Journal of Central Banking Theory and Practice, 2026, 3, pp. 186-233 *UDC: 336.748.12(61)*

Received: 21 November 2025; accepted: 8 July 2026 *DOI: 10.2478/jcbtp-2026-0026*

Inflation, Income Inequality, and Energy Poverty: Assessing the Moderating Role of Central Bank Independence in Sub-Saharan Africa

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Abstract: This paper contributes to the literature on inflation and income inequality by bringing the issue of energy deprivation into the picture. The study assesses the interconnections between inflation, energy poverty, and income inequality across SSA countries while accounting for the potentially moderating role of CBI in a panel of 24 countries spanning from 2005 to 2022. We employ Driscoll-Kraay fixed effects and Method of Moments Quantile Regression (MMQR) estimators to control for cross-sectional dependence and distributional heterogeneity in the data. The results show that inflation significantly increases income inequality, stressing its regressive effects in the region. In turn, higher income inequality is found to exacerbate energy poverty by reducing households' access to clean fuels and modern energy technologies. Institutional governance consistently reduces inequality and improves energy access, emphasizing its importance in development outcomes. Central bank independence plays a dual role: while it is associated with lower average income inequality, it amplifies the inequality-increasing effect of inflation. However, its moderating effect on the inflation–energy poverty nexus is weak in mean regressions but becomes more relevant in highly deprived situations. The heterogeneity analysis reveals that these relationships vary across the distribution of inequality and energy poverty. The effect of inequality on energy poverty is stronger at lower and median quantiles, while institutional effects become more pronounced at higher deprivation levels.

Similarly, the role of central bank independence and inflation differs across quantiles, confirming substantial distributional asymmetries. These results suggest that macroeconomic stability, institutional quality, and energy access are deeply interconnected, and their effects are highly context-dependent. The study concludes that addressing inequality and energy poverty in Sub-Saharan Africa requires coordinated monetary, fiscal, and institutional policies that explicitly consider distributional heterogeneity.

Keywords: Inflation, Income Inequality, Energy Poverty, Central Bank Independence, Sub-Saharan Africa.

JEL Classification: E31, D31, I32, E58, Q43, O55.

1. Introduction

Persistent macroeconomic dynamics and institutional deficits associated with the inflationary scourge, income inequality and the lingering energy poverty challenge are the main forces that stand between the region’s drive for inclusive and sustainable development. In one way or the other, episodes of volatile price movements, rising living costs and non-uniform welfare distribution across households and countries have continued to be hallmarks even with improvements in macroeconomic management and growth performance in some Sub-Saharan African (SSA) countries in recent years. On one hand, inflation in SSA has negative consequences on real incomes and disproportionately weighs on the poor, thereby sustaining high poverty levels, and on the other hand, it is the deep-seated structural inequality which limits the shock absorption capacity of households to reduce the potential adverse consequences of price shocks.

On average, the SSA region had an inflation rate of 17.8% in 2022 that is much higher than the global average of 8.7% (International Monetary Fund, 2023). In addition, a lingering energy poverty, estimated to be affecting nearly 600 million people or about 53% of SSA population (International Energy Agency, 2023), continues to be a source of disquiet. Energy poverty is also a multifaceted notion that is made up of the elements of access, affordability, reliability and modernity of energy services (Ogede, Oduola, and Onanuga, 2023, Ogede, Omitogun, et al, 2023). In SSA, households on average spend about 10-20% of their income on energy in contrast to 3-5% observed in more developed countries (African Development Bank, 2022). In an economy like this, energy spending tends to take the biggest bite of the small household budget and this also spills over into human capital and social welfare. These realities within SSA economy have engendered a paradoxical macro-institutional environment that is where growth co-exists with wide-ranging social exclusion within the countries and the region.

Inflation, income inequality, and energy poverty are conceptually related by mutually reinforcing transmission mechanisms. Inflation is a regressive tax that disproportionately affects poorer households whose consumption baskets are largely geared toward food and energy. This causes a faster loss in real purchasing power among the poor, exacerbating income inequality. Rising inequality, in turn, limits access to clean and efficient energy technologies, as low-income households cannot afford the up-front expenditures involved with contemporary energy solutions. Furthermore, energy poverty contributes to inequality by restricting productivity, educational achievement, and health outcomes, reinforcing a cycle of deprivation. Within this integrated framework, central bank independence (CBI) appears as an important institutional component that operates via two independent but complementary pathways. First, the stabilisation channel represents the CBI's traditional role in shaping inflation trends. According to the theoretical literature on monetary policy credibility, independent central banks are better equipped to withstand political temptations to adopt expansionary policies, decreasing inflationary bias and volatility. CBI indirectly reduces income inequality and energy poverty by lowering macroeconomic instability, which disproportionately impacts poor populations. Lower and more stable inflation protects real incomes, improves predictability, and encourages long-term investment, particularly in the energy industry. Second, the distributional moderation channel explains how CBI influences the transmission of inflation to inequality and energy poverty. Specifically, the institutional framework characterised by the degree of central bank independence determines the extent to which inflation results in welfare differences. This channel functions through monetary policy design and transmission mechanisms. Independent central banks may implement tighter anti-inflationary measures that stabilise prices, although these policies can have varying effects across income levels due to labour market, credit circumstances, and asset price adjustments. As a result, while CBI improves macroeconomic stability, it may also change the distributional incidence of inflation and policy responses, reducing or exacerbating inequality and energy poverty depending on country characteristics.

Empirically, several strands of literatures point to the fact that macroeconomic stability (Delessa et al., 2024; Ullah et al., 2024; Ali & Vargas-Hernández, 2024), and institutional quality and governance (Mehmood et al., 2022; Kibria & Toufique, 2023; Malindini, 2021) jointly determine welfare outcomes in developing economies. Yet, limited studies have empirically documented the interactive effects between inflation, inequality, and energy poverty, particularly in SSA, where weak institutions and shocks tend to accentuate the social consequences of macroeconomic volatility. While there have been studies that separately assessed the inflation–inequality nexus (Albanesi, 2007; Delessa et al., 2024), and the drivers of energy poverty (Pachauri and Spreng, 2011; Nussbaumer et al., 2012, amongst others), relatively few have jointly and empirically explored the interlinkages of these phenomena within a region where there exist large differences in the degree of Central Bank Independence (CBI). CBI, on its part, is a critical but little researched institutional determinant of monetary policy credibility and effectiveness in SSA. Theoretically, Central Bank Independence embodies an institutional check on inflationary bias and fiscal dominance (Okorie, 2021; Jácome & Pienknagura, 2022). In this sense, the literature on the subject has established that on average, countries with higher CBI score tend to experience lower and more stable inflation rates. This, in part, is explained by the fact that independent central banks are less likely to bow to political pressures that lead to the genesis of inflationary episodes as a result of unsustainable monetary expansions (Okorie, 2021; Jácome & Pienknagura, 2022). The perceived insulation of monetary policy from short-term political influences is also believed to contribute to better economic stability and growth prospects by virtue of reducing inflation variability and uncertainty, as well as improving policy predictability. In this light, it is posited that CBI is good for policy credibility as it stabilizes expectations and anchors long-term investment, and this is especially relevant in the energy sector. However, in the African context where political business cycles and fiscal encroachment tend to be more pronounced on monetary policy autonomy, the extent to which central bank autonomy generates welfare and energy access outcomes that are equitable and developmental in the region is an empirical enigma that has received scant attention in the economics literature. This justifies the efforts of this study to, in a modest way, contribute to the closing of this important gap by interrogating whether and how CBI not only engenders price stability but also, more significantly, buttresses inclusive welfare and energy access.

Against this backdrop, this paper's main objective is to investigate the nexus between inflation, income inequality, and energy poverty in Sub-Saharan Africa with a specific emphasis on the moderating role of Central Bank Independence (CBI). The specific research objectives that this study hopes to achieve are threefold: first, to estimate the direct effect of inflation on income inequality and energy poverty in SSA; second, to interrogate the linkage between income inequality and energy poverty in the region, and finally, to analyse how the moderating levels of Central Bank Independence affect the impact of inflation on both income inequality and energy poverty. In sum, the above-mentioned specific objectives can be rephrased to yield the three key research questions; What is the effect of inflation on income inequality and energy poverty in SSA? How does income inequality contribute to energy poverty in the region? And, to what extent does CBI moderate the effects of inflation on income inequality and energy poverty in SSA?

