661089	.176453
_cons	-1.025814	.9193038	-1.12	0.265	-2.829944	.7783166
sigma_u	.35376094					
sigma_e	.26866371					
Rho	.63421026	(fraction of variance due to u_i)				

Source: Researcher 2024

4.5.3 Testing the Direct Hypotheses

To test the hypotheses, we examine the p-values and t-statistics from the regression results. If the p-value is less than the significance level (typically 0.05), we reject the null hypothesis, suggesting that the factor has a statistically significant effect on fiscal sustainability. Conversely, if the p-value is greater than 0.05, we fail to reject the null hypothesis, suggesting the factor has no significant effect.

The first null hypothesis (H_{01}) stated that: *Climate change has no significant effect on fiscal sustainability in SSA*

The findings in Table 4.10 confirm that the effect of Climate change had a positive and significant impact on FS (β=0.4098, $\rho<0.05$). Therefore, null hypothesis (H_{01}) was rejected. Fiscal sustainability, as measured by the debt-to-GDP ratio, is a crucial indicator of a country's ability to manage its public finances over the long term. The positive coefficient of 0.4098 implies that countries in Sub-Saharan Africa that effectively mitigate the impacts of climate change tend to improve their fiscal sustainability. This finding aligns with the broader understanding that climate change poses significant risks to economic growth and development, which can subsequently impact a country's fiscal position (Tarhule, 2007). This study also conforms to that of Ekins and Speck (2014), which reported that climate change positively influence fiscal sustainability. They further explained that expenditures on adaptation to climate change are relevant to fiscal sustainability because some expenditure will need to be financed by the public sector, but they should also reduce the need for post-disaster expenditures in the future. Economic measures aimed at mitigating climate change by mitigating greenhouse gas emissions have implications for public budgets as they generate income through taxes and emission trading schemes, or incur expenses through subsidies. For instance, a study examining the impact of climate change on budget balances and debt in the Middle East and North Africa region found that changes in temperature adversely affected government budgets and increased public debt, although no significant impact was observed for changes in rainfall (Gıovanıs & Özdamar, 2022). Similarly, another study on the economic growth implications of climate change in Africa emphasized the substantial rise in temperature experienced by many countries in the continent over the past five decades, with the indirect impacts of climate change, such as increased

morbidity and mortality, having significant economic and welfare consequences. (Abidoye & Odusola, 2015). Economic measures aimed at increasing revenue appear to be especially efficient during a period when budgetary austerity is necessary. Subsidizing the use of fossil fuels, however, have detrimental effects on both public finances and the environment. Similar findings were reported in previous studies (Nakatani. R (2021),Cevik & Nanda (2020), Tol, (2018)).

Morever, results of this study are consistent with existing research on the linkages between climate change and fiscal sustainability. A study on the impact of climate change in rural Zimbabwe found that the absence and limited access to various forms of capital assets, such as natural, human, and social capital, can undermine the sustainability of rural African societies in the face of climate change (Dube et al., 2018). Similarly, research on the perceived effects of climate change on forests and forest-based livelihoods in Malawi highlighted the vulnerability of sub-Saharan African countries to the adverse impacts of climate change due to factors like poverty and limited capacity to adapt to such changes (chisale et al 2021).

However on the contrary, Nordhaus (2016) argues that while climate change affects economic growth, its short-term impact on fiscal sustainability, particularly debt levels, is minimal. The author suggests that in certain scenarios, the costs of aggressive climate action might outweigh the benefits in the short term for SSA economies with high existing debt burdens. Additionally Dell and co-authors (2014) found that climate change affects economic productivity but did not find significant evidence of its direct impact on fiscal sustainability in lower-income regions. The study suggests that the relationship between climate policies and fiscal sustainability is complex and highly dependent on other economic factors like governance and institutional capacity.

The second null hypothesis (H_{02}) stated that; *Institutional quality do not significantly influence fiscal sustainability in SSA*

The findings in Table 4.10 indicate that institutional quality had a negative and significant impact on FS ($\beta 2 = -0.0631, \rho < 0.05$); hence H_{02} was rejected. The negative relationship between institutional quality and fiscal sustainability implies that countries with weaker institutions are more likely to face challenges in maintaining long-term fiscal stability. This can have far-reaching consequences, including limited access to international credit markets, reduced investment and economic growth, and increased vulnerability to external shocks. The results presented align with the wider research on the influence of institutional quality on economic development. Existing studies indicate that robust institutions marked by transparency, accountability, and adherence to the rule of law are crucial for advancing financial development and economic growth (Acemoglu et al 2019, Gollwitzer, 2010, Sandow et al., 2022, Anthony-Orji et al., 2019 , Ahmad, 2007). Conversely, poor institutional quality can compromise fiscal discipline, leading to inefficient allocation of public resources and the buildup of unsustainable debt levels (Alesina and Perotti,1996, Nguyen and Luong, 2021).

The third hypothesis (H_{03}) stated that; *Foreign exchange rate do not have a significant impact on fiscal sustainability in SSA*

The regression results in Table 4.10 illustrate that Foreign exchange has a strong positive and significant effect on FS ($\beta = 0.7773, \rho < 0.05$); thus H_{03} is rejected. The foreign exchange rate has a significant positive impact on fiscal sustainability in sub-Saharan Africa. The coefficient of 0.7773 indicates that a 1% increase in the foreign exchange rate is associated with a 0.7773% improvement in fiscal sustainability. A stable or strong foreign exchange rate is associated with improved fiscal sustainability,

(as measured by the debt-to-GDP ratio) likely because it reduces the cost of servicing foreign-denominated debt and increases economic stability. This finding has important implications for the region's fiscal outlook. Fiscal sustainability is a crucial aspect of economic stability and growth, and the foreign exchange rate is an important factor in determining a country's ability to service its debt obligations and maintain a healthy fiscal position. (Nabieu et al., 2020) This result is consistent with the findings of Aizenman (2020), who argue that countries with stable foreign exchange rates are better equipped to handle external shocks, which in turn supports fiscal sustainability. This is particularly relevant for SSA countries with high levels of foreign debt or exposure to volatile global markets.

The fourth hypothesis (H_{04}) stated that; *FDI has no significant influence on fiscal sustainability in SSA*

The regression results in Table 4.10 illustrate that FDI has a negative and significant effect on FS (β= -0.5381, $\rho<0.05$); thus H_{04} is rejected. With a coefficient of -0.5381, the negative sign suggests that as FDI inflows increase, fiscal sustainability decreases. This is contrary to the general expectation that FDI would bolster economic development and fiscal health, by bringing in foreign capital, boosting revenue, and creating jobs. Instead, these results point to a scenario where FDI might be exacerbating fiscal imbalances in SSA. Several reasons could explain this negative relationship as highlighted by previous studies: First, Many countries in SSA attract FDI through tax holidays or subsidies. While these incentives attract foreign investors, they can erode the government's tax base, thereby weakening fiscal sustainability (Ayanwale, (2007). Secondly, FDI may lead to outflows of capital as foreign investors repatriate profits back to their home countries. This drains foreign exchange reserves and creates pressure

on government finances, particularly when foreign currency debt servicing is involved (Arezki & Sy, 2016, Ndikumana, 2003). Lastly, in some SSA countries, weak institutions and poor governance can result in FDI being inefficiently managed, leading to little contribution to fiscal revenue, and sometimes increasing the fiscal burden through corruption or mismanagement (Asiedu, 2013, Ajayi & Ndikumana, 2015).

