Fiscal Sustainability in Sub-Saharan Africa: The Effects of Climate Change, Institutional Quality, Foreign Exchange Rate and Foreign Direct Investment

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DOI: https://dx.doi.org/10.47772/IJRISS.2025.906000142

Received: 23 May 2025; Accepted: 29 May 2025; Published: 03 July 2025

ABSTRACT

Purpose

This paper empirically analyses the effect of climate change, institutional quality, foreign exchange rate and foreign direct investment on fiscal sustainability in Sub-Saharan Africa (SSA).

Design/methodology/approach

The study is based on 989 country-year observations from 43 SSA countries spanning 2000 to 2023. A fixed effects model was employed to analyze the panel data, while the Generalized Method of Moments (GMM) was used to validate the regression results and address potential endogeneity.

Research findings

The findings challenge conventional expectations. Climate change shows a statistically significant positive effect on fiscal sustainability, suggesting that with effective adaptation and mitigation strategies, it can generate fiscal benefits. Institutional quality has a significant negative relationship, highlighting how weak institutions erode fiscal performance through corruption and inefficiency. A stable foreign exchange rate positively influences fiscal sustainability by reducing external debt risks. Conversely, FDI shows a negative impact, suggesting that in the presence of weak regulatory frameworks, it may contribute to revenue losses via tax avoidance and capital outflows.

Practical implications

The results offer important insights for policymakers, investors, and regulators. Policymakers in SSA should prioritize climate adaptation and mitigation investments—such as resilient infrastructure, sustainable agriculture, and renewable energy—to reduce long-term disaster costs and stabilize fiscal performance. Institutional reforms and stronger public financial management systems are also essential for improving fiscal outcomes and attracting quality investment. Additionally, SSA governments should re-evaluate tax incentives, promote investment in non-extractive sectors, and strengthen domestic economic linkages.

Originality/value

This study contributes to the growing literature on fiscal sustainability by offering empirical evidence on the roles of climate change, institutional quality, exchange rates, and FDI in a developing region context, where these interrelations remain underexplored

INTRODUCTION

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 (Chen 2020, Chemnyongoi & Kiriga 2020).

Nabieu et al., 2020 argue that fiscal sustainability remains a persistent concern for Sub-Saharan African (SSA) economies amid high debt burdens, limited revenue bases, and rising global uncertainties. As of 2023, over twenty two countries in the region were at high risk of debt distress (up from 20 in 2020) (World Bank, 2023). Despite the numerous support and economic bailout that Sub Saharan Africa received, through Heavily Indebted Poor Countries (HIPC) debt relief initiative and the Multilateral Debt Relief Initiative, 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) (IMF 2023). 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 interest load on public debt has escalated, diminishing resources for development financing, rising from a median of 4.6 percent of government revenues (excluding grants) at the close of 2012 to 10.4 percent by the end of 2022. In 34 sub-Saharan African countries, the proportion of government revenues (excluding grants) allocated to interest payments rose, with an increase exceeding 10 percentage points in 13 countries (IMF 2023).

The lack of fiscal sustainability poses numerous threats to a nation, endangering its economic health and social stability. Substantial and escalating debt loads might inhibit private investment, obstructing economic progress. This transpires when governments vie with enterprises for loanable capital, resulting in increased interest rates (OECD, 2023; Arteta et al., 2016). Moreover, governments may be compelled to reduce expenditures on vital services and infrastructure to fulfill debt obligations, so constraining economic potential and fiscal capacity, which hinders a government's ability to address economic recessions or unexpected occurrences.

The critical concern of national debt solvency, encountered by numerous nations alongside the global financial crisis of 2008, has ignited discourse on how countries can implement macroeconomic stabilisation policies while ensuring the sustainable growth of public debt (IMF, 2023; Efuntade e.t al., 2022; AJayi & Edewusi, 2020; Matuka & Asafo, 2018; Adesuyi & Falowo, 2013). Developing nations were profoundly impacted by the crisis, although not being its origin. The reduction in international trade led to significant budgetary imbalances for several of them (Collignon, 2012). Inefficiencies in state expenditure and deficiencies in revenue collecting procedures exacerbated the problem. Since 2009, fiscal balances have significantly deteriorated, raising concerns about the potential unsustainability of these nations' public finances when substantial investment is needed to meet shared climate and development goals (Schmidt & Shah, 2015; Chirambo, 2018).