As noted above, in terms of contributions, this study makes three important theoretical and empirical contributions to the growing macroeconomic and development policy literatures on Sub-Saharan Africa. First, it provides new empirical evidence on the institutional transmission channels linking inflation, inequality, and energy poverty in SSA demonstrating that macroeconomic instability and its associated policy have social costs that go beyond the erosion of purchasing power. Second, it brings CBI, as a moderating mechanism, to bear on this nexus and demonstrates that monetary autonomy not only anchors inflation expectations but also has a crucial role to play in fostering inclusive welfare through improved income distribution and energy access. This extends the developmental relevance of monetary institutions beyond their conventional stabilization role. Third, methodologically, the study combines Driscoll-Kraay fixed-effects estimation with Method of Moments Quantile Regression (MMQR) to account for cross-sectional dependence and distributional heterogeneity across countries. While these approaches improve the robustness of the estimates by controlling for unobserved country-specific effects and common shocks, they do not fully eliminate concerns related to reverse causality or omitted time-varying factors. Consequently, the empirical results should be interpreted as conditional associations rather than definitive causal effects. Nonetheless, the combined framework provides valuable evidence on how inflation, inequality, energy poverty, and monetary institutions are related across different segments of the distribution. The two techniques also yield policy-relevant guidance for designing more coordinated policy frameworks where monetary independence, fiscal discipline and institutional quality and governance functions as a mutually reinforcing sets of instruments for pursuing and achieving inclusive and energy-secure growth in the region.

The remaining part of the paper is structured as follows. Section 2 presents the review of relevant literature on inflation, income inequality, and energy poverty. Section 3 discusses the study's methodology and data sources while Section 4 presents and discuses main empirical results, examining patterns of energy poverty and the mediating role of central bank independence. Section 5 concludes with policy implications and direction for future studies.

2. Literature Review

2.1. Inflation and Income Inequality

The relationship between inflation and income inequality has evolved noticeably and a substantial body of empirical research have demonstrated that the nexus varies based on the inflation level and institutional factors. One of those studies relies predominantly on nonlinear (often U-shaped or inverted U-shaped) relationship between inflation and income inequality. In developed countries, moderate inflation may reduce inequality up to a threshold, after which further inflation increases inequality. In developing countries, the relationship can be inverted, with inflation initially reducing inequality before rising again at higher rates (Siami-Namini & Hudson, 2019; Monnin, 2014; Akarsu & Gharehgozli, 2024; Glawe & Wagner, 2024; Balcılar et al., 2017). For instance, Siami-Namini and Hudson (2019) explore the short- and long-run Granger causality relationship between inflation and income inequality using the

Toda and Yamamoto (1995) and a Vector Error Correction Model (VECM) approaches for panel data of 24 developed countries (DCs) and 66 developing countries (LDCs) over the period of 1990-2014. The findings show the existence of a nonlinear relationship between inflation and income inequality. While there is no bidirectional Granger causality between inflation and income inequality in the short-run, there is bidirectional Granger causality in the long-run for both the DCs and LDCs group.

Recently, Glawe and Wagner (2024) examined the relation between inflation and inequality in 44 middle-income countries between 1996 and 2017, and argued that for an inverse U-shaped relationship, inflation initially leads to higher inequality, reaches a turning point, and then leads to lower inequality. However, Nguyen (2025) notes that inflation tends to exacerbate income inequality in advanced economies but may narrow the gap in developing nations, possibly due to differences in economic structure and policy responses. The author contends that infrastructure development increases income inequality in advanced countries but alleviates it in developing ones across a sample of 34 advanced countries and 44 developing nations from 2010 to 2023. Empirical literature points out the existence of heterogeneity across income levels as well. Results of these studies indicate that lower-income households are more heavily affected by inflation as they consume a more "inflation sensitive" basket of goods, therefore suffer a higher "inflation inequality" (Jaravel, 2021; Berisha et al., 2022; Rolim & Marins, 2024, amongst others). From the perspective of Rolim and Marins (2024), in response to a positive foreign price shock, the profit share and the within-workers inequality (in real terms) increase because low-wage workers suffer more from these shocks. The authors further postulate that the described effect is to some extent conditioned by the transmission channels' strength of monetary policy, making the monetary authority reaction a probable contributor of amplifying or abating these distributional consequences.

The role of financial development and institutional governance are also reported in the empirical literature. These studies contend that financial development can moderate the adverse effects of inflation on inequality, providing insurance mechanisms against inflation risk. Strong institutions and low corruption also influence the direction and magnitude of inflation's impact on inequality (see Kim & Lin, 2023; Göcen, 2023). Empirical evidence also suggests that inflation rates above certain thresholds (e.g., 6% or 13%) are associated with rising inequality, while lower rates may have neutral or even equalizing effects (Glawe & Wagner, 2024; Balcılar et al., 2017). As such, an effective monetary policy, inflation targeting, and inclusive financial development can mitigate the inequality-worsening effects of inflation, especially in advanced economies (Garcia & Cross, 2024; Kartaev et al., 2020; Rolim & Marins, 2024). Garcia and Cross (2024) for example, argue that contractionary monetary policy shocks increase income inequality in the G7. But in some cases, controlling for inflation targeting eliminates the effect while mixed evidence is found for the Eurozone countries with an area-wide inflation target.

2.2. Inflation and Energy Poverty

Empirical research from diverse global contexts demonstrates that inflation, particularly energy price inflation, significantly worsens energy poverty by reducing affordability and access to modern energy services. The first strand of studies argues for direct link between inflation and energy poverty. It is noted that in both developing and developed countries, increases in energy prices due to inflation directly drive more households into energy poverty. For example, Alem and Demeke (2020) note that, in urban Ethiopia, energy price inflation (notably kerosene) increased the likelihood of households falling into energy poverty, forcing a shift to dirtier fuels like charcoal with negative health and environmental consequences. In European countries, the post-pandemic surge in energy commodity prices (especially gas) has delayed improvements in energy poverty, with inflationary pressures making it harder for households to afford adequate energy (Carfora & Scandurra, 2024; Halkos & Aslanidis, 2023). Electricity prices are a primary driver of energy poverty across Europe, with economic downturns and inflation compounding the problem (Halkos & Gkampoura, 2021; Maxim et al., 2016).

In a group of 32 developing countries, inflation is found to have a negative effect on energy poverty through the channel of income and affordability. A U-shaped relationship also exists, where high inflation and very low inflation both tend to increase energy poverty, usually through income inequality (Memiş & Aydın, 2024; Husnain et al., 2021). Husnain et al. (2021) utilize panel ARDL based on pooled mean group and panel quantile regression and argue that the stage of economic development is the crucial determinant in the energy poverty decision. Financial development is negatively associated with access to electricity. Ogede, Oduola and Onanuga (2023) contribute to the growing literature on energy poverty by examining if economic policy uncertainty affects energy poverty (EP), and if economic policy uncertainty moderates the relationship between government spending and energy poverty in SSA using two different econometric methods, i.e., cross-sectional autoregressive distributed lags (CS-ARDL), and panel quantile regression (PQR) models. The CS-ARDL results show that government expenditure reduces EP, and the interactive effect of economic policy uncertainty on government expenditure on energy poverty is negative. PQR results reveal a positive and significant effect of the interaction of EPU with government expenditure on energy poverty in 50th and 75th quantiles of 0.116 and 1.347, respectively, thus corroborating the results of the non-interactive model. Recently, Memiş and Aydın (2024) analyzed the effects of public expenditures and inflation on EP for 32 developing countries using Panel GMM and 3SLS methods. The authors argue that public expenditures are a crucial public policy instrument to combat energy poverty. In contrast, the study shows that inflation negatively affects EP.

The last strand of empirical literature, however, reveals negative impact of inflation on energy poverty can be moderated by strong governance and effective public expenditure. In Africa, higher governance quality can reverse the adverse effects of inflation on energy poverty, but only beyond certain institutional thresholds (Mawutor et al., 2023; Memiş & Aydın, 2024). Mawutor et al. (2023) employ two-step System Generalized Methods of Moment model with linear interaction between cost of living and governance quality in 40 African countries between 2000 and 2019) The findings show that the conditional effect of inflation on energy poverty is negative while the governance quality acts as a moderator on the relationship between inflation and energy poverty beyond a threshold. The governance quality at initial stages would not drive the needed reduction in energy poverty unless it goes beyond the threshold of 0.03, 0.02 and 0.07. Furthermore, Han et al. (2023), use the panel quantile approach to demonstrate the significance of easing energy poverty in order to foster economic growth in the selected Eastern European countries from 1996 to 2018. The findings indicate that CO_2 emissions have a positive effect on economic growth, but policies to reduce fossil fuel consumption can both boost economic growth and mitigate negative environmental impacts.