4.6 Robust Checks

Table 4.11 shows results of robust checks using System Generalized Method of Moments (System GMM). The usage of System GMM was to ensure the reliability, validity, and robustness of the econometric analysis. System GMM is a widely used estimation technique, particularly for panel data analysis, due to its ability to address endogeneity, autocorrelation, heteroskedasticity, and omitted variable biases. The GMM estimation technique is particularly useful in panel data settings, as it allows for the control of unobserved heterogeneity and provides consistent estimates when the regressors are endogenous (Arellano & Bond, 1991). The results from the GMM model are compared with the fixed effects (FE) model to examine whether the findings remain consistent.

From the table, the panel data structure consists of 931 observations from 43 Sub-Saharan African nations across multiple years, averaging 21.65 observations per country. The F-statistic of 219.48 and a p-value of 0.000 signify substantial explanatory power for variation in Fiscal Sustainability. Diagnostic assessments, encompassing autocorrelation (AR1 and AR2) and over identifying restrictions (Sargan and Hansen tests), affirm the model's validity, indicating no presence of second-order autocorrelation (AR2 p=0.592) and confirming valid instruments (Hansen p=0.511).

The findings reveal substantial relationship between Fiscal Sustainability and several explanatory variables. The coefficient for Lagged Fiscal Sustainability (FS t−1) is 0.299, indicating the continuity of fiscal conditions across time, as shown in fiscally responsible nations such as Botswana. Unexpectedly, GDP growth has a negative coefficient of -0.035 ($p<0.001$) a much weaker effect compared to the fixed effect model coefficient of -0.399, indicating that robust development may sometimes hurt fiscal stability because of changes in income or growth volatility, a phenomenon seen in Nigeria's oil-dependent economy. The Nigerian economy has experienced periods of economic expansion that did not translate into sustainable fiscal health (Collier and Venables, 2011). Inflation positively influences fiscal sustainability in both models, but the effect size is slightly smaller in the System GMM model (0.091 $p<0.001$). The findings indicate that moderate inflation may be beneficial in stabilizing public finances; however, instances such as Zimbabwe's hyperinflation illustrate the dangers of extreme inflation. The results for human capital contradict each other—fixed effect model suggests that human capital positively influences fiscal sustainability, while System GMM finds a negative effect. The magnitude is very minimal at 0.021. The negative effect evidenced by a coefficient of -0.008 ($p=0.006$), possibly is an indicative of the financial strain from education and healthcare expenditures, as illustrated by Kenya's initiatives in universal healthcare. Population increases, exhibiting a negligible coefficient of -0.008 ($p=0.945$), does not significantly affect fiscal sustainability, indicating that demographic changes alone do not dictate fiscal results. However, there is a significant discrepancy between the models. While the fixed effect model suggests that population growth positively influences fiscal sustainability, the System GMM model finds no effect.

The empirical findings reveal that climate change exerts a significant positive influence on fiscal sustainability, as indicated by the p-value (0.000) and the positive coefficient (0.1368). The rejection of the null hypothesis suggests that countries in SSA that effectively manage the impacts of climate change can enhance their fiscal sustainability. This result can be attributed to the fact that climate change, while traditionally seen as a risk factor, can stimulate positive fiscal outcomes if appropriate adaptation and mitigation policies are in place. While both models indicate that climate change has a positive and significant impact on fiscal sustainability, the fixed effect model estimates a much stronger effect than the System GMM model. The difference suggests that when accounting for endogeneity and dynamic effects, the impact of climate change on fiscal sustainability is smaller. Institutional quality adversely affects financial stability, with a value of -0.055 ($p=0.009$), underscoring the detrimental consequences of corruption and inefficiencies, as evidenced in Kenya. Institutional quality negatively affects fiscal sustainability in both models, though the magnitude is slightly larger in the fixed effect model. The similar significance levels and coefficients suggest that weak institutions undermine fiscal sustainability across SSA. In contrast, foreign exchange rate significantly bolster fiscal stability, with a coefficient of 0.774 ($p<0.001$), highlighting that stabilizing exchange rate improves the fiscal health through reduced debt service and trade costs. Both models produce nearly identical estimates for the effect of exchange rate stability on fiscal sustainability. The results strongly suggest that exchange rate stability enhances fiscal health by reducing external debt servicing costs. Foreign Direct Investment (FDI) demonstrates an inverse correlation with fiscal sustainability, indicated by a coefficient of -0.258 ($p<0.001$), possibly attributable to profit repatriation or tax base erosion associated with FDI incentives.

The fixed effect model suggests a much stronger negative impact of FDI on fiscal sustainability (-0.5381) compared to the System GMM model.

Table 4.11: System GMM Results

Group variable: Country ID		Number of obs	=	931		
Time variable : Year		Number of groups	=	43		
Number of instruments = 30		Obs per group: min	=	7		
F(9, 42)	= 219.48	Avg	=	21.65		
Prob > F	= 0.000	Max	=	22		
FSS	Coef.	Std. Err.	T	P>t	[95% Conf.	Interval]
FSS L1.	.2992311	.0431925	6.93	0.000	.2120651	.3863971
GDP	-.0350566	.0084838	4.13	0.000	.0179356	.0521775
INF	.0907304	.0233792	3.88	0.000	.0435492	.1379116
HC	-.0080999	.0027886	-2.90	0.006	-.0137275	-.0024722
POP	-.0080089	.1159165	-0.07	0.945	-.2419378	.22592
CC	.1367796	.0240013	5.70	0.000	.088343	.1852162
IQ	-.0548397	.0199525	-2.75	0.009	-.0951053	-.014574
FX	.7740955	.044908	17.24	0.000	.6834675	.8647235
FDI	-.2577359	.0606935	-4.25	0.000	-.3802204	-.1352514
_cons	1.137388	.4914124	2.31	0.026	.1456777	2.129098
AR(1)	0.000					
AR(2)	0.592					
Sargan test	0.102					
Hansen test	0.511					

4.7 Discussion of the Findings

The first objective of the study was to evaluate the effect of climate change on fiscal sustainability. The study reported a positive and significant effect in both the fixed effect and System GMM model. This result can be attributed to the fact that climate change, while traditionally seen as a risk factor, can stimulate positive fiscal outcomes if appropriate adaptation and mitigation policies are in place. Conceptually, 'greening' development involves the imposition of both new constraints and opportunities (Collier & Venables 2012). Specifically, the management of climate-related risks reduces the likelihood of economic shocks, stabilizes government revenue flows, and minimizes

the costs associated with disaster recovery. This result aligns with the broader understanding that climate change poses significant risks to economic growth and development, which can subsequently impact a country's fiscal position (Abidoye & Odusola, 2015). The literature has extensively documented the various channels through which climate change can affect a country's fiscal balance, including reduced tax revenues, increased spending on disaster relief and recovery, and the need for investments in climate change adaptation and mitigation measures. (Abidoye & Odusola, 2015) The findings presented in this study enhance the information and contributes to growing body of evidence on the fiscal consequences of climate change in Sub-Saharan Africa.