One of the most critical external threats to fiscal stability in SSA is climate change. The region accounts for only 0.5 percent of total carbon dioxide emissions while bearing the greatest burden of climate change costs (Moss, 2020; IMF, 2017). These climatic shocks impose severe fiscal burdens on already resource-constrained governments, diverting public expenditures from development goals to emergency responses and recovery measures. The World Bank 2023 report, estimates that climate-related shocks alone could reduce GDP growth in SSA by 2-4% annually by 2030, further straining fiscal space. Climate change is having widespread and severe effects on Sub-Saharan Africa, a region highly vulnerable due to its reliance on rain-fed agriculture, limited resources, and fragile infrastructure. Rising temperatures, erratic rainfall, and extreme weather events are reducing crop yields, threatening food and water security, increasing the spread of diseases, reducing exports and household income, and infrastructural damages. These impacts are leading to higher levels of poverty, displacement, and conflict, while also putting pressure on health systems and economies (FAO, 2021). Moreover transition to low carbon requires significant investments making the cost of adaptation and mitigation efforts strain public budgets (Parrado et al., 2020).

Parallel to environmental concerns is the issue of institutional quality, which remains a structural weakness across many SSA nations. Empirical literature attributes the underdevelopment of Sub-Saharan Africa to inadequate institutional quality (Fagbemi, 2020; Erdogan & Acaravci, 2022). Governance indicators such as control of corruption, regulatory quality, and government effectiveness consistently rank low in the region, undermining both revenue mobilization and efficient public spending (World Governance Indicators, 2023). According to Kaufmann et al., (2010), poor institutional frameworks erode investor confidence, limit the absorption of external financial assistance, and exacerbate fiscal imbalances through mismanagement and leakages.

Moreover, foreign direct investment (FDI)—often seen as a stabilizing force in emerging economies—has shown inconsistent trends in SSA. While FDI can offer much-needed capital and tax revenue, yet resource-sector investments in SSA have often led to weak tax performance and capital flight (Okafor, 2014; Ofori, 2019). Advanced countries in Sub-Saharan Africa, such as South Africa, and Nigeria, have attracted substantial foreign direct investment. According to the World Bank (2018), foreign direct investment in Sub-Saharan Africa reached over $44 billion in 2022, a significant increase over previous years. However, there is no fiscal stability as a result of this investment boom. Its impact on fiscal sustainability is often contingent on the sectoral composition of investment and the regulatory environment (Asiedu, 2013; Ajayi & Ndikumana, 2015). For resource-rich SSA countries, FDI is frequently concentrated in extractive industries with limited spillovers into broader fiscal or economic development. Furthermore, in the absence of strong institutional oversight, FDI may contribute to capital flight, tax avoidance, or environmental degradation (Ndikumana, 2015, 2017). Additionally, 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 (Were 2024; Nandelenga 2021; Vito & Mario, 1988). When a country's currency depreciates, it can lead to higher import costs, which can increase government spending and worsen fiscal deficits (Cooper, 2019). For instance, between January 2022 and June 2023, currencies in countries like Ghana, Nigeria, and Malawi depreciated by over 20%, leading to higher debt servicing costs and depletion of foreign reserves as central banks intervened to stabilize their currencies. In SSA, the exchange rate pass-through to inflation is notably high; 1% depreciation against the US dollar can increase inflation by approximately 0.22 percentage points within a year. This effect is more pronounced during periods of depreciation than appreciation, making it challenging to control inflation once it accelerates. This can have implications for debt sustainability as increased borrowing may be necessary to cover the deficit (World Bank, 2018; Coulibaly et al 2019).

Despite the evident importance of these variables—climate change, institutional quality, foreign exchange rate and FDI—in shaping fiscal sustainability, existing literature tends to address them in isolation. A comprehensive analysis 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. For the rest of the paper, we proceed as follows. Section 2 discusses previous literature and hypotheses development. Section 3 introduces the research method. We present the results and discussion in Section 4. Section 5 concludes our research, and we provide limitations and future studies

EMPIRICAL LITERATURE

Climate change and Fiscal sustainability

Bachner & Bednar (2018) used a computable general equilibrium model to methodically investigate how climate change affects the expenditure and revenue components of public budgets across 10 different impact zones in Austria. The researchers next looked at several ways fiscal tools or foreign borrowing could balance cuts in public service provision as well as related effects on the whole economy. The researchers found that without counterbalancing, climate change's effects on government budgets are amplified since they comprise both direct expenditure effects and macroeconomic feedback effects lowering the whole income base. Fiscal policies' budgetary and macroeconomic consequences show significant differences under counterbalancing. Similarly, Yahaya et al. (2021) looked at how climate change affected budget balance and projected its consequences for fiscal policy in ECOWAS countries. A balanced panel dataset of 14 nations from 2008 to 2018 was analyzed using the two-step dynamic GMM method. The study found that the only weather factor aggravating budget deficits is rain. The growth of budget deficits was also influenced by other macroeconomic

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue VI June 2025

factors including inflation and the debt-to-GDP ratio. This study indicates that unanticipated and too heavy rain might upset the fiscal balance of ECOWAS countries by reducing income streams or raising costs. El-Morsy (2023) examined the correlation between climate change risks and macroeconomic policies, using Egypt as a case study. He assessed the impact of climate-related threats on fiscal health, governmental budgets, and economic growth. The study established that climate change significantly threatens macro-financial stability, affecting government spending, debt sustainability, and the valuation of financial assets.