2.3. Income Inequality and Energy Poverty

Empirical literature across diverse regions consistently demonstrates a strong, positive relationship between income inequality and energy poverty. Studies from Europe, Asia, Africa, and Latin America find that higher income inequality is significantly associated with greater energy poverty. This relationship holds across both developed and developing countries, though the mechanisms and severity may differ (see Igawa & Managi, 2022; Simionescu, 2025; Bardazzi et al., 2021; Acheampong et al., 2022; Wang, Umair, et al., 2024; Opoku et al., 2023; Cheikh et al., 2023; Jayasinghe et al., 2021; Simionescu & Cifuentes-Faura, 2024). For instance, Igawa and Managi (2022), use the original survey data of 37 countries at various economic levels and argue that energy poverty for country-average households shows an improving trend with economic development in the accessibility and reliability dimensions, while affordability is the worst in countries with a middle level of economic development and greater income inequality. Recently, Simionescu (2025) uses the method of moments quantile regression (MMQR) and mean group (MG) estimator to examine the impact of income inequality on energy poverty and other interconnected indicators in the European Union over the period 2005 to 2023. The findings reveal that income inequality based on Gini index enhances energy poverty, while gender pay gap, economic growth, and urban population reduce it. However, income inequality affects energy poverty through reduced affordability, limited access, and lower reliability of energy services for low-income households. In middle-income countries, affordability is especially problematic where income gaps are wide (Igawa & Managi, 2022; Simionescu, 2025; Bardazzi et al., 2021).

Wang, Fang et al. (2024) employ two-way fixed-effects model and asymmetry analysis to examine whether the income gap between urban and rural regions exacerbates rural energy poverty in 30 China provinces spanning from 2005 to 2023. The findings indicate that an increase in the urban-rural income disparity significantly intensifies rural energy poverty.

Notably, at higher income distributional quantiles, the gap's effect on energy poverty is more noticeable, while at lower quantiles, its impact is less severe. Also, Opoku et al (2023) argue that economic growth, trade liberation, urbanization, population growth, and financial development increase income inequality and access to clean fuels and technology. ?

Besides effective governance, targeted social programs, and equitable renewable energy policies have been outlined in empirical literature as determining factors that break the link between income inequality and energy poverty. Studies such as Acheampong et al (2022), Certomà et al. (2023), and Simionescu and Cifuentes-Faura (2024) contend that poor governance institutions or lack of targeted interventions can worsen the energy poverty circumstances. The shift to modern or green energy can reduce energy poverty and inequality if access is distributed equitably. Otherwise, transitions may inadvertently increase disparities (Soto & Martínez-Cobas, 2024; Śmiech et al., 2025). For instance, Śmiech et al. (2025), investigate the relationships arising from the transition process to green economies and energy poverty in relation to income inequality across 22 Latin American countries spanning from 2000 to 2021. The authors employ feasible generalized least squares (FGLS) and panel corrected standard errors (PCSE) and demonstrate that energy poverty significantly affects income inequality.

2.4. Identified Gaps

A cursory look at the existing empirical literature shows that a bulk of the empirical studies relies on data from developed economies in Europe, Asia, and Latin America, with little to no consideration of African economies. However, it is worth noting that SSA has a number of structural features that are likely to affect the interaction among inflation, inequality, and energy poverty. The factors that we are aware of include, among others, weak monetary transmission, a high share of the population in informal employment, net imports of food and energy, and weak institutions. This lack of region-specific evidence is a crucial gap in the existing literature. The moderating role of Central Bank Independence (CBI) is also not well understood. Institutional factors such as the quality of governance, financial development, corruption, and economic policy uncertainty have been identified as mediators of the effect of inflation on inequality; however, the moderation effect of central bank independence has been sparingly considered. CBI may help alleviate the cost of inflation by anchoring inflation expectations and ensuring that monetary policy is credible. However, its potential to cushion energy poverty or reduce inequality has not been fully explored in either theoretical or empirical works. Moreover, a majority of the recent studies only examine the pairwise interactions. As such, several works may focus on inflation and inequality or inflation and energy poverty, but few give a thought to the simultaneous interaction of all the three factors. Inflation may drive inequality, which then amplifies energy poverty. This is to say that there are triangular interactions that have not been fully theorised or empirically tested.

3. Methodology

3.1. Model Specification

In line with the study's objectives, three empirical models are developed to capture (i) the effect of inflation on energy poverty, (ii) the relationship between income inequality and energy poverty, and (iii) whether the moderating role of Central Bank Independence (CBI) is explicitly incorporated into the model equation (1) and (2) through interaction terms between inflation and CBI. The study examines the effect of inflation on income inequality and the moderating role of Central Bank Independence; the following baseline model is specified:

$$INEQ_{it} = \delta_0 + \delta_1 INF_{it} + \delta_2 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \tag{1}$$

where $INEQ_{it}$, INF_{it}, and CBI_{it} , denote income inequality in country *i* at time *t*; and inflation rate. X_{it} is a vector of control variables. The terms μ_i and $\lambda_t$represent country-specific and time-specific effects, respectively, while ε_{it} is the idiosyncratic error term. The parameter of primary interest is δ_2. Secondly, the study explores the link between income inequality and energy poverty by adopting the specification below:

$$EP_{it} = \gamma_0 + \gamma_1 INEQ_{it} + \gamma_2 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \tag{2}$$

where EP_{it} denotes energy poverty, proxied by the share of population without access to electricity or clean fuels for cooking; and γ_1 measures the extent to which income inequality contributes to energy poverty, controlling for other socioeconomic and institutional factors. All other variables are as previously defined. The moderating role of Central Bank Independence (CBI) is explicitly incorporated into the model equation (1) and (2) through interaction terms between inflation and CBI. Equation (3) presents the moderating role of Central Bank Independence with inflation on income inequality:

$$INEQ_{it} = \delta_0 + \delta_1 INF_{it} + \delta_2 CBI_{it} + \delta_3 (INF_{it} * CBI_{it}) + \delta_4 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

where $INEQ_{it}$, INF_{it}, and CBI_{it} , denote income inequality in country *i* at time t; inflation rate, and index of Central Bank Independence, respectively. $(INF_{it} * CBI_{it})$ captures the moderating effect of central bank independence on the inflation–inequality relationship. X_{it} is a vector of control variables. The terms μ_i and $\lambda_t$represent country-specific and time-specific effects, respectively, while ε_{it} is the idiosyncratic error term. The parameter of primary interest is δ_3. All other variables are as previously defined. Meanwhile, the moderating influence of Central Bank Independence is captured using model equation (4), which is expressed as:

$$EP_{it} = \propto_0 + \propto_1 INF_{it} + \propto_2 CBI_{it} + \propto_3 (INF_{it} * CBI_{it}) + \propto_4 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (4)$$

where EP_{it} denotes energy poverty, proxied by the share of the population without access to electricity or clean fuels for cooking, while the other variables are as previously defined. However, $\propto_3$ captures how the degree of central bank independence conditions the effect of inflation on energy poverty. Given the above, the moderating role of Central Bank Independence is assessed by examining both the sign and significance of the interaction terms $(INF_{it} * CBI_{it})$ in Equations (3) and (4). As such, the marginal effects of inflation at different levels of CBI are computed as:

$$\frac{\delta INEQ_{it}}{\delta INF_{it}} = \delta_1 + \delta_3 CBI_{it} \quad (5)$$

$$\frac{\delta EF_{it}}{\delta INF_{it}} = \propto_1 + \propto_3 CBI_{it} \quad (6)$$

Model equations (5) and (6) demonstrate that the impact of inflation on inequality and energy poverty depends on the degree of CBI. A negative and statistically significant δ_3 would imply that higher central bank independence mitigates the adverse impact of inflation on income inequality, suggesting that stronger institutional autonomy promotes inclusive macroeconomic stability. Similarly, a negative coefficient on $\propto_3$ would indicate that greater independence of monetary authorities weakens the inflationary pressure that deepens EP, possibly by stabilizing prices of energy-related goods and services.