It is truism that Climate change is regarded as one of the most significant problems confronting humanity today (Cook et al., 2013; IPCC, 2018). The challenges created by this unprecedented issue jeopardize the planet's sustainability and health, while simultaneously exacerbating intergenerational disparities in social, economic, environmental, and geographic dimensions (Caney, 2016; Ciplet et al., 2015; Hamman et al., 2018; IPCC, 2014; Meyer, 2017). One critical aspect that has garnered increasing attention is the potential impact of climate change on fiscal sustainability, which is the ability of governments to maintain their long-term financial obligations. (Bellon et al, 2022).

Africa is presently the green continent, accounts for only 2–3 per cent of the world’s carbon emissions. However many SSA countries face heightened vulnerability to climate change, given their reliance on climate-sensitive sectors such as agriculture, fisheries, and natural resources (World Bank 2020, Sultan & Gaetani 2016). Governments face increased spending pressures due to climate adaptation, disaster

recovery, and infrastructure resilience. For example, Mozambique and Malawi frequently experience floods and cyclones, leading to substantial fiscal outlays to repair infrastructure and assist affected populations. The positive correlation between climate change and fiscal sustainability suggests that those countries that are proactive in building climate-resilient infrastructure and economies tend to fare better fiscally. Effective climate adaptation strategies, such as investing in sustainable agriculture, energy, and water systems, have the potential to reduce climate-induced economic disruptions, thus promoting fiscal stability.

Stern (2007) in *The Economics of Climate Change* argued that the cost of inaction on climate change is far greater than the cost of implementing climate-resilient policies. Investments in sustainable infrastructure and climate adaptation create long-term benefits, including improved fiscal stability, by reducing the costs associated with climate-related disasters. Similarly, Kessler (2019) emphasized that country with robust climate adaptation frameworks in SSA have seen improvements in both economic performance and fiscal sustainability, particularly as they avoid the fiscal shocks caused by environmental disruptions. Additionally, this result aligns with recent literature, such as Rafaty (2018), which found that climate-related investments, such as carbon pricing and infrastructure resilience, can improve fiscal outcomes by reducing long-term environmental costs and attracting international funding for green projects. Furthermore, Diffenbaugh and Burke (2019) highlight that climate-induced economic fluctuations are more pronounced in developing regions, and investments in climate resilience are crucial to mitigating long-term economic instability. A 2015 study by E. Delpiazzo explores the fiscal sustainability of climate adaptation investments in Italy, with a particular focus on their medium-term economic implications. The findings reveal that adaptation investments lead to improved fiscal outcomes relative to the

inaction scenario. Notably, anticipatory adaptation measures are shown to produce even stronger fiscal benefits, including reductions in both the deficit-to-GDP and debt-to-GDP ratios, alongside enhanced economic growth. These results highlight the fiscal advantages of investing in climate resilience and underscore the critical role of proactive adaptation strategies in safeguarding long-term fiscal sustainability.

These findings are particularly relevant in the context of the Sustainable Development Goals adopted by the United Nations in 2015, which aim to address global challenges, including climate change and its impact on sustainable development. More specifically, this finding is closely linked to the United Nations Sustainable Development Goals (SDGs), particularly SDG 13 (Climate Action), SDG 8 (Decent Work and Economic Growth), and SDG 17 (Partnerships for the Goals). SDG 13 emphasizes the need to combat climate change and its impacts, and this study illustrates how achieving SDG 13 also fosters SDG 8, which aims to promote sustained, inclusive, and sustainable economic growth. By mitigating climate change, SSA countries are better able to support stable economic growth, contributing to poverty alleviation and economic development. Moreover, SDG 17 calls for stronger partnerships and collaborative efforts across regions to enhance climate resilience and fiscal stability, suggesting that international cooperation could further strengthen SSA countries' ability to address these challenges. Carbon taxes or green bonds can improve fiscal sustainability (Alamgir & Cheng, 2023), and governments may receive external funding or increase domestic revenues. However, this positive impact may not endure if climate change results in more frequent and severe environmental disasters, which would require more public spending on recovery.

Second objective sought to determine the influence of institutional quality on fiscal sustainability in SSA. The study reported a negative relationship between institutional quality and fiscal sustainability in both models. This highlights that weak institutions undermine fiscal sustainability by fostering corruption, inefficiency, and mismanagement of public resources. In Sub-Saharan Africa, numerous nations contend with structural challenges like deficient governance frameworks, corruption, and inefficiencies in public financial management. Inadequate institutions intensify budgetary difficulties by diminishing tax revenue collection and amplifying inefficiencies in governmental expenditure (Nguyen & Luong, 2021). Angola and Nigeria, both resource-rich nations, have historically had governance deficiencies that compromise budgetary discipline, despite their vast natural resources (Collier, 2007, Wiig & Kolstad, 2010, Omoke & Opuala, 2021). Inadequate institutional frameworks result in the misallocation of public funds, inefficient spending, and an inability to prioritize investments that foster long-term fiscal sustainability. Weak institutions not only compromise fiscal health but also hinder broader developmental goals by perpetuating inefficiencies and inequities (Acemoglu & Robinson, 2012, IMF 2019).

The findings are particularly relevant to SDG 16 (Peace, Justice, and Strong Institutions) and SDG 17 (Partnerships for the Goals), both of which emphasize the importance of institutional frameworks in achieving sustainable development (United Nations, 2015). Weak institutions hinder progress toward these goals in several ways: It erodes public trust in government, reducing citizens' willingness to pay taxes and engage in fiscal policy. This erosion of trust leads to weaker revenue bases and diminished capacity to fund public services such as education, healthcare, and infrastructure ((Kaufmann & Kraay, 2002). For example, in countries with high levels of corruption, tax evasion and informal economic activities are more prevalent, further

straining fiscal systems (Transparency International, 2023). It impedes domestic resource mobilization efforts, which are critical for financing development initiatives (IMF, 2019). Inadequate governance reduces the effectiveness of partnerships with international organizations and foreign investors, as seen in cases where mismanaged funds discourage external support or investments (Acemoglu & Robinson, 2012).Poor institutions often result in inequitable public spending, where resources are directed toward politically connected elites rather than the broader population. This exacerbates social and economic inequalities, undermining efforts to reduce poverty (SDG 1) and achieve inclusive economic growth (SDG 8) (World Bank, 2022). Institutional weaknesses can also hinder access to international climate funds, such as the Green Climate Fund, by failing to meet transparency and accountability requirements (UNEP, 2021). This limits the ability of SSA countries to address climate change, a key factor affecting fiscal stability in the region (Sachs et al, 2016).