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, Suresh et al. (2024) undertook a study looking at how floods and cyclones affect India's budget and economy at the subnational government level. This work created a physical disaster severity indicator to evaluate the impact on fiscal sustainability after disasters. By merging disaster intensity index and budgetary data from 1995 to 2018, the study created a panel dataset of 25 Indian states. Using Panel Vector Autoregression, the study found that floods and cyclones cause a state's overall government expenditure to rise and its budget deficit to worsen. Chen et al. (2023) investigated the impact of climate change on the financial obligations of the government. They examined fiscal data from Chinese local governments covering the period from 2000 to 2020. A review of county-level budgetary data in China demonstrated that each additional day of excessive temperatures annually leads to a CNY 0.002 billion increase in the overall public budget deficit. The increment represented 0.1093% of the municipal budgetary deficit. Lis & Nickel (2010) examined in their 2010 paper how severe weather affected budget balances in EU countries, OECD countries, and developing countries. Results including macroeconomic, financial, and political elements show that every country group responds differently in fiscal deficit to weather shocks. They show how much budget balances in emerging countries with young democracies and weak institutions are affected by extreme weather events. The results also show that budget balances were statistically significant and positively connected with actual GDP growth, inflation, and delayed changes in the debt ratio.

Recent empirical research shows that there is a nexus between climate change and sovereign creditworthiness. Agarwala et al. (2021) developed a taxonomy linking climate risks to sovereign fiscal risks; applied to UK case studies using macroeconomic modeling. Findings indicate that both physical and transition climate risks can significantly impact sovereign creditworthiness and debt sustainability. Nader (2023) further emphasize the link between natural disasters and sovereign debt, suggesting that climate change may exacerbate existing vulnerabilities. Cevik and Tovar-Jalles (2020) analyze the bond rates of 98 economies from 1995 onward and determine that climate vulnerability and preparedness affect governments' borrowing costs. A 1% increase in climate sensitivity raises the long-term government bond spreads of emerging economies by roughly 3%. Beirne et al. (2021) developed panel structural VAR models to analyze the impact of climate risk and cost of sovereign borrowing in Southeast Asia from 2002–2018. They discovered that for sovereign borrowing rates, susceptibility to the direct consequences of climate change is far more significant than climate risk resilience.

Additionally, 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. Beirne et al. (2024) investigated the relationship between fiscal space and climate risk across 199 economies over the period from 1990 to 2022. Using panel local projection methods, they analyzed how political stability and financial development influence the link between climate risk and fiscal space. Their findings revealed that climate-related threats negatively impact fiscal space, with the most vulnerable economies experiencing the greatest effects.

A comparative study by Zenios (2021) looked at the risks from climate change to sovereign debt using Italy as a case study. He established that climate change had adverse effect on debt dynamics; however it was difficult to make precise comparisons given that different study regions experience different climate conditions.

Based on the theoretical and empirical reviews, we formulate the following hypotheses:

Climate change has a significant effect on Fiscal sustainability in SSA

Institutional Quality and Fiscal Sustainability

Multiple researches have proven a positive relationship between institutional robustness and effective fiscal performance. Ahmad (2007) and Alt and Lassen (2006) discovered that enhancements in the rule of law and government effectiveness correlate with diminished budget deficits and lowered public debt levels. These findings highlight the essential role of institutional integrity in upholding fiscal discipline. Complementing this, Alesina and Perotti (1996) emphasized that countries with strong corruption control mechanisms tend to exhibit greater fiscal transparency and discipline, suggesting that institutional accountability helps limit rent-seeking behavior and inefficient spending.

Jalles (2011) conducted a comprehensive study of 72 developing countries from 1970 to 2005, focusing on institutional indicators such as democratic oversight and corruption control. The study concluded that lower corruption levels were strongly linked to improved debt management, reinforcing the idea that good governance is essential for favorable debt dynamics. Similarly, Beecroft et al. (2018), in their analysis of 15 West African countries from 1996 to 2012, found that institutional quality—particularly regulatory effectiveness—significantly enhances fiscal performance by limiting political capture and curbing excessive spending. Weak institutional frameworks, by contrast, were associated with larger fiscal deficits and diminished economic development.