3.2. Data and Measurement

Table 1 includes the list of countries included in the analysis, in addition to descriptive statistics, and measurement details for the 24 sub-Sahara African (SSA) countries in the study covering the period 2005-2022. The sample selection was based on the availability of harmonized macroeconomic data on inflation, income inequality, energy access, and central bank independence indicators in the study period. Data sources include various international databases namely, the World Bank World Development Indicator (WDI), Standardized World Income Inequality Database (SWIID), World Bank Worldwide Governance Indicator (WGI), and index of de jure Central Bank Independence (CBIR) from Romelli (2022; 2025). With respect to the dependent variables, income inequality is proxied using the Gini coefficient. The Gini coefficient ranges from 0 to 100, where 0 represents perfect equality and 100 signifies maximum inequality. The log form of Gini index is used as this helps in (1) reducing heteroskedasticity in the error term and (2) ease of interpreting the coefficients in terms of elasticities. In line with Koomson and Danquah (2021), Ogede, Oduola and Onanuga (2023), and Ogede, Omitogun et al (2023), the study also proxies energy poverty through the percentage of population without access to electricity and clean fuels for cooking. Inflation is measured as the annual percentage change in the consumer price index (CPI, 2010 = 100). It captures macroeconomic instability. Albeit theoretical and empirical literature is still divided on the effects of inflation, there is a broad consensus on its regressive impact on welfare, as inflation reduces the real income of lower-income households more than that of the upper-income class, hence increasing income inequality (Albanesi, 2007; Bulír, 2001). The de jure Central Bank Independence index (ranging from 0 to 1) is the main moderating variable. It indicates the extent of institutional insulation of the monetary authority from political pressures. Since the CBI variable is bounded and relatively persistent with little variability within a single country, it was standardized rather than log-transformed:

$$CBIR_{std,it} = \frac{CBIR_{it} - \ddot{CBIR}}{SD(CBIR)} \quad (7)$$

This ensures comparability across countries and mitigates potential non-stationarity, consistent with macro-institutional literature (e.g. Garriga, 2016; Romelli, 2022). Equation (7) eliminates time drift, ensures comparability, and deals with mild non-stationarity flagged by panel unit-root tests. The interaction of inflation and z-score standardized CBIR tests the moderating role of monetary policy autonomy in the inflation–inequality and inflation-energy poverty linkages. Theoretically, higher CBIs should dampen the negative impact of inflation on income distribution and energy poverty by supporting price stability and monetary policy credibility.

As for control variables, real GDP growth rate (the growth rate of real GDP per capita) captures the pace of economic growth and its implications for the distribution of income and access to welfare services. Economic growth is often associated with higher employment and income-earning opportunities, welfare, and energy access (Fosu, 2017). Economic growth can expand fiscal space by increasing government revenues, thereby enabling greater investment in infrastructure and social programmes. However, growth is not necessarily distributionally neutral, and its poverty-reducing effects depend partly on how its benefits are distributed (Ali & Zhuang, 2007; Doherty et al., 2018). Economic growth does not necessarily reduce inequality in Sub-Saharan Africa, particularly when it is not accompanied by structural transformation and the movement of labour towards higher-productivity activities. Evidence suggests that structural transformation can reduce inequality by shifting workers from low-productivity sectors towards more productive employment (Morsy et al., 2023). Therefore, GDP growth is included to control for the macroeconomic component of welfare changes, independent of the institutional and monetary policy mechanisms underpinning this study. Population growth is also included as a structural driver of both inequality and energy poverty. Population dynamics influence energy demand and access, contribute to spatial disparities in energy provision, and create additional challenges for the pace and direction of energy transition, particularly in rapidly growing economies (IEA, 2025). A high population growth rate can constrain improvements in per-capita income and place pressure on employment, public services, and productive resources, thereby limiting the poverty-reducing effects of economic growth (Ahluwalia et al., 1979; Onyeoma, 2020). On the other hand, a moderate growth rate can support labour supply and domestic market growth, and also promote inclusive development, if it is complemented with pro-productivity measures. Including population growth as a control variable helps isolate the effect of monetary policy independence on inequality and energy poverty, from the impact of demographic forces that influence both income distribution and energy access in SSA. Finally, institutional quality (GOV) is controlled to underpin the mediating role of institutional quality in the relationships between inflation, inequality, and energy poverty. Good governance ensures credibility, accountability, transparency in policy implementation, efficient use of resources, and generally better public service delivery (Kaufmann et al., 2023). In fact, empirical evidence suggests that stronger governance can support more equitable development and faster expansion of energy access in Sub-Saharan Africa, partly through improved regulatory quality, regulatory independence, government effectiveness, and stronger control of corruption (Imam et al., 2019; Bidiasse et al., 2025).

Table 1: Data, sources, and measurement

Variable	**Measurement**	**Source**
Inflation (INF)	% of Consumer Price Index	World Bank World development indicator (WDI)
Income Inequality (INEQ)	Gini coefficient	World Income Inequality Database (WIID) / SWIID
Energy Poverty (EP)	% of population with access to clean fuels and technologies for cooking	World Bank (WDI)
Central Bank Indep. (CBI)	Index of independence	Romelli (2022; 2025)
Economic growth (GDP)	GDP growth	World Bank (WDI)
Institutional Governance (IG)	Institutional governance	Worldwide Governance Indicators
Population (POP)	Population growth	World Bank (WDI)

3.3. Empirical Strategy

The empirical strategy focuses on three considerations: cross-country dependence, slope heterogeneity, and potential long-run relationships among the variables of interest. Guided by these considerations, the main analysis is carried out in several steps, including the baseline fixed-effects estimation, inference based on Driscoll-Kraay standard errors, and distribution-sensitive quantile methods. First, the study conducts diagnostic checks on the panel properties. The Pesaran CD and Breusch-Pagan LM statistics indicate that shocks are transmitted across SSA economies, while the slope-heterogeneity tests suggest that the hypothesis of common coefficients is rejected. These results suggest that country-level dynamics differ in ways that a pooled estimator cannot capture, and that standard fixed-effects models should be corrected for contemporaneous correlation and non-spherical errors. Consistent with these findings, the baseline specification uses fixed-effects with Driscoll-Kraay standard errors. This choice is robust to cross-sectional dependence, serial correlation, and heteroskedasticity.

Second, given that several variables in the analysis are non-stationary and move together in the long run, panel cointegration tests are performed to check for the existence of stable equilibrium relationships between the core variables of interest. The results provide support for cointegration across the key variables of inequality, inflation, energy poverty, and governance, and thus suggest that the models capture the short-run and long-run components of the distributional and energy-access processes. A key adjustment to the non-stationary Central Bank Independence Index (CBIR) is to standardise it through z-score transformation. This approach eliminates the deterministic drift and ensures a similar scale for the CBIR variable across countries. As a robustness check, one of the models is based on the first difference of CBIR instead. Third, the core estimations are conducted in two stages. The first set of models focus on the direct relations between inflation, inequality, and energy poverty and use fixed-effects with Driscoll–Kraay corrections. These regressions provide estimates of the average marginal effects while controlling for governance, economic growth, and population dynamics. In the second stage, the models are extended with interaction terms between inflation and Central Bank Independence to evaluate whether monetary autonomy conditions the effects of price instability on inequality and energy deprivation. This two-stage approach is motivated by the institutional hypothesis that credible monetary arrangements can shape the distributive and welfare effects of macroeconomic shocks. An important consideration in interpreting the results is the potential endogeneity among inflation, income inequality, energy poverty, and central bank independence. These variables may be jointly determined through broader political economy processes, institutional reforms, fiscal conditions, and macroeconomic shocks. Although country and time fixed effects help account for unobserved heterogeneity, and governance controls partially capture institutional influences, residual endogeneity arising from reverse causality and omitted time-varying factors cannot be completely ruled out. Therefore, the empirical estimates are interpreted as evidence of conditional associations rather than strict causal relationships. In addition, the de jure Central Bank Independence (CBI) index exhibits a high degree of persistence over time. Because fixed-effects estimators rely primarily on within-country variation, the limited temporal variation in CBI may constrain the precision with which moderating effects are identified. The robustness analysis using alternative transformations of the CBI index is intended to mitigate, though not entirely eliminate, this concern. Finally, given the evidence of marked heterogeneity in inequality and energy-access outcomes within the region, the analysis is extended to Method of Moments Quantile Regression (MMQR). This approach allows the coefficients to be distribution-sensitive across the range of inequality and energy poverty. In this way, the MMQR framework can explain how inflation, governance, and central-bank institutions work in low-, median-, and high-inequality environments. The MMQR approach is also consistent with the earlier diagnostic results of heterogeneity and dependence and is used to provide a complete picture of the distributional implications of macroeconomic conditions and institutional characteristics.

4. Results and Discussion

4.1. Descriptive Statistics and Preliminary Diagnostics

Table 2 presents the descriptive statistics for the variables used in the analysis. The results indicate substantial variation across countries and over time, which is suitable for panel estimation. Energy poverty (EP), measured as the percentage of the population with access to clean fuels and technologies for cooking, has a mean value of 26.07, with a wide range from 0.2 to 99.1. This dispersion reflects the significant heterogeneity in access to modern energy services across Sub-Saharan Africa, where some countries have made notable progress while others remain highly energy-deprived. The relatively high standard deviation (28.49) and positive skewness suggest that a large number of observations are concentrated at lower levels of access, with fewer countries achieving near-universal access. Income inequality (INEQ), proxied by the Gini coefficient, has an average of 43.95, indicating generally high levels of inequality across the region. The distribution ranges from 29.8 to 64.8, with moderate dispersion (standard deviation of 7.72). The positive skewness further suggests that inequality is more pronounced in a subset of countries, consistent with existing evidence on uneven income distribution in SSA economies.