Therefore institutional quality and governance in Sub-Saharan Africa (SSA) must be rapidly restructured to enhance fiscal sustainability, green investments and effectively harness its abundant natural resources. Unlike developed economies that have already locked in capital-intensive infrastructure, SSA has a unique latecomer advantage—it can adopt cutting-edge technologies, however, this advantage comes with urgency. SSA grapples with persistent energy shortages necessitate urgent investment decisions. Delaying such investments in anticipation of future technological advancements could hinder economic growth and fiscal sustainability, making institutional reforms and governance improvements even more critical for ensuring sustainable development.

The third objective analyzed the influence of foreign exchange rate on fiscal sustainability in SSA. The study reported a positive and significant effect in both the

models. This finding aligns with the broader economic theory that exchange rate stability contributes to macroeconomic resilience and fiscal health by lowering the cost of external debt servicing and enhancing investor confidence (Nabieu et al., 2020).

A steady or robust exchange rate reduces fiscal risks linked to foreign-denominated debt. Numerous SSA nations own substantial foreign debt, rendering them vulnerable to currency depreciation threats. The depreciation of the local currency elevates the expense of repaying foreign debt, hence intensifying pressure on government finances and worsening fiscal deficits (Aizenman, 2020). In contrast, stability in currency rates guarantees predictable costs for debt repayment, thus improving fiscal sustainability. Reinhart and Rogoff (2010) substantiate this claim by emphasizing that exchange rate volatility can trigger sovereign debt crises, especially in developing economies where foreign currency-denominated debt represents a significant portion of public debt.

Sub-Saharan African economies are highly vulnerable to external shocks, including fluctuations in commodity prices, global interest rates, and capital flows. Aizenman (2020) contends that nations with stable exchange rates are more adept at mitigating such shocks, hence diminishing the probability of fiscal crisis. The study results support this viewpoint, indicating that a robust exchange rate correlates with enhanced budgetary sustainability in Sub-Saharan Africa. This resilience is essential due to the region's substantial dependence on commodity exports, where unfavorable terms-of-trade shocks can profoundly affect government revenues and debt sustainability (World Bank, 2021).

Fiscal sustainability is a fundamental pillar for sustainable development, as it determines the ability of governments to finance public services, infrastructure, and social programs critical for achieving the SDGs. The role of foreign exchange rates in

shaping fiscal sustainability has direct and indirect consequences for economic growth, poverty alleviation, and long-term development in SSA. A stable and robust foreign exchange rate enhances fiscal sustainability by reducing the expense of repaying foreign-denominated debt. This enables governments to commit additional resources to poverty alleviation initiatives, including social protection programs, education, and healthcare. In Sub-Saharan Africa, where poverty is a significant issue, an effectively managed exchange rate helps avert economic crises that disproportionately impact the impoverished (World Bank, 2021). Moreover, exchange rate stability fosters economic resilience, reducing vulnerability to external shocks that could push more people into poverty (Aizenman, 2020). Additionally, the stability of exchange rates is essential for cultivating a business-friendly atmosphere that promotes investment and employment growth. Stable currency rates facilitate controlled inflation, enabling businesses to plan long-term investments with increased assurance. This fosters elevated employment rates and enhanced earnings, which are crucial for attaining SDG 8 (Decent Work and Economic Growth) (Reinhart & Rogoff, 2010).

It also worth to mention that the stability of foreign exchange rates improves the capacity of Sub-Saharan African governments to finance extensive infrastructure projects without incurring high borrowing costs. Infrastructure development, including transportation, electricity, and telecommunications, is crucial for industrialization, innovation, and comprehensive economic transformation. Fiscal sustainability guarantees that SSA nations can uphold long-term infrastructure expenditures, an essential element of SDG 9 (Industry, Innovation, and Infrastructure) (UNECA, 2021).

The fourth objective sought to examine the significance of FDI on fiscal sustainability in SSA. The results indicate that FDI has a significant negative effect on fiscal sustainability. This result goes against the common belief that FDI helps the economy grow and the government's finances by bringing in foreign money, creating jobs, and opening up new revenue streams. Instead, it shows that FDI may make fiscal imbalances in SSA economies worse in some situations. Its impact on fiscal sustainability depends on how it is structured and managed. The negative coefficient suggests that rather than strengthening fiscal sustainability, FDI may be contributing to fiscal distress in SSA.

A possible explanation is that numerous SSA governments employ tax incentives, including lowered corporate tax rates, and import duty exemptions, to draw foreign investors. Although these incentives can effectively enhance FDI inflows, they frequently result in considerable revenue losses, undermining long-term fiscal sustainability and thereby constraining the government's capacity to mobilize domestic resources for development (Wang et al 2013, Klemm & Van Parys, 2012). The loss of revenue directly affects fiscal sustainability, necessitating that governments either increase borrowing or reduce essential public services to address the deficit. The return of profits by foreign investors is another important issue. Unlike domestic investments, a big chunk of FDI profits are sent back to the investors' home countries. This means that the host country doesn't gain as much net capital (Arezki & Sy, 2016). This flow of money can reduce a country's foreign exchange reserves and put pressure on its finances, especially if it relies on debt in foreign currencies to pay for its growth (Ndikumana & Boyce, 2011). According to a report released by the World Bank in 2021, SSA countries with high levels of profit repatriation tend to have worsening fiscal

balances. This is because FDI does not always mean retained earnings or investments in the local economy.

The effectiveness of FDI in promoting fiscal sustainability is also contingent on governance quality and institutional strength. In many SSA countries, weak institutions and poor governance limit the positive effects of FDI, leading to inefficiencies and potential fiscal burdens (Asiedu, 2013; Ajayi & Ndikumana, 2015). Corruption, bureaucratic inefficiencies, and lack of transparency in investment deals can result in situations where FDI does not contribute meaningfully to tax revenue but instead fosters rent-seeking behavior and capital flight. In extreme cases, poorly managed FDI projects may even increase public expenditures, as governments are forced to finance infrastructure and services that benefit foreign investors at the expense of domestic needs. This observation is not unexpected, as SSA countries often exhibit underdeveloped political systems and poor fiscal discipline. The majority of individuals addressing macroeconomic issues are politicians with limited or no knowledge of fiscal policy sustainability and most times are driven by their own selfish interests (Olatunde et al, 2019).

Additionally, the nature of FDI received by SSA nations significantly influences its budgetary implications. Many FDIs in SSA go to extractive industries like oil, gas, and mining, which need a lot of capital to run and don't create many jobs (Besada, 2013, Robert, 2015). This sector-specific investment framework frequently leads to enclave/island economies, wherein foreign enterprises function independently from the wider economy, yielding little contributions to domestic revenue production. Moreover a lot of investors in the extractive sector work out special deals that let them bring back gains without having to pay a lot of taxes on them, which makes the economy even less

stable (Collier & Venables, 2008). In this regard SSA countries should therefore prioritize productive FDI sectors—such as manufacturing, technology, and services—rather than extractive industries; they can increase job creation, skills development, and technology transfer, fostering sustainable economic growth (SDG 8) (Asiedu, 2013).