Examining the influence of institutional quality on public debt across 27 transition countries from 2000 to 2018, Nguyen and Luong (2021) provide more understanding. Using several econometric methods including two-step GMM and OLS, their research found that poor governance, particularly in relation to corruption control, causes more debt build-up. Interestingly, they also discovered that institutional improvements after regime changes occasionally matched with short-term rises in public debt, suggesting the transitory complexity of institutional growth.

At the national level, Abdullahi and Jibril (2024) used a threshold regression approach with Nigerian data from 1993 to 2022 to analyze the interplay between rule of law, corruption, and debt sustainability. Their findings showed that while higher rule of law is linked with lower debt levels, corruption greatly aggravates public debt when it crosses a particular threshold. These results support the case that institutional quality is a key factor of fiscal resilience.

Hunjra et al. (2023) widened the range by connecting institutional quality with more general sustainability measures across 65 developing countries from 1984 to 2019. Although institutional strength was positively connected to economic sustainability, it had a negative correlation with CO_2 emissions and was not successful in reducing deforestation. Though environmental issues like forest management stayed less susceptible to these institutional variables, political stability, administrative capability, and system accountability were discovered to significantly influence sustainable development results.

Fagbemi (2020), concentrating particularly on West Africa, contended that although long-term fiscal sustainability depends on excellent governance and democratic responsibility, institutional signs by themselves are not great predictors of short-term fiscal success. Nonetheless, the study supports the ongoing improvement of governance systems to improve policy efficacy and economic prudence. Digdowiseiso (2023) underlined in a related way that the degree of institutional arrangements has a major impact on successful fiscal decentralization in developing nations, hence supporting the more general relevance of governance in fiscal results.

Although robust institutions typically foster budgetary sustainability, specific problems may compromise their efficacy. Research conducted by Acemuglo and Robinson (2019) and Robinson and Torvik (2011) underscores the possible impact of vested interests and elite capture, resulting in policy choices that favor immediate political advantages at the expense of long-term economic stability.

Based on the theoretical and empirical reviews, we formulate the following hypotheses:

Institutional quality has a significant effect on Fiscal sustainability in SSA

Foreign Exchange Rate and Fiscal Sustainability

The empirical correlation between foreign exchange rate fluctuations and fiscal sustainability has garnered significant scholarly interest, particularly in the context of developing and rising nations. Researchers agree that variations in exchange rates can profoundly affect fiscal indicators, similarly to how fiscal imbalances can exert pressure on exchange rate regimes. Baldacci et al. (2008) demonstrate that depreciation of exchange rates typically worsens fiscal balances, particularly in nations encumbered by significant foreign-denominated debt. The primary reason is that a depreciated home currency escalates the expense of repaying foreign debt, thereby exacerbating fiscal deficits. Alesina et al. (2001) substantiate this perspective by demonstrating that economies exhibiting strong exchange rate pass-through are more vulnerable to fiscal constraints during depreciation phases, as inflation and nominal depreciation rapidly result in increased government expenditures. Similarly according to Cavallo et al. (2002), an economy's foreign currency-denominated debt generates changes in the exchange rate, affects capital inflows and outflows, and pushes national output during the crisis phase.

Building on this, the literature often references the "twin deficits" hypothesis, which posits a direct link between fiscal deficits and current account deficits. Kim and Roubini (2008), using a structural VAR model, conclude that expanding fiscal deficits may cause real exchange rate appreciation in the short run due to surging domestic demand. However, over the longer term, this appreciation is often reversed, undermining export competitiveness and thereby affecting fiscal performance negatively. In efforts to assess fiscal sustainability empirically, researchers often turn to frameworks like Bohn's (1998) model, which tests whether governments react to rising debt-to-GDP ratios by adjusting primary surpluses. Mendoza and Ostry (2008) extended this framework by incorporating exchange rate shocks, concluding that such shocks could undermine fiscal solvency unless met with strong policy responses.

According to Ekananda (2017), the value of one currency in relation to other currencies plays a significant influence in consumer spending decisions due to the fact that it provides a common language for comparing pricing across different countries. The amount of a country's foreign debt, which is paid back in foreign currency according to the currency of the country that loaned it, can also be determined by the exchange rate. Fida et al. (2012) employed the Johansen cointegration method to examine the long-term co-integration between foreign debt and exchange rate, validating their enduring link using VAR and cointegration, thereby demonstrating a robust association between the two variables.

Based on the theoretical and empirical reviews, we formulate the following hypotheses:

H3. Foreign Exchange Rate has a significant effect on Fiscal sustainability in SSA

Foreign Direct Investment and Fiscal Sustainability

Empirical investigations into the relationship between foreign direct investment (FDI) and fiscal sustainability in emerging markets and developing economies have expanded significantly over the past two decades. Increasingly, researchers emphasize the dual dimensions of FDI—quantity (volume or stock of inflows) and quality (sectorial composition, origin, and value-added potential)—as essential to understanding how FDI influences fiscal outcomes. Numerous studies have explored the macroeconomic implications of FDI volumes for fiscal health in Sub-Saharan Africa (SSA).