Inflation (INF), measured as the annual percentage change in the consumer price index, exhibits substantial variability, with a mean of 73.35 and a maximum of 708.32. The large standard deviation (95.03), high skewness (2.88), and leptokurtic distribution (kurtosis of 15.76) indicate the presence of extreme inflation episodes in some countries, likely reflecting periods of macroeconomic instability, exchange rate pressures, or fiscal imbalances. The presence of negative values confirms that some countries experienced deflationary episodes, justifying the use of inflation in levels. Central bank independence (CBI) has a mean value of 0.66, suggesting a moderate degree of institutional autonomy across the sampled countries. The relatively low standard deviation (0.14) reflects the institutional persistence of legal central bank arrangements and suggests limited temporal variation within countries. This characteristic is common in de jure measures of central bank independence and has implications for identification under fixed-effects estimation, as moderating effects are identified primarily from within-country changes over time. Consequently, the estimated interaction effects should be interpreted with appropriate caution. The slight negative skewness implies that a number of countries exhibit relatively higher levels of independence. Institutional governance (IG) records an average value of 1.94, with moderate dispersion, reflecting variations in institutional quality across the region. Economic growth (GDP) averages 3.02 percent, although the wide range from -14.14 to 17.33 percent highlights the volatility of growth performance in SSA economies. Population growth (POP) also shows considerable variation, with a mean of 31.61 and a wide spread, reflecting differences in demographic dynamics across countries.

Table 2: Descriptive Statistics

Variables	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Obser.
EP	26.07083	99.1	0.2	28.49075	1.208456	3.363941	432
INEQ	43.954	64.8	29.8	7.7182	1.1605	3.9629	432
INF	73.350	708.32	-2.0176	95.026	2.8843	15.758	432
CBIR	0.6622	0.8535	0.3795	0.1384	-0.4905	2.0667	432
IG	1.9383	3.3701	0.8154	0.6240	0.4589	2.5362	432
GDP	3.0191	17.332	-14.144	3.9066	0.4124	4.1785	432
POP	31.611	94.5	0	36.387	0.6467	1.5752	432

Source: Authors' computation using World Bank (2024), WIID/SWIID, IEA, and Romelli (2022, 2025).

Table 3 reports the pairwise correlation matrix alongside variance inflation factors (VIF). The correlation coefficients are generally low to moderate, suggesting the absence of strong linear associations among the explanatory variables. Notably, energy poverty is positively correlated with inequality (0.3749) and institutional governance (0.5477), while it is negatively associated with population growth (-0.3978). Inflation exhibits weak correlations with most variables, indicating that its effects are unlikely to be driven by simple bivariate relationships. The VIF values are all well below the conventional threshold of 10, with a mean VIF of 1.47, confirming that multicollinearity is not a concern in the estimated models.

Table 3: Correlation Analysis and VIF

	EP	**INEQ**	**INF**	**CBIR**	**IG**	**GDP**	**POP**	**VIF**	**1/VIF**
EP	1								
INEQ	0.3749	1						1.23	0.8111
INF	0.0182	-0.0233	1					1.45	0.6902
CBIR	0.0152	-0.205	0.0984	1				1.25	0.8029
IG	0.5477	0.3799	-0.1948	-0.1735	1			1.31	0.7653
GDP	0.1071	0.0641	0.2074	-0.0007	0.0265	1		1.43	0.6994
POP	-0.3978	-0.1433	-0.4813	-0.2763	-0.1141	-0.5166	1	2.13	0.4688
Mean VIF								1.47	

4.1.1. Cross-Sectional Dependence and Heterogeneity Tests

Table 4 reports the results of the diagnostic tests for cross-sectional dependence (CD), slope heterogeneity, and model adequacy. Pesaran CD is highly significant ($p<0.01$) in the inflation, inequality, and energy-poverty equations, implying that shocks or policy shifts in one SSA country affect the entire panel. The Breusch-Pagan LM test also rejects the null of no CD, confirming the presence of contemporaneous correlation among the panel units. In addition, the Pesaran slope-heterogeneity test rejects the null hypothesis of homogeneous coefficients ($p < 0.05$), implying that the coefficients of explanatory variables differ across the countries in the sample, as can be expected given the variation in the macroeconomic structures, institutional capacities, and policy regimes in SSA. Economically, these preliminary diagnostics suggest that the economies of SSA are linked through common regional price movements and policy diffusion, and that the assumption of a common parameter across countries is inappropriate. Therefore, this study reports Fixed-Effects estimators with Driscoll-Kraay (DK) standard errors to correct for serial correlation, heteroskedasticity, and spatial dependence, while complementing with MMQR to account for cross-country heterogeneity and distributional effects.

Table 4: Cross-sectional Dependence (CD) and Heterogeneity Tests

Slope Heterogeneity Test	Pesaran & Yamagata (2008)	Blomquist & Westerlund (2013)
Delta	11.231***	15.766***
Adj. Delta	15.067***	21.152***
CD Test Statistics	CD-test	abs(corr)
EP	48.75***	0.888
INEQ	-1.14	0.475
INF	10.28***	0.488
IG	1.36	0.467
GDP	6.71***	0.341
POP	26.12***	0.541

Notes: *CD: Pesaran (2015, 2021)*

, **, and * denote significance at the 10%, 5%, and 1% levels, respectively.*

4.1.2. Panel Unit Root and Cointegration Tests

The results of the panel unit root and cointegration tests. The Cross-Sectionally Augmented Im-Pesaran-Shin (CIPS) and Cross-Sectionally Augmented Dicky Fuller (CADF) tests were applied to investigate the order of integration of each variable. It is important to note that the Central Bank Independence index (CBIR) appears non-stationary in levels but becomes stationary after first differencing, suggesting an I(1) process. Therefore, to ensure robustness of estimation results, CBIR was standardized (z-score transformation) prior to estimation, effectively eliminating any deterministic drift and ensuring comparability across countries with different nominal ratings. The results of Panel cointegration tests, reported in Table 5, including the Pedroni (1999), Kao (1999), and Westerlund (2005), confirm the existence of a long-run equilibrium relationship ($p<0.01$) between the variables. This means that inflation, inequality, energy poverty, and institutional indicators move together in the long term, consistent with the existence of macroeconomic equilibrium conditions across SSA countries.

Table 5: Results of panel cointegration test

Kao test for cointegration	Statistic	p-value
Modified Dickey-Fuller t	0.6817	0.2477
Dickey-Fuller t	0.4739	0.3178
Augmented Dickey-Fuller t	0.9117	0.1810
Unadjusted modified Dickey Fuller t	1.8460**	0.0324
Unadjusted Dickey-Fuller t	1.5253*	0.0636
Pedroni test for cointegration		
Modified Phillips-Perron t	6.9178***	0.0000
Phillips-Perron t	12.126	0.1126
Augmented Dickey-Fuller t	0.7899	0.2148
Westerlund for cointegration		
Variance ratio	7.4256***	0.0010

**p<0.10; **p<0.05; ***p<0.01, respectively.*

4.2. Empirical Results

The estimation results of the FE-DK and MMQR quantile models are presented in Tables 6-9. The baseline models are reported in Tables 6 and 7.

4.2.1. Direct effect of inflation on income inequality in SSA

Table 6 presents estimate of the effect of inflation on income inequality in Sub-Saharan Africa. Income inequality is measured by the Gini coefficient while inflation is proxied by CPI. INF's coefficient is positive and highly significant (0.00026), suggesting that a per cent increase in inflation leads to an increase of 0.00026 units in income inequality. These results show that inflation worsens income inequality; hence inflation is regressive. Inflation hurts the poor who spend a relatively higher share of their budget on food and services and who own fewer assets that are denominated in nominal terms. Furthermore, nominal wage rigidities and lagged adjustments to income exacerbate the problem. Thus, our findings are concurrent with those found in Jaravel (2021), Berisha et al. (2022), and Rolim and Marins (2024), whereby inflationary shocks worsen income inequality because poorer households spend a larger fraction of their budgets on food and have a higher elasticity of demand than richer households. Rolim and Marins (2024) show that rising price levels increase inequality within workers (between those who earn low wages versus others). Our finding corroborates their result but with a continental focus. The estimated coefficient differs from those that have found a U-shaped relationship (Siami-Namini & Hudson, 2019; Glawe & Wagner, 2024) or inverted-U shaped relationship (Balcılar et al., 2017) between inflation and income inequality. According to these studies, inequality falls with increasing inflation up to a threshold point and starts increasing after the threshold point is reached (vice versa). We argue that the positive coefficient observed might be because the sample is restricted to Sub-Saharan African countries where inflation has mostly been in the phase that worsens inequality. We also differ from Nguyen (2025) who found that inflation reduces income inequality in developing countries; this might be because we are studying a specific region. In Sub-Saharan Africa, institutional weaknesses such as poor financial infrastructure may exacerbate inflation's impact on income inequality.