The negative relationship between FDI and fiscal sustainability presents a challenge to SSA's ability to finance poverty alleviation programs. Although FDI is a type of international economic cooperation, the results imply that poor governance and too high profit repatriation cause many SSA nations to find it difficult to maximize the benefits of foreign investment. Strengthening regional economic integration, negotiating fair investment agreements, and promoting partnerships between domestic and foreign firms can help SSA harness FDI for sustainable development (Arezki & Sy, 2016).

Table 4.12: Summary Table for Hierarchical Regression models

Fiscal sustainability	Model 1 Coef.	Model 2 Coef.
CONSTANT	-5.336(0.983)	-1.026(0.919)
GDP	-0.453(0.061) **	-0.399(0.054) **
Human capital	0.026(.007) **	0.0127(0.006) **
Population	1.412(0.193) **	0.538(0.182) **
Inflation	0.198(0.032) **	0.121(0.028) **
Climate change	-	0.410(0.051) **
Institutional quality	-	-0.063(0.024) **
Foreign exchange	-	0.777(0.064) **
Foreign direct investment	-	-0.538(0.136) **
sigma_u	0.43347404	0.35376094
sigma_e	0.3117869	0.26866371
Rho	0.6590411	0.63421026
R^2	0.0314	0.2244
Δ-R^2	-	0.193
Chi2	30.94	62.17
Prob> Chi2	0.0000	0.0000
No obs	989	989

Source : Researcher 2024

Table 4.13: Summary Results of Hypotheses Tests

Hypotheses	β	P<5%	DECISION
H_{01}: Climate change has no significant effect on fiscal sustainability in SSA	0.4098	0.000	Rejected
H_{02}: Institutional quality does not significantly influence fiscal sustainability in SSA	-0.0631	0.009	Rejected
H_{03}: Foreign exchange rate does not have a significant impact on fiscal sustainability in SSA	0.7773	0.000	Rejected
H_{04}: FDI has no significant influence on fiscal sustainability in SSA	-0.5381	0.000	Rejected

Source: Researcher 2024

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter includes a summary of the findings, a conclusion, recommendations, limitations of the study, and areas for future research.

5.1 Summary of findings of the study

The general objective of the study was to analyze the relationships between climate change, foreign exchange rates, institutional quality, foreign direct investment, and fiscal sustainability in Sub Saharan Africa. The independent variables consisted of climate change, foreign exchange rates, institutional quality, foreign direct investment and the dependent variable fiscal sustainability. The target population comprised all Sub-Saharan Africa States. The study period spanned from 2000 until 2023

The study found that climate change and foreign exchange rate had a positive and significant influence on fiscal sustainability while institutional quality and foreign direct investment had a negative influence.

5.1.1 Effect of climate change on fiscal sustainability

The first objective of the study was to evaluate the effect of climate change on fiscal sustainability. The study found a positive and significant effect in both the fixed effect and System GMM models, suggesting that climate change, if managed with proper adaptation and mitigation policies, can stimulate positive fiscal outcomes. Managing climate-related risks reduces economic shocks, stabilizes revenue flows, and lowers disaster recovery costs (Abidoye & Odusola, 2015). Many SSA countries are highly vulnerable to climate change due to reliance on climate-sensitive sectors, which increases government spending on climate adaptation and infrastructure resilience. The

study highlights that proactive investments in sustainable agriculture, energy, and water systems can promote fiscal stability. This finding aligns with literature on the importance of climate resilience in improving fiscal outcomes (Stern, 2007; Kessler, 2019; Rafaty, 2018). The study's findings are relevant to the UN Sustainable Development Goals, particularly SDGs 13, 8, and 17, emphasizing climate action, sustainable growth, and international cooperation.

5.1.2 Effect of institutional quality on fiscal sustainability

The second objective of the study sought to determine the influence of institutional quality on fiscal sustainability in Sub-Saharan Africa (SSA). The study found a negative relationship, highlighting that weak institutions undermine fiscal sustainability by fostering corruption, inefficiency, and mismanagement of public resources. Many SSA countries face structural challenges like poor governance, corruption, and inefficiencies in public financial management, which diminish tax revenues and amplify budgetary inefficiencies (Nguyen & Luong, 2021). Countries like Angola and Nigeria have struggled with governance issues that compromise fiscal discipline despite abundant natural resources (Collier, 2007; Wiig & Kolstad, 2010). Weak institutions hinder the effective allocation of funds, which impedes both fiscal sustainability and broader developmental goals (Acemoglu & Robinson, 2012). These findings are relevant to SDG 16 (Peace, Justice, and Strong Institutions) and SDG 17 (Partnerships for the Goals), showing that poor institutional frameworks erode trust, hinder domestic resource mobilization, and exacerbate social inequalities (IMF, 2019; Transparency International, 2023).

5.1.3 Effect of Foreign Exchange Rate on fiscal sustainability

The study's third objective examined how foreign exchange rates impact fiscal sustainability in Sub-Saharan Africa (SSA). Findings indicate a positive and significant relationship, reinforcing economic theories that stable exchange rates lower external debt servicing costs and enhance investor confidence (Nabieu et al., 2020). Many SSA nations hold substantial foreign debt, making them vulnerable to currency depreciation, which increases repayment costs and fiscal deficits (Aizenman, 2020). Exchange rate stability mitigates these risks, ensuring predictable debt costs and improving fiscal sustainability (Reinhart & Rogoff, 2010). SSA economies are highly susceptible to external shocks, including commodity price fluctuations and capital flow changes. Countries with stable exchange rates are better equipped to withstand these shocks, reducing the likelihood of fiscal crises (World Bank, 2021). Furthermore, stability allows governments to distribute money to social initiatives, thereby alleviating poverty and promoting economic progress (Aizenman, 2020). Moreover, stable currency rate foster investments, enhances employment, and promote industrialization, hence advancing SDG 8 and SDG 9 (UNECA, 2021).

5.1.4 Effect of Foreign Direct Investment on fiscal sustainability

The fourth objective of the study analyzed the influence of Foreign Direct Investment (FDI) on fiscal sustainability in Sub-Saharan Africa (SSA). The findings reveal a significant negative relationship, contradicting the prevailing notion that foreign direct investment (FDI) enhances government finances through the attraction of foreign capital, job creation, and revenue expansion. This is due to extensive tax incentives, such as reduced corporate tax rates and import duty exemptions, which attract FDI but cause revenue losses, weakening fiscal stability (Wang et al., 2013; Klemm & Van Parys, 2012). Additionally, a large portion of FDI profits is repatriated to investors'

home countries rather than reinvested locally, depleting foreign exchange reserves and increasing fiscal pressure, particularly for nations reliant on foreign-denominated debt (Arezki & Sy, 2016; Ndikumana & Boyce, 2011). Governance weaknesses further reduce FDI's benefits, as corruption and inefficiencies limit revenue contributions (Asiedu, 2013; Ajayi & Ndikumana, 2015). Most FDI targets extractive industries, which generate little employment and tax revenue (Besada, 2013; Robert, 2015). To improve fiscal sustainability, SSA should prioritize FDI in productive sectors like manufacturing and technology, strengthen economic integration, and negotiate fairer investment agreements (Asiedu, 2013; Arezki & Sy, 2016).