Akinlo (2004) examined the impact of FDI on economic growth in Nigeria from 1970 to 2001. The error correction model (ECM) results indicated that both private capital and lagged foreign capital had minimal and statistically insignificant effects on economic growth. These findings support the view that extractive FDI contributes less to growth than FDI in the manufacturing sector. Although FDI significantly influences GDP, its direct link to fiscal sustainability depends largely on institutional capacity and the macroeconomic policy environment. Similarly, Anyanwu (2012) found that higher FDI inflows are often associated with improved tax revenues, driven by the expansion of formal economic activities. This, in turn, can alleviate fiscal pressures—especially in contexts where the rule of law is strong, further encouraging FDI. From 2004 to 2012, Balikcioglu et al. (2016) analyzed the impact of FDI on corporate tax payments in Turkey and concluded that FDI positively influenced tax compliance and revenue. Binha (2021) reported similar findings, demonstrating

that in Zimbabwe, FDI significantly enhanced tax revenue growth. One explanation for this is that technology spillovers from FDI improved the productivity of local enterprises.

Asiedu (2006) explored how macroeconomic instability, investment restrictions, corruption, and political instability affected FDI in Africa. Using panel data from 22 countries spanning 1984 to 2000, the study found that while natural resources and market size promoted FDI, other factors such as low inflation, quality infrastructure, an educated workforce, openness to foreign investment, reduced corruption, political stability, and a sound legal system also played critical roles. The research concluded that even resource-poor countries can attract FDI by enhancing institutional quality and improving their policy frameworks. Wako (2018) found that economic growth, institutional quality, and natural resource endowments all positively influenced FDI attraction. However, institutional quality was both a determinant and an outcome: economic growth improved institutional quality, while FDI was found to increase corruption and erode the rule of law. The study introduced the notion of an institutional resource curse, suggesting that while FDI can spur growth, it may also contribute to deindustrialization and institutional degradation. Therefore, attracting FDI requires careful policy consideration to balance its benefits against potential long-term risks.

Diallo et al. (2021) examined FDI inflows in Sub-Saharan Africa from 1980 to 2017 and identified a long-term crowding-in effect: a 1% increase in FDI (as a share of GDP) was associated with a 0.3% rise in private domestic investment. However, the realization of this potential is often hindered by budget deficits, debt accumulation, political instability, and corruption. Kubaje et al. (2024), using a fixed effects model, found that FDI had a strong positive impact on GDP growth. However, tax revenue as a share of GDP had no statistically significant effect. Their dynamic threshold model suggested that tax revenues contribute to economic growth only up to a certain point, beyond which they may become detrimental. The study concluded that developing African economies should simultaneously pursue FDI and reform their tax structures to achieve sustainable economic growth. Heid and Marquez (2019) examined the impact of fiscal discipline on foreign direct investment (FDI) stocks in over 150 countries between 2001 and 2011. They used the budget balance and the public debt-to-GDP ratio as primary metrics. To evaluate country-specific characteristics, they devised a unique approach that incorporated domestic and foreign direct investment data. The findings revealed that continuous budgetary discipline was strongly connected with FDI stocks, while fiscally unsustainable policies did not influence their decline.

Based on the theoretical and empirical reviews, we formulate the following hypotheses:

FDI has a significant effect on Fiscal sustainability in SSA

Research Design

Sample size and data

This study examined the economic phenomena in Sub-Saharan Africa, concentrating on 42 nations from 2000 to 2023. The sample size was established based on the number of sovereign republics and the availability of extensive data. Secondary data was obtained from credible source; the World Bank database. The final dataset is of comprising 989 country-year observations. This substantial dataset offers a solid basis for study, enabling a thorough comprehension of the economic processes being studied in the context of Sub-Saharan Africa. This time span was chosen so that the study can capture patterns and trends that are pertinent to the region's recent economic developments and difficulties.

Measurement of variables

The variables used in this study are presented in Table 1.

Table 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	World Bank	CO_2 Emission metric tons to GDP ratio
Institutional Quality	Independent variable	IQ	World Bank	Governance -composite Index
Foreign exchange rate	Independent Variable	FX	World Bank	Local currency to USD Rate
Foreign Direc Investment	Independent variable	FDI	World Bank	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

Regression models

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.

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

Testing the effect of control variables on Fiscal sustainability.

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

Testing the effect of independent variable on fiscal sustainability.

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

FINDINGS AND DISCUSSION

Descriptive statistics

The descriptive statistics for the research variable over the period 2000 to 2023 are presented in table 2 as shown below.