IG has a negative and significant coefficient (-0.07644). This implies that a 1-unit improvement in institutional governance reduces income inequality by approximately 0.076%, suggesting that better institutions lower income inequality. However, this paper's critical takeaway relates to the negative and significant coefficient on institutional governance. Supporting strong institutions lessens income inequality and may blunt inflation's impact on income distribution. From our study, we can infer that better financial development reduces inflation's detrimental effects on income inequality. This is consistent with studies that show financial development channels moderate inflation's impact on income inequality (Kim & Lin, 2023; Göcen, 2023). That being said, the results presented herein lend indirect credence to this paper's main argument on central bank independence. As alluded to in the literature review, independent and credible central banks are usually domiciled in countries with strong institutions. Finally, GDP and POP are positive but insignificant. GDP's insignificance in determining inequality is consistent with the aforementioned “non-inclusive growth” explanation. POP was also not found to be statistically significant.

Table 6: Effect of Inflation on Income Inequality

Variables	Coef.	Std. Err.	P>t
INF	0.00026***	0.00003	0.000
IG	-0.07644**	0.02240	0.003
GDPgrowth	0.00136	0.00114	0.249
PopGw	0.00057	0.00044	0.209
Constant	3.8757***	0.05447	0.000

**p<0.10; **p<0.05; ***p<0.01, respectively.*

4.2.2. Direct effect of income inequality on energy poverty in SSA

Table 7 presents the estimated impact of income inequality on energy poverty in Sub-Saharan Africa, controlling for institutional governance, economic growth, and population growth. Energy poverty is proxied by the percentage of the population with access to clean fuels and technologies for cooking, implying that higher values reflect lower levels of energy poverty. Income inequality is measured using the Gini coefficient. The coefficient on income inequality (INEQ) is negative and statistically significant ($\beta = -12.6762$, $p < 0.01$). Given that the dependent variable measures access to clean cooking technologies, this result indicates that higher income inequality reduces access to clean energy, thereby worsening energy poverty. That is, a unit increase in the income inequality leads to a 12.6762 percentage point decrease in access to clean cooking fuels and technologies. Economically, the magnitude suggests that increases in inequality substantially limit households' ability to transition to modern energy sources, reinforcing disparities in energy access. The negative relationship between income inequality and access to clean energy is strongly consistent with the extant empirical literature, which widely documents a positive association between inequality and energy poverty. Studies such as Igawa and Managi (2022), Simionescu (2025), and Wang, Umair et al. (2024) demonstrate that higher income inequality reduces affordability, limits access, and constrains the reliability of energy services, particularly for low-income households. The present findings align with this consensus, confirming that inequality is a key structural driver of energy deprivation in Sub-Saharan Africa. The magnitude and significance of the inequality coefficient further support the argument that affordability is a central channel through which inequality affects energy poverty. As highlighted in the literature, households at the lower end of the income distribution face significant financial barriers to adopting clean energy technologies, especially in contexts where income disparities are wide (Bardazzi et al., 2021; Simionescu, 2025). This reinforces the idea that reducing inequality is critical for achieving universal access to modern energy.

Institutional governance (IG) exhibits a positive and statistically significant coefficient (3.32374), suggesting that stronger institutions improve access to clean energy and, by implication, reduce energy poverty. This underscores the importance of governance quality in facilitating energy infrastructure development, enhancing policy implementation, and ensuring equitable distribution of energy resources. The positive role of institutional governance observed in this study is also consistent with prior research emphasizing the importance of institutional quality and policy effectiveness in addressing energy poverty (Acheampong et al., 2022; Certomà et al., 2023; Simionescu & Cifuentes-Faura, 2024). Strong institutions can facilitate targeted energy policies, improve infrastructure investment, and ensure equitable distribution of energy services, thereby weakening the link between inequality and energy poverty. Economic growth (GDP growth) shows a negative and statistically significant effect (-0.25832), indicating that increases in economic growth are associated with lower access to clean fuels in this specification. This counterintuitive result may suggest that economic growth in the region is not sufficiently inclusive or energy-access-oriented, potentially reflecting sectoral imbalances or unequal distribution of growth benefits. The negative effect of economic growth aligns with arguments in the literature that growth alone is insufficient and may even exacerbate disparities if not accompanied by inclusive policies (Igawa & Managi, 2022). In such cases, the benefits of growth may be captured by higher-income groups, leaving vulnerable populations without improved energy access. Similarly, population (POP) is also negative and significant (-0.12959), implying that rising population pressures reduce access to clean energy. This may be due to increased demand for energy services outpacing infrastructure development, particularly in rapidly growing urban and rural settlements. These findings echo the view that demographic pressures can strain energy infrastructure and exacerbate access challenges, particularly in developing regions with limited capacity to expand energy services. The foregoing, however, emphasises that income inequality is a critical determinant of energy poverty in Sub-Saharan Africa, operating primarily through affordability constraints. The findings also underscore the importance of institutional governance as a mitigating factor capable of improving energy access outcomes. Moreover, the lack of inclusive growth and rising population pressures further complicate efforts to achieve universal energy access. These insights suggest that policies aimed at reducing energy poverty must go beyond expanding supply and instead address underlying distributional issues, including income inequality and institutional weaknesses.

Table 7: Effect of Income Inequality on Energy Poverty

Variables	Coef.	Std. Err.	P>t
INEQ	-12.6762***	3.99015	0.006
IG	3.32374***	0.90394	0.002
GDPgrowth	-0.25832**	0.98289	0.018
PopGw	-0.12959***	0.22091	0.000
Constant	72.2834***	15.1155	0.000

**p<0.10; **p<0.05; ***p<0.01, respectively.*

4.2.3. Moderating effect of Central Bank Independence (CBI) on the inflation-income inequality nexus

Table 8 examines whether central bank independence (CBI) moderates the relationship between inflation and income inequality in Sub-Saharan Africa. Two specifications are reported: the main model using standardized CBI index ($CBIR_{st}d$), which is corrected for scale heterogeneity and non-stationarity, and a robustness check using an alternative measure, the first-differenced CBI (ΔCBIR), to ensure the consistency of results under alternative stationarity treatment. The dependent variable is income inequality (INEQ) which is proxied using the Gini coefficient. All specifications include the interaction term (INF × CBI) to identify whether inflation's distributional impact varies by levels of central bank independence. Following the baseline model, inflation (INF) is positive and highly statistically significant across both specifications (0.00023). The effect suggests that inflation contributes to increasing income inequality, holding all else equal. Consistent with the argument above, higher central bank independence (CBI) is associated with lower levels of income inequality based on a negative and weakly significant coefficient (-0.0356). As expected, institutional governance (IG) is negative and highly significant, GDP growth and population growth are statistically insignificant. Based on these results, the central finding is that the interaction term is positive and statistically significant (0.0064). The positive sign contradicts the hypothesis that independent central banks can counteract inflation's negative distributional impact. Instead, the results suggest that increases in central bank independence are associated with a stronger positive effect of inflation on income inequality. While the baseline estimates indicate that greater central bank independence amplifies the inequality-increasing effect of inflation, the subsequent quantile analysis reveals a more nuanced pattern. Specifically, the positive interaction effect is concentrated in the lower and middle segments of the inequality distribution and becomes statistically insignificant at higher inequality levels. This suggests that the average moderating effect reported in the fixed-effects estimates may not be uniform across countries. Rather, the influence of central bank independence on the inflation-inequality relationship appears to depend on underlying distributional conditions, highlighting the importance of accounting for heterogeneity when evaluating the social consequences of monetary institutions.