5.2 Theoretical Reflection

Keynesian Theory: The study's results about climate change and inflation are in line with Keynesian economics, which says that the government should step in to keep the economy stable. When climate change is handled well by investing in resilience, it can have positive effects that are in line with Keynesian ideas of proactive fiscal policy. SSA countries can lower the long-term costs of climate change and keep their budgets in good shape by engaging in adaptation and mitigation. The results also show that modest inflation can boost economic activity and bring in more money for the government. This is in line with Keynes's ideas about using inflation to boost demand.

Debt Overhang Theory: The findings of the study regarding foreign exchange rates and foreign direct investment align with the debt overhang theory, which suggests that high levels of external debt can constrain a nation's growth and development potential. Stable exchange rates decrease the costs associated with servicing foreign-denominated debt, thereby alleviating the risks linked to debt overhang. The negative impacts of foreign direct investment, particularly through tax incentives and profit repatriation, correspond

with the debt overhang theory by depleting capital that could otherwise enhance fiscal stability.

Institutional Theory: The findings regarding institutional quality are closely aligned with institutional theory, emphasizing the significance of robust institutions for sustainable economic and fiscal results. Inadequate institutions compromise fiscal sustainability by restricting the government's capacity to generate revenue, manage public resources effectively, and mitigate corruption. The findings of the study underscore the necessity for institutional reforms in Sub-Saharan Africa to enable governments to manage fiscal policy effectively, mitigate corruption, and enhance public financial management systems, thereby promoting sustainable economic growth.

Environmental Kuznets Curve (EKC): The EKC posits that as economies grow, environmental degradation initially increases but later decreases as income per capita rises, and nations invest in cleaner technologies. Fiscal sustainability is an element of economic growth meaning investment in cleaner technologies cannot happen without fiscal health therefore the relationship between climate change and fiscal sustainability can also be understood through the lens of the Environmental Kuznets Curve (EKC). While the study found that climate change initially presents risks to fiscal sustainability in SSA, the findings suggest that with increased investment in climate resilience, SSA countries could mitigate these risks, leading to better long-term fiscal outcomes. Climate change positively influencing fiscal sustainability may indicate a transition toward the downward side of the EKC, where the governments are using climate responsive fiscal measures. As SSA economies grow, the focus on green technologies and climate adaptation will help improve both environmental quality and fiscal sustainability.

5.3 Conclusion

Regression results not only showed strong links between various explanatory variables and fiscal sustainability, but also provided insight into how these factors play in shaping the fiscal health of SSA nations, which are among the most vulnerable to both climate-induced and economic shocks. The results suggest that while climate change, institutional quality, exchange rates, and FDI all present both risks and opportunities for fiscal stability, their impact is heavily dependent on how governments manage these variables.

One of the key findings of the study was the positive relationship between climate change and fiscal sustainability, contrary to the conventional view that climate change is merely a risk factor. The study showed that when SSA countries adopt effective climate adaptation and mitigation strategies, climate change can have a positive impact on fiscal sustainability. The research found that well-managed climate-related risks, such as flooding, drought, and other natural disasters, can stabilize government revenue flows, minimize disaster recovery costs, and reduce the likelihood of economic shocks. Countries that invest in resilient infrastructure, sustainable agriculture, and renewable energy systems tend to have better fiscal health as they can mitigate the impacts of climate disruptions and continue to fund critical public services. This finding aligns with the broader international discourse on climate change and its implications for sustainable development, particularly in the context of the United Nations' Sustainable Development Goals (SDGs), especially SDG 13 (Climate Action) and SDG 8 (Decent Work and Economic Growth). It also supports the notion that "greening" the economy—through investments in green technologies and climate-resilient infrastructure—can create long-term fiscal stability by attracting international climate finance and fostering sustainable economic growth.

The second major objective of the study, which focused on the impact of institutional quality on fiscal sustainability, revealed a negative relationship. The study found that weak institutions, marked by corruption, inefficiency, and mismanagement of public resources, significantly undermine fiscal stability in SSA. Poor governance not only reduces the effectiveness of public financial management but also hampers revenue generation efforts by diminishing tax compliance and increasing the scope for tax evasion. This creates a vicious cycle where low revenues lead to higher deficits, and the government's ability to finance essential services like education, healthcare, and infrastructure development is severely constrained. It is a major factor contributing to fiscal distress in developing economies hence limits SSA countries' ability to attract international investment and secure partnerships with foreign investors, thereby hindering economic growth and the achievement of broader developmental goals such as poverty alleviation and inclusive growth. The findings highlight the critical need for robust institutional reforms to enhance fiscal sustainability and promote long-term development in SSA. Countries must focus on strengthening public sector institutions, combating corruption, improving transparency, and fostering better governance to create a stable and conducive environment for sustainable development.

The positive relationship between exchange rate and fiscal sustainability suggested that SSA countries with stable exchange rates have better fiscal outcomes. This is because stable exchange rates lower the risks of foreign-denominated debt and boost investor confidence. Changes in the exchange rate, on the other hand, make fiscal problems worse by making it hard to predict how much external debt will cost and putting more pressure on government finances. This finding is particularly important in SSA, where many countries are heavily reliant on foreign debt and commodity exports. A depreciating currency increases the cost of repaying foreign debt, worsening fiscal

deficits and reducing the government's ability to fund essential public services. In contrast, countries with stable exchange rates are better equipped to mitigate external shocks such as fluctuations in global commodity prices and capital flows, which often lead to fiscal crises. Stability in exchange rates also contributes to economic resilience by fostering a business-friendly environment, promoting investments, and facilitating long-term economic growth. This highlights the importance of sound monetary and exchange rate policies for maintaining fiscal sustainability in SSA. Governments in the region need to adopt policies that stabilize their currencies and enhance macroeconomic resilience, which will not only reduce the risk of fiscal crises but also improve investor confidence, thus stimulating growth and job creation. Finally although foreign direct investment (FDI) is typically regarded as a catalyst for economic growth and development, the study revealed that in Sub-Saharan Africa (SSA), FDI frequently worsens fiscal imbalances instead of promoting fiscal sustainability. The research indicates that the adverse effects of FDI are partially attributable to the significant tax incentives provided by SSA nations to lure foreign investors, leading to considerable revenue losses. These incentives, such as tax exemptions and reduced corporate tax rates, often outweigh the benefits of FDI inflows, leading to deficits and increased borrowing. Additionally, a significant portion of FDI profits are repatriated to the investors' home countries, reducing the net capital inflows to the host country and putting further pressure on foreign exchange reserves. This outflow of capital is particularly problematic for countries that rely on foreign debt to finance their development, as it exacerbates the burden of external debt. The study also found that much of the FDI in SSA is directed towards extractive industries such as oil, gas, and mining, which require large capital investments but offer limited job creation and contribute minimally to domestic revenue generation. The enclave nature of these

industries means that foreign enterprises operate in isolation from the broader economy, which further limits the fiscal benefits of FDI. According to the research analyses, it appears that our results are in alignment with Keynesian and institutional theory arguments for explaining the logic behind why government should intervene. The study emphasizes the need for governments in SSA countries to reform their FDI strategies by focusing on attracting investments in sectors that promote job creation, technology transfer, and sustainable development, such as manufacturing and services.