Table 2: Summary Descriptive Statistics

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
HC	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

Fiscal Sustainability has a mean value of 3.12 indicating low fiscal health. A relatively high standard deviation of 5.06 indicates substantial variation in fiscal sustainability among the observations. The minimum value of 0.005 and the maximum value of 59.67 highlight significant differences across countries in terms of fiscal health. This variability can be attributed to changes in debt levels, revenue generation, and expenditure management, which result in various fiscal circumstances Kumar & Baldacci (2010).

The mean of climate change was 47061.11, with a minimum of 53.5, a maximum of 833713.8, and a standard deviation of 154676.7. A mean of 47,061 and a substantial standard deviation of 154,676 signify considerable variations in the adverse effects of climate change. A range from 53.5 to 833,713 indicates that certain areas are more severely affected by climate change hence suffers severe economic and societal repercussions.

The mean institutional quality was -0.7657887, with a minimum of -2.224527, a maximum of 1.044383, and a standard deviation of 0.6615381. The negative mean value for institutional quality (-0.7657887) indicates that, on average, the institutions in the panel fall below a neutral or positive standard, potentially reflecting difficulties in institutional environments, governance, rule of law, or corruption control. The interval from -2.224527 to 1.044383 indicates that although certain countries exhibit markedly superior performance, numerous others are hindered by inadequate institutional quality, which obstructs development.

The average foreign exchange rate is projected at 13.8 million local currency per USD, accompanied by a substantial standard deviation of 224 million, signifying considerable regional variability. The minimum exchange rate is 0.0445, indicating that certain countries possess stable or stronger currencies, whilst the maximum is 6.72 billion, presumably indicative of Zimbabwe's hyperinflation and currency devaluation. This significant variation underscores the disparities in currency stability between nations, especially during periods of economic upheaval.

The mean of foreign direct investment (FDI) is -76,086.46, with a fairly large standard deviation of 1,704,399. Foreign Direct Investment inflows range from -4.23e+07 to 103.34 demonstrating significant variation, with some nations experiencing huge capital flight and others receiving large investments. Ironically, Ghana is one of the countries receiving substantial inflows while also being one of the most distressed.

The average economic growth was 60.6 billion, accompanied by a substantial standard deviation of 224 billion, signifying considerable variability in economic sizes within the sample. The spectrum of economic growth ranges from 76 million to 2.06 trillion, highlighting the contrasts between developed and less developed nations. The variability in economic growth significantly affects fiscal sustainability, as economic recessions may worsen fiscal difficulties by reducing tax collections and elevating debt levels (Baharumshah et al., 2017).

Human Capital, proxied by health expenditure has a mean value of 5.26, with a standard deviation of 2.32. This indicates moderate variability in health expenditure across the sample. The minimum value of 1.47 suggests that some countries invest very little in health, while the maximum value of 22.2 indicates a relatively high level of investment in human capital in certain countries especially after covid-19 outbreak.

Population has a mean value of 20.8 million, but with a high standard deviation of 30.5 million, reflecting considerable variation in the size of the populations among the countries. The minimum value of 143,714 suggests that some countries have relatively small populations, while the maximum of 219 million shows the presence of countries with much larger populations. Large populations require more government expenditure on infrastructure, health, and education, which can challenge fiscal sustainability (Alesina & Perotti, 1996).

Ultimately, the mean inflation rate is 10.26, indicating moderately high inflation throughout the sample. The substantial standard deviation of 33.60 signifies considerable variability, with values spanning from a minimum of -16.86 (deflation) to a maximum of 557.2 (hyperinflation). This significant variation highlights the economic uncertainty that certain countries may encounter, as the data reveals both deflationary and hyperinflationary conditions.

Correlation Analysis

The objective of correlation analysis is to comprehend the nature and extent of the link between research variables. Table 3 displays the pairwise correlation coefficients for the studied variables.

Table 3: 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

The negative correlation between Fiscal sustainability (FSS) and foreign direct investment (FDI –0.0737 $\rho <$ 0.05) merits attention. FDI often flows into SSA countries with high growth potential but weak fiscal structures, such as extractive industries in resource-rich countries. These inflows may not directly support fiscal sustainability, especially if revenues from FDI are poorly captured by the tax system or if incentives (such as tax holidays) reduce fiscal returns.

The table indicates a positive correlation between GDP and fiscal sustainability ($r = 0.0369$; $\rho < 0.05$). A marginal positive correlation exists between GDP and fiscal sustainability, indicating that as GDP rises, fiscal sustainability may enhance; nevertheless, this correlation is small and statistically insignificant. Likewise, the positive correlation between fiscal sustainability and climate change (0.2412; $\rho < 0.05$) may initially appear paradoxical. This may indicate the growing significance of climate finance, adaptation funds, and international assistance systems tied to climate vulnerability. In SSA countries, which are disproportionately impacted by climate-related disasters, fiscal frameworks could be enhanced by concessional funding linked to environmental resilience and adaptation.