There are three potential channels through which this finding can be explained. First, inflation tends to fall under environments with highly independent central banks as the institutions are more likely to implement contractionary monetary policy rules (e.g. higher interest rates). However, these policies can come with distributional side-effects that could increase inequality during inflationary periods: lower employment creation, depressed wage growth for low-income workers, and tight credit conditions. These effects can weigh heavier on certain households and outweigh contractionary policy benefits during inflationary periods. Second, there could be uneven benefits of central bank credibility and reduced inflation rates on income distribution. Households with higher incomes benefit more from a stable financial market, while everyone benefits from the weaker side effects of contractionary monetary policy. Inflation is costly to households that benefit less from stable financial markets, such as low-income households who face indirect effects of liquidity contraction due to contractionary monetary policy. Lastly, the results can potentially be driven by institutional asymmetries where increases in central bank independence are not matched with other policies (i.e. fiscal, social welfare policies, etc.). While autonomous central banks can effectively mitigate inflation, institutional differences mean some economies are more susceptible to inequality during inflationary periods. Hence, it is impossible to rule out that contractionary monetary policy plays a role in amplifying inequality at the same time central banks reduce inflation. However, much of the literature agree that better managed monetary policy and inflation targeting regimes help reduce inequality (Kartaev et al., 2020; Garcia & Cross, 2024). Interestingly, there is evidence suggesting that contractionary monetary shocks can have a positive effect on income inequality among advanced economies (Kartaev et al., 2020). If anything, the positive interaction term supports Rolim and Marins' (2024) argument that inflation's distributional impact hinges on the type of transmission channel via monetary policy. Garcia and Cross' (2024) finding on contractionary monetary policy shocks similarly suggest that policies designed to lower inflation can have adverse distribution effects.

Table 8: Moderating Role of CBI on Inflation-Inequality Nexus

Variables	**Main Model - CBIR_std**		**Robustness Check - d_CBIR**	
DV: INEQ	Coef.	Std. Err.	Coef.	Std. Err.
INF	0.00023***	0.00004	0.00023***	0.00004
CBIR_std	-0.03555*	0.01805	-0.03563*	0.01810
INFCBIR	0.00635**	0.00275	0.00642**	0.00277
IG	-0.07473***	0.02381	-0.07475***	0.02383
GDPgrowth	0.00136	0.00115	0.00136	0.00115
PopGw	0.00055	0.00040	0.00055	0.00040
Constant	3.88499***	0.05623	3.88494***	0.05620

**p<0.10; **p<0.05; ***p<0.01, respectively.*

Concurrently, CBI's negative and significant coefficient provides evidence that institutional credibility can play a role in reducing inequality (Kim & Lin, 2023). Taken together, these two effects suggest that CBI has both a direct effect on reducing inequality and an indirect effect on amplifying it through inflation. However, the robustness model using the alternative CBI measure (the first-differenced CBI (ΔCBIR)) produces nearly identical coefficients and significance levels, confirming the stability of the results. The consistency across specifications strengthens confidence in the conclusion that the moderating role of CBI is both statistically and economically meaningful. These findings highlight the significance role of central bank independence in Sub-Saharan Africa. While CBI contributes to lower inequality on average, it may intensify the adverse distributional effects of inflation under certain conditions. This underscores the importance of coordinating monetary policy with complementary fiscal and social policies to protect vulnerable populations. Furthermore, the findings suggest that simply increasing central bank independence is not sufficient; the policy framework within which independence operates is equally critical for achieving inclusive outcomes.

4.2.4. Moderating effect of Central Bank Independence (CBI) on the inflation-energy poverty nexus

Table 9 investigates whether central bank independence (CBI) moderates the relationship between inflation and energy poverty in Sub-Saharan Africa. Energy poverty (EP) is proxied by access to clean fuels and technologies for cooking, such that higher values indicate lower energy poverty. Two specifications are presented: the main model using standardized CBI ($CBIR_{st}d$) and a robustness check using an alternative measure (the first-differenced CBI (ΔCBIR)). The interaction term (INF×CBI) allows for testing whether inflation's influence depends on monetary policy independence. Inflation (INF) is positive and significant in both specifications ($\beta \approx 0.0135$, $p < 0.01$). The variable thus positively relates to access to clean energy (lower energy poverty). This estimate is surprising at first since inflation in energy prices would be expected to lower rather than increase affordability. However, inflation may also proxy for macroeconomic trends like increased growth periods, government spending, or investments which could increase access to energy more broadly. Additionally, CBI is positive and weakly significant across both models (6.78), suggesting monetary policy independence helps improve access to clean energy. Lastly, IG is positive but insignificant, implying no stable direct relationship with energy poverty in this specification, while GDP has the expected negative sign and is weakly significant (0.18, $p < 0.10$). Population (POP) is negative and significant (0.132, $p < 0.01$), implying rising population pressures lower access to clean fuels. This estimate confirms expectations since increasing population pressures suggest fixed or slowly growing energy infrastructures are strained.

The coefficient of the INF × CB interaction term is positive and insignificant in both the main and robustness models ($\beta \approx 0.54$, $p > 0.10$). That is, monetary policy independence does not moderate how inflation relates to energy poverty in SSA. In other words, although inflation and CBI separately influence energy access within SSA, their joint (interactive) effect is statistically indistinguishable from zero. This implies inflation impacts energy poverty similarly at different levels of central bank independence in the observed sample. We hypothesize this occurs because inflation impacts energy poverty through different transmission channels than income inequality. Monetary policy independence and central bank strength can indirectly impact inflation and broader financing conditions. However, energy poverty is likely more heavily determined by access to energy infrastructure, pricing policies, income distribution, and public investments. Put differently, the positive inflation coefficient likely captures specific dynamics within SSA that link inflation with increased access to energy. This could occur through higher government spending, subsidies, or direct investment in energy access initiatives. It may also pick up periods of adjustment where energy consumption grows with increasing prices. Again, while the positive influence of CBI aligns with broad improvements in energy access through more credible institutions, it does not suggest these institutions indirectly affect inflation dynamics related to energy poverty.

Table 9: Moderating Role of CBI on Inflation–Energy Poverty Nexus

Variables	Main Model- cbir_std		Robustness Check- d_cbir	
DV: EP	Coef.	Std. Err.	Coef.	Std. Err.
INF	0.01349***	0.00407	0.01350***	0.00404
cbir_std	6.78700*	3.42885	6.77431*	3.43568
INFCBIR	0.54263	0.35742	0.54157	0.35818
IG	1.52764	0.99342	1.52952	0.99152
GDPgrowth	-0.17999*	0.0899	-0.17910*	0.08952
PopGw	-0.13171***	0.0284	-0.13170***	0.02843
Constant	21.1900***	2.7036	21.204***	2.72271

**p<0.10; **p<0.05; ***p<0.01, respectively.*

This finding contrasts with the large empirical literature which consistently finds that inflation negatively impacts energy poverty through diminished affordability, though this effect is typically specific to energy price inflation (see Halkos & Aslanidis, 2023; Alem & Demeke, 2020). The result is however not inconsistent with recent work that has found nonlinear effects of inflation on energy poverty or other work that shows the effect varies by economy (Memiş & Aydın, 2024; Husnain et al., 2021). The insignificant moderating effect of CBI also departs from studies that highlight how governance and institutional quality play critical roles in shaping inflation's influence (Mawutor et al., 2023). This could imply central bank independence is not a helpful proxy for institutional quality within SSA or that independence alone is not sufficient to impact energy poverty without fiscal or sector-targeted policies. Meanwhile, CBI's general positivity in improving energy access is consistent with work that suggests institutional strength and macroeconomic stability contribute to improved developmental outcomes like infrastructure and service delivery. Further, this model's robustness specification results when re-estimating with the alternative CBI measure (the first-differenced CBI (ΔCBIR)) are nearly identical to the baseline in both coefficient magnitude and significance. This similarity suggests our findings are reliable and that the null moderating effect does not depend on the CBI measure. Instead, the results tell us that although inflation and CBI both matter for energy poverty levels in SSA, central bank independence is not a statistically important modifier of inflation's influence on energy poverty. This suggests policymakers should focus on sector-targeted policies like energy subsidies, infrastructure investments, and targeted energy programs to reduce energy deprivation. Taken at face value, the findings imply monetary policy cannot be used to reduce energy poverty on its own.

4.2.5. Heterogeneity Analysis of Inflation, CBI, and Inequality

The MMQR estimates provide important additional insights beyond the average effects reported by the fixed-effects models. In particular, they reveal several distributional patterns that complicate the interpretation of the baseline results. Rather than simply confirming the average estimates, the quantile regressions indicate that the effects of inflation, inequality, and central bank independence vary considerably across the distribution of inequality and energy poverty. Consequently, the MMQR findings should be interpreted as evidence of substantive heterogeneity in the relationships under investigation. Table 10 presents the MMQR estimates for heterogeneous effects as well as position to identify possible distributional dynamics of our main variables of interest at different points (25th, 50th, and 75th quantiles) in the income inequality and energy poverty distributions. Firstly, Table 10 panel A shows the results when allowing for heterogeneity in inflation–inequality relationship. The inflation is statistically insignificant across all quantiles. The coefficients reduce from positive at lower quantiles to slightly negative at higher quantiles. Therefore, inflation does not have identical distributional impacts when heterogeneity is considered. IG positively and increasingly significantly affects income inequality from lower to higher quantiles. The positive relationship between inequality and institutional governance becomes stronger at higher levels of income inequality. This may imply that governance in unequal countries may be associated with long-standing institutional biases that disproportionately benefit higher income households. GDP is negative and significant at Q25 indicating that growth can decrease inequality in relatively equal countries, but after a certain level of equality is reached, the effect vanishes and reverses. Population growth exerts a negative and increasingly significant effect along the inequality distribution. This could be as a result of the fact that when inequality levels are very high, there is less room to compress them so population growth may lead to some form of inequality compression through shifts in the labour market. The difference between quantiles could be a reflection of differences in the structure of economy. At higher levels of inequality, economies of countries may have different channels through which inflation is transmitted when compared to relatively equal countries.