In a nutshell, by adopting effective climate adaptation strategies, strengthening governance frameworks, ensuring exchange rate stability, and focusing on productive FDI sectors, SSA countries can improve their fiscal health, enhance economic growth, and achieve sustainable development. However, these efforts require strong political will, sound economic policies, and international cooperation. By addressing the challenges identified in this study, SSA countries can lay the foundation for long-term fiscal stability, economic growth, and social development.

5.4 Policy Recommendations

This study urges policymakers to prioritize investments in **climate adaptation and mitigation strategies**, such as resilient infrastructure, sustainable agriculture, and renewable energy projects. These investments can reduce the long-term costs of climate-related disasters, stabilize revenue flows, and mitigate fiscal risks associated with environmental shocks. By aligning fiscal policy with climate resilience goals, countries can better navigate the challenges posed by climate change while fostering long-term economic growth. In addition, policymakers should explore issuing green bonds and attracting international climate finance to fund sustainability projects. This will reduce the fiscal burden on the state and ensure steady financing for climate-related

initiatives. Implement policies that promote climate-smart agriculture, especially in economies reliant on agriculture. By enhancing agricultural resilience, SSA countries can stabilize rural incomes and government revenues, while also ensuring food security. On the other hand, effective governance is crucial for fiscal sustainability. Governments in SSA should implement **institutional reforms** aimed at improving transparency, reducing corruption, and enhancing public financial management systems. Strengthening tax compliance, increasing revenue mobilization, and improving resource allocation are key strategies to ensure that governments can meet their fiscal obligations without undermining long-term development objectives. Policymakers should also work on building **stronger institutional frameworks** to attract foreign investment and reduce the inefficiencies in public spending that often undermine fiscal health. Key policies should include; Implementation of comprehensive reforms in public financial management to enhance budgeting, expenditure control, and revenue collection. Improved transparency in fiscal accounts and debt management will help prevent corruption and inefficiencies. Strengthen anti-corruption frameworks by establishing independent anti-corruption commissions and ensuring the judiciary is capable of addressing corruption cases transparently. Fighting corruption will improve the efficiency of public spending and increase government revenues. Invest in training programs for public sector employees, particularly in key areas like financial management, procurement, and regulatory oversight. A skilled and accountable bureaucracy will reduce wastage of public funds and improve fiscal sustainability. The robust institutions will also come in handy in ensuring the stability of foreign exchange rate and boost investors' confidence. Additionally, the policy makers should strengthen** foreign reserve management **to ensure that countries have adequate reserves to intervene in the foreign exchange market, when necessary, as well reduce

dependency on foreign-denominated debt; Countries should aim to minimize their exposure to foreign-denominated debt by developing domestic capital markets and issuing debt in local currencies whenever possible. This of course calls for adoption flexible exchange rate regimes which will reduce exchange rate risks and improve fiscal sustainability.

The negative relationship between FDI and fiscal sustainability highlights the need for more carefully managed FDI policies, especially in extractive sectors. While FDI can bring growth opportunities, it is essential to ensure that the benefits are shared broadly and contribute to government revenues rather than capital flight or tax incentives that reduce fiscal space. To maximize the fiscal benefits of FDI, policymakers may reform their policies to attract investments that contribute to **long-term growth** and **sustainable development**. This involves focusing on **non-extractive sectors** such as manufacturing, technology, and services, which are more likely to create jobs and contribute significantly to local tax revenue. Furthermore, governments should carefully review and rationalize tax incentives offered to foreign investors. While incentives can attract FDI, they often reduce the tax base and fiscal revenues in the long term. Policies should ensure that incentives are time-limited, sector-specific, and tied to clear development goals. Most importantly, strengthen local linkages: Policies should encourage FDI that integrates with local supply chains and promotes knowledge and technology transfer. This will enhance local capacities and reduce the reliance on capital outflows that negatively affect fiscal sustainability.

As SSA countries continue to grow economically, they should adopt the principles of the Environmental Kuznets Curve (EKC) by promoting green technologies and sustainable industrial practices. Investing in renewable energy, efficient resource

management, and environmentally friendly production methods will not only contribute to environmental sustainability but also help mitigate the fiscal risks associated with climate change. Governments should provide incentives for businesses to adopt clean technologies and integrate environmental considerations into their fiscal policies to promote both fiscal and environmental health. In conclusion, fiscal sustainability being a challenge in SSA, governments need to adopt fiscal policies that strike a balance between fostering growth and maintaining debt sustainability. SSA countries must implement and adhere to debt sustainability frameworks that limit excessive borrowing. Debt transparency should be prioritized, with clear mechanisms for reporting and monitoring public debt to avoid unsustainable debt accumulation.

5.5 Limitations of the study and suggestions for further research

This study has several limitations. First, this study was limited to SSA region, which, while valuable for regional analysis, does not provide insights into fiscal sustainability trends in other emerging economies. This limits the broader applicability of the findings to other regions with different economic and institutional structures. Therefore, future studies can extend beyond SSA to incorporate other emerging regions and allow for comparative analysis. Secondly, major limitation was the lack of comprehensive data for some Sub-Saharan African (SSA) countries, such as Somalia, Djibouti, Namibia and South Sudan. The unavailability of reliable and consistent data for these nations may have affected the generalizability of the findings, as certain regional dynamics were not fully captured. Thirdly, the study used only four key variables to examine fiscal sustainability thus for future research, researchers could expand the scope by including additional independent variables influencing fiscal sustainability such as population growth, human capital, and inflation. These factors have been shown to

impact fiscal sustainability and could provide a more comprehensive understanding of fiscal policy in SSA.

Additionally, future studies may consider incorporating institutional quality as a moderating variable to assess whether the strength of governance systems alters the magnitude or direction of the effects that climate change, foreign exchange dynamics, and foreign direct investment exert on fiscal sustainability in Sub-Saharan Africa. This would provide deeper insights into the conditions under which macroeconomic and environmental factors either enhance or undermine fiscal stability in the region.