The negative relationship between the fiscal sustainability and institutional quality (–0.2291; $\rho < 0.05$) is a notable finding, as it challenges the common belief that strong institutions result in improved fiscal results. In Sub-Saharan Africa, this may indicate a scenario where nations with fragile institutions are subjected to increased external scrutiny (e.g., IMF programs) or are forced to implement fiscal reforms owing to crisis circumstances, resulting in temporary fiscal sustainability.

The positive association between fiscal sustainability and the foreign exchange rate (0.4620 $p<0.05$) suggests that countries with relatively stable or appreciating currencies tend to enjoy better fiscal health. In the SSA context, this is understandable given the region's dependence on external borrowing and import financing. Currency stability can reduce the cost of debt servicing—especially for countries with large shares of foreign-denominated debt—and contribute to greater fiscal space.

The correlation matrix reveals a positive yet insignificant association between Human capital and FS (0.0075; $\rho < 0.05$). Nonetheless, it exhibits a positive association with FX (0.1444*) and FDI (0.1306*), indicating that investment in human capital could attract foreign investment or bolster currency stability, despite the direct fiscal impact being currently weak. Moreover a positive but weaker correlation with population (0.1199; $p<0.05$) may indicate that larger populations can support broader tax bases and greater fiscal capacity, assuming demographic dividends are harnessed effectively. In SSA, where many countries are experiencing rapid population growth, the challenge lies in turning this growth into economic and fiscal gains through investment in education, health, and job creation.

At last, fiscal sustainability and inflation are positively correlated ($r = 0.2432$; $\rho< 0.05$). Its significance implies that moderate rates of inflation could help fiscal sustainability, perhaps by lowering the actual value of debt or raising nominal tax collections.

REGRESSION ANALYSIS RESULTS

In this paper, four hypotheses were evaluated to assess the relationship between climate change, institutional quality, foreign exchange rate, FDI and fiscal sustainability in Sub Saharan Africa. Prior to hypothesis testing, study examines how various control factors—GDP, population, human capital, and inflation—affect fiscal sustainability. The results reveal a negative relationship between economic growth and fiscal sustainability, while inflation, human capital, and population all show positive correlations with fiscal sustainability, each with a p-value of 0.000. The results for the direct effect are presented in table 4 below.

The model generates R-squared of 0.2244 for the evaluation carried in on above, while the Prob > chi2= 0.000. The within variation R^2 is higher (0.3465), reflecting a stronger explanatory power of changes within countries over time. The regression results in Table 4 indicate that climate change have a significant positive effect on fiscal sustainability ($\beta=0.4098$, $\rho<0.05$). Consequently, H01 is rejected. This implies that a unit increase in climate change leads to a 0.4098 unit increase in fiscal sustainability. The positive coefficient of 0.4098 indicates that Sub-Saharan African countries that successfully address the effects of climate change are likely to enhance their fiscal sustainability. This outcome corresponds with the prevailing comprehension that climate change presents substantial threats to economic growth and development, which may subsequently affect a nation's fiscal status (Abidoye & Odusola, 2015; Odusola, & Abidoye, 2015; Rafaty 2018). More specifically, this finding is closely linked to the United Nations Sustainable Development Goals (SDGs), particularly SDG 13 (Climate Action) which emphasizes the need to combat climate change and its impacts through mitigation and adaptation mechanisms.

Conversely, institutional quality (IQ) exhibits a negative correlation with fiscal sustainability evidenced by a statistically significant coefficient of –0.063. This highlights that weak institutions undermine fiscal sustainability by fostering corruption, inefficiency, and mismanagement of public resources. Fosu (2013) emphasizes that enhancements in institutional quality in Sub-Saharan Africa do not inherently result in improved fiscal outcomes unless they are paired with successful public finance reforms. Adams & Luiz (2022) further explain that in many SSA countries, formal institutions are often undermined by informal political arrangements and elite capture, weakening their role in ensuring fiscal discipline. Furthermore poor governance diminishes the efficacy of collaborations with foreign investors and international organizations, as

evidenced in instances when mismanaged finances undermine outside support or investments (Acemoglu & Robinson, 2012). The results are especially pertinent to SDG 16 (Peace, Justice, and Strong Institutions) and SDG 17 (Partnerships for the Goals), both of which underscore the significance of institutional frameworks in attaining sustainable development (UN, 2015).