Panel B model 2 discusses results of heterogeneity in inequality-energy poverty nexus. The results show that INEQ positively and highly significantly affects energy poverty at the lower and median quantiles (Q25 & Q50). However, at Q75 the effect of inequality on energy poverty becomes statistically insignificant. This finding could mean that inequality hinders access to clean energy more in countries that are relatively less energy poor but has less effect as countries get highly energy poor. IG is positive and highly significant across all quantiles and the magnitude of the coefficients increases at higher quantiles. This suggests that one additional point increase in institutional governance will have a greater impact in countries that are highly energy poor when compared to countries that are less energy poor. GDP is negative and only significant at lower and median quantiles, implying that growth can help improve access to clean energy in relatively well performing countries. The effect of growth on energy poverty vanishes at higher quantiles, suggesting that the benefits of growth do not translate to improved energy access at high levels of energy poverty. This can be explained by the fact that at higher levels of energy poverty countries put more emphasis on policies that support access to clean energy as more people are energy poor. POP is negative and highly significantly across all quantiles holding greater negative effect at higher quantiles. The increasing negative effect could be attributed to the increasing pressure on energy systems as population growth rates increase. However, at higher quantiles of energy poverty the structural factors, such as energy infrastructure, play a greater role in determining energy access and this tends to overshadow the effects of inequality. Although inequality continues to have a positive effect, while institutional governance effects remain positive and significant across all quantiles, GDP and population growth effects differ across quantiles when heterogeneity is considered in the inequality-energy poverty nexus.

Table 10: MMQR Estimates Across Quantiles

	Coeff.	St. Error	Coeff.	St. Error	Coeff.	St. Error
Panel A: Income Inequality Equation (Model 1)						
DV: INEQ	Q25		Q50		Q75	
INF	0.00006	0.00009	0.00002	0.00008	-0.00001	0.00011
IG	0.02286	0.01816	0.09088***	0.01685	0.15740***	0.02106
GDP	-0.00557**	0.00264	-0.00105	0.00252	0.00335	0.00320
POP	-0.00029	0.00025	-0.00046*	0.00024	-0.00062**	0.00030
Constant	3.62868***	0.03525	3.61324***	0.03383	3.59815***	0.04304
Panel B: Energy Poverty Equation (Model 2)						
DV: EP	Q25		Q50		Q75	
INEQ	34.228***	4.83354	29.7050***	6.86007	19.2129	15.0603
IG	15.737***	1.33971	18.3112***	1.83410	24.282***	4.16370
GDP	-0.68248***	0.20465	-0.73392**	0.29345	-0.8532	0.63816
POP	-0.22692***	0.01928	-0.26329***	0.02660	-0.34766***	0.06001
Constant	-136.49***	17.5902	-116.957***	24.9115	-71.6242	54.813
Panel C: Income Inequality Equation (Model 3)						
DV: INEQ	Q25		Q50		Q75	
INF	-0.00030**	0.00013	-0.00021	0.00013	-0.00007	0.00018
CBIR	-0.21178***	0.07686	-0.27381**	0.07732	-0.37375***	0.10765
INFCBIR	0.05421****	0.01227	0.03387***	0.01239	0.00110	0.01681
IG	0.06483***	0.01689	0.08855***	0.01703	0.12678***	0.02334
GDP	-0.00740***	0.00245	-0.00377	0.00247	0.00208	0.00339
POP	0.00043	0.00036	-0.00020	0.0003	-0.00123**	0.00049
Constant	3.59381***	0.07636	3.72447***	0.0771	3.93499***	0.10523
Panel D: Energy Poverty Equation (Model 4)						
DV: EP	Q25		Q50		Q75	
INF	-0.01104	0.01312	-0.0032	0.01647	0.00973	0.02820
CBIR	10.8193*	6.14717	7.86997	7.71930	2.99335	13.2008
INFCBIR	-2.6484***	0.95446	-3.5332***	1.19726	-4.99621**	2.05668
IG	18.3949***	1.43121	19.2878***	1.79668	20.7641***	3.07633
GDP	-0.87041***	0.23878	-0.8539***	0.29999	-0.82673	0.51204
POP	-0.31311***	0.03164	-0.3801***	0.03945	-0.49108***	0.06944
Constant	-11.7601*	6.56641	0.50394	8.21786	20.7822	14.2852

Notes: Robust standard errors in parentheses.

****p<0.01, **p<0.05, p<0.10.*

Panel C presents the heterogeneous moderating effects of central bank independence on the inflation-inequality nexus. The direct effect of CBI remains negative and statistically significant across quantiles, suggesting that stronger monetary institutions are generally associated with lower levels of inequality. However, the interaction term between inflation and CBI is positive and statistically significant at the 25th and 50th quantiles but becomes statistically insignificant at the 75th quantile. This finding is broadly consistent with the baseline fixed-effects estimates but reveals that the amplification effect is concentrated among countries with relatively low and moderate levels of inequality. In highly unequal countries, the moderating role of central bank independence appears substantially weaker. Therefore, the average interaction effect masks important variation across the inequality distribution. Panel C model 3 discusses the finding regarding heterogeneity in the moderating role of CBI on Inequality. The results show that INF negatively and significantly affect income inequality at lower quantile but becomes statistically not significant from median quantile onwards. This may mean that inflation can help in reducing inequality in countries that are relatively equal but has no clear effect beyond a certain level of inequality. CBIR has a negative and significant effect across all quantiles with greater effect at higher quantiles. One unit increase in CBI will have a greater effect in countries that are highly unequal when compared to countries with lower quantiles of inequality. (INF × CBI) is positive and highly significant at lower and median quantiles but becomes statistically insignificant at Q75. This finding may imply that CBI has a greater role in fuelling inequality in countries that have low and middle levels of inequality, but at high levels of inequality, the role of CBI as a moderator of inflation on inequality lessens. Although inflation continues to have a negative sign when interacting with CBI. This diminishing effect at higher quantiles may also be explained by institutional saturation. Beyond a certain level of CBI, inequality continues to decrease but does not increase by much with each additional level of CBI introduced.

Panel D reveals an important empirical contrast with the baseline energy-poverty estimates. While the fixed-effects model reports an insignificant interaction between inflation and central bank independence, the MMQR results show that the interaction term is negative and statistically significant across all quantiles of the energy-poverty distribution. This suggests that greater central bank independence may weaken the adverse association between inflation and energy deprivation in certain distributional contexts, even though this effect is not evident in the average estimates. The divergence between the fixed-effects and MMQR results highlights the importance of recognising heterogeneity across countries and cautions against relying exclusively on mean effects when assessing the welfare implications of monetary institutions. Panel D model 4 presents the findings of heterogeneity in the moderating role of CBI on Energy poverty. INF is statistically insignificant across all quantiles which is consistent with our previous finding that inflation, when considered with heterogeneity, has a weak and meaningless direct relationship with energy poverty. CBIR is positive but only weakly significantly at lower quantile implying that Central Bank Independence has a weak direct relationship with energy access. (INF × CBI) is negative and statistically significant across all quantiles holding a greater magnitude at higher quantiles. Unlike the previous interaction effect the moderating effect of CBIR increases as the level of energy poverty increases. This result implies that CBI helps in reducing the inequality impacts of inflation on energy poverty more at higher quantiles of energy poverty. This can be attributed to the fact that at high levels of energy poverty, credible monetary institutions may have a greater stabilizing role by anchoring inflation expectations which may help to maintain energy affordability. IG remains positive and highly significantly across all quantiles, while GDP and POP continue to exert negative effect on energy access. However, these effects differ across quantiles.

4.3. Limitations of the Study

Despite its contributions, this study has several limitations that should be acknowledged. First, despite the use of fixed effects, Driscoll-Kraay corrections, and MMQR estimation, the possibility of residual endogeneity cannot