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APPENDICES

Appendix I: Stata Output

```
. hausman fe re
```

	Coefficients (b) fe	(B) re	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
GDP	-.3991105	-.3610553	-.0380552	.0222781
DINF	.121281	.1279239	-.0066429	.
HC	.0126945	.0130897	-.0003952	.0014182
WPP	.5375872	.3881299	.1494573	.12149
CEM	.4097996	.3511136	.0586859	.0279125
IQ3	-.0630974	-.0565754	-.006522	.0082834
FX	.7772738	.8175482	-.0402744	.008152
FDI4	-.5381266	-.5126753	-.0254513	.0080333

```
                b = consistent under Ho and Ha; obtained from xtreg
     B = inconsistent under Ha, efficient under Ho; obtained from xtreg

 Test:  Ho:  difference in coefficients not systematic

           chi2(8) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                   =       24.62
         Prob>chi2 =      0.0018
         (V_b-V_B is not positive definite)

.
```

```
. xtreg FSS GDP DINF HC WPP CEM IQ3 FX FDI4,fe

Fixed-effects (within) regression               Number of obs      =       989
Group variable: CountryID                       Number of groups   =        43

R-sq:                                           Obs per group:
     within  = 0.3465                                         min =        23
     between = 0.1741                                         avg =      23.0
     overall = 0.2244                                         max =        23

                                                F(8,938)           =     62.17
corr(u_i, Xb)  = -0.3663                        Prob > F           =    0.0000

------------------------------------------------------------------------------
         FSS |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         GDP |  -.3991105   .0540719    -7.38   0.000    -.5052263   -.2929947
        DINF |    .121281   .0281132     4.31   0.000     .0661089    .176453
          HC |   .0126945   .0058744     2.16   0.031      .001166    .024223
         WPP |   .5375872   .1816255     2.96   0.003     .1811477    .8940267
         CEM |   .4097996   .0509084     8.05   0.000     .3098921    .5097071
         IQ3 |  -.0630974   .0239384    -2.64   0.009    -.1100763   -.0161184
          FX |   .7772738   .0644117    12.07   0.000     .6508661    .9036816
        FDI4 |  -.5381266   .1361471    -3.95   0.000    -.8053147   -.2709385
       _cons |  -1.025814   .9193038    -1.12   0.265    -2.829944    .7783166
-------------+----------------------------------------------------------------
     sigma_u |  .35376094
     sigma_e |  .26866371
         rho |  .63421026   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0: F(42, 938) = 28.71                     Prob > F = 0.0000
```

Dynamic panel-data estimation, two-step system GMM

Group variable: CountryID		Number of obs	= 931
Time variable : Year		Number of groups	= 43
Number of instruments = 30		Obs per group: min	= 7
F(9, 42)	= 219.48	avg	= 21.65
Prob > F	= 0.000	max	= 22

FSS	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
FSS						
L1.	.2992311	.0431925	6.93	0.000	.2120651	.3863971
GDP	-.1368513	.0410246	-3.34	0.002	-.2196424	-.0540603
DINF	.0907304	.0233792	3.88	0.000	.0435492	.1379116
HC	-.0080999	.0027886	-2.90	0.006	-.0137275	-.0024722
WPP	-.0080089	.1159165	-0.07	0.945	-.2419378	.22592
CEM	.1367796	.0240013	5.70	0.000	.088343	.1852162
IQ3	-.0548397	.0199525	-2.75	0.009	-.0951053	-.014574
FX	.7740955	.044908	17.24	0.000	.6834675	.8647235
FDI4	-.2577359	.0606935	-4.25	0.000	-.3802204	-.1352514
_cons	1.137388	.4914124	2.31	0.026	.1456777	2.129098

Warning: Uncorrected two-step standard errors are unreliable.

Instruments for first differences equation
  Standard
    D.(DINF HC CEM IQ3 GDP FX FDI4 L.WPP L.GDP L.DINF L.HC L.CEM L.IQ3 L.FX
    L.FDI4)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L2.(LD.FSS LD.FDI4 LD.GDP LD.IQ3 LD.FX LD.CEM LD.HC) collapsed
Instruments for levels equation
  Standard
    DINF HC CEM IQ3 GDP FX FDI4 L.WPP L.GDP L.DINF L.HC L.CEM L.IQ3 L.FX
    L.FDI4
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    DL.(LD.FSS LD.FDI4 LD.GDP LD.IQ3 LD.FX LD.CEM LD.HC) collapsed

Arellano-Bond test for AR(1) in first differences: z = -4.46 Pr > z = 0.000
Arellano-Bond test for AR(2) in first differences: z = 0.54 Pr > z = 0.592

Sargan test of overid. restrictions: chi2(20) = 64.76 Prob > chi2 = 0.000
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(20) = 19.16 Prob > chi2 = 0.511
  (Robust, but weakened by many instruments.)

Appendix II: Data Collection Schedule

Variable / Years	1 Climate change	2 Institutional Quality	3 FDI	4 Foreign Exchange Rate	5 Population	6 Inflation	7 Economic Growth	8 Human Capital	9 Fiscal sustainability
2000									
2001									
2002									
2003									
2004									
2005									
2006									
2007									
2008									
2009									
2010									
2011									
2012									
2013									
2014									
2015									
2016									
2017									
2018									
2019									
2020									
2021									
2022									
2023									

Appendix III: Introduction Letter

MOI UNIVERSITY
POSTGRADUATE OFFICE
SCHOOL OF BUSINESS AND ECONOMICS

Tel: 0790940508
0771336914
0736138770
Fax No: (053) 43047
Email: sbepostgraduate@mu.ac.ke

P.O. Box 3900
Eldoret.
Kenya

RE: MU/SBE/PGR/ACD/21B

DATE: 15th May, 2024

TO WHOM IT MAY CONCERN:

RE: KINUTHIA RAHAB WANJIKU– SBE/ECON/5534/20

The above named is a bonafide student of Moi University, School of Business & Economics. She is pursuing **Doctor of Philosophy in Economics** Degree.

Ms. Wanjiku successfully completed coursework and has defended her proposal at both Departmental and School Levels. She is proceeding to the field to collect data for her research titled: "***Climate Change, Institution Quality, Foreign Exchange, Foreign Direct Investment and Fiscal Sustainability in Sub-Saharan Africa***"

Any assistance accorded to her will be highly appreciated.

Yours faithfully,

SCHOOL OF BUSINESS & ECONOMICS
MOI UNIVERSITY
P.O Box 3900 ELDORET 30100

PROF. RONALD BONUKE
ASSOCIATE DEAN AND CHAIR-POSTGRADUATE STUDIES

/pn

Appendix IV: Plagiarism Awareness Certificate

SR868

ISO 9001:2019 Certified Institution

THESIS WRITING COURSE

PLAGIARISM AWARENESS CERTIFICATE

This certificate is awarded to

KINUTHIA RAHAB WANJIKU

PHD/ECON/5534/20

In recognition for passing the University's plagiarism

Awareness test for Thesis **entitled**: **CLIMATE CHANGE, INSTITUTIONAL QUALITY, FOREIGN EXCHANGE, FOREIGN DIRECT INVESTMENT AND FISCAL SUSTAINABILITY IN SUB-SAHARAN AFRICA with** similarity index of 12% and striving to maintain academic integrity.

Word count: 51955

Awarded by

Prof. Anne Syomwene Kisilu CERM-ESA

Project Leader Date: 09/06/2025