The foreign exchange rate variable demonstrates a strong positive relationship with fiscal sustainability (coefficient = 0.777), indicating that exchange rate stability significantly contributes to improved fiscal outcomes. In a region where much of the public debt is denominated in foreign currencies, exchange rate volatility directly impacts debt servicing costs. Aizenman, (2020) confirm that SSA countries with volatile exchange rates tend to face higher fiscal deficits, largely due to increased repayment obligations on external debt. The International Monetary Fund (IMF, 2020) also warns that currency depreciation can erode fiscal space by inflating the cost of foreign-denominated liabilities.

Interestingly, the results reveal a negative and statistically significant relationship between foreign direct investment (FDI) and fiscal sustainability (coefficient = –0.538). This suggests that FDI inflows do not necessarily contribute to stronger fiscal outcomes in SSA. One explanation is that many governments in the region offer generous tax incentives and holidays to attract foreign investors, especially in extractive sectors such as oil, gas, and mining (Wang et al 2013; Ajayi (2006), documents that those incentives often reduce the tax base and limit the fiscal benefits of FDI. UNCTAD (2020) similarly notes that much of the FDI entering SSA flows into sectors that are either poorly taxed or have weak linkages with the broader economy, thereby limiting their contribution to domestic revenue generation. Additionally 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 (Ajayi & Ndikumana, 2015 Adegboye et al 2020).

Table 4: Fixed Effects Regression Results

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)		

GMM Robust Checks

Since GMM enables the control of unobserved heterogeneity and offers consistent estimates when the regressors are endogenous, it is very effective in panel data situations (Arellano & Bond, 1991). It was used to guarantee the dependability, validity, and strength of the econometric study. The coefficients and significance of the control variables in the System GMM results differ from the fixed effects model results; however for the predator variables the coefficients showed the same directions with the fixed model, though with different magnitude but all significant. The coefficient for Lagged Fiscal Sustainability (FS t−1) is 0.299, indicating the continuity of fiscal conditions across time.

The study reveals a significant discrepancy between the fixed effect model and System GMM model regarding human capital and population growth. The fixed effect model suggests that human capital positively influences fiscal sustainability, while the System GMM model finds a negative effect. The magnitude is negligible at 0.021. The negative impact indicated by a coefficient of -0.008 (p=0.006) may reflect the financial burden of education and healthcare costs, as demonstrated by Kenya's universal healthcare initiatives. 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.

The GMM model reveals 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). Although both models show that climate change has a positive and major influence on fiscal sustainability, the fixed effect model predicts a far greater impact than the System GMM model. Both models show a negative relationship between institutional quality and fiscal sustainability, with the fixed effect model showing a somewhat stronger negative relationship. It appears that fiscal sustainability is undermined by weak institutions across SSA (-0.055 ($p<0.009$), as indicated by the identical significance levels and coefficients. Alternatively, the stabilization of the exchange rate enhances fiscal health by reducing debt servicing and trade expenses, as evidenced by the considerable impact of the foreign exchange rate on fiscal stability ($r=0.774$, $p<0.001$). The impact of a stable exchange rate on fiscal sustainability is estimated almost identically by both models. The findings provide compelling evidence that a stable exchange rate improves fiscal health by lowering the costs of servicing foreign debt. The relationship between fiscal sustainability and Foreign Direct Investment (FDI) shows a negative association, with a coefficient of -0.258 ($p<0.001$). This could be because of the erosion of the tax base or the repatriation of profits linked to FDI incentives. In contrast to the System GMM model, the fixed effect model indicates that FDI has a significantly more negative influence on fiscal sustainability (-0.5381).

Table 5: 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	0.000					
Hansen test	0.511					

Source: Researcher (2024)

CONCLUSION

This study investigated the impact of climate change, institutional quality, foreign exchange rate, foreign direct investment and fiscal sustainability in SSA. Utilizing secondary data, the study applied regression analysis to assess the relationships between the key research variables. The findings indicate that all the predictor variables have a significant effect on fiscal sustainability, with climate change and foreign exchange rate exhibiting a positive association, while institutional quality and FDI showed a negative relationship. Notably climate change can improve fiscal sustainability contrary to the conventional view that climate change is merely a risk factor while FDI typically regarded as a catalyst for economic growth and development; in SSA it frequently worsens fiscal imbalances.

Contributions to Knowledge

The study's findings contribute to the literature by demonstrating that economic, institutional and environmental factors determine the fiscal health of a nation. This highlights the need for more stringent regulatory oversight to ensure that these factors are considered when formulating and implementing fiscal policies as fiscal sustainability is key for the achievement of sustainable development goals. At the same time 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.

RECOMMENDATIONS

Based on these findings, several recommendations emerge. Policymakers and regulatory bodies are urged; 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.

Limitation of the study

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. Future research could explore additional economic, environmental and social factors and extend beyond SSA to incorporate other emerging regions and allow for comparative analysis. Furthermore, the effectiveness of debt sustainability framework should be examined.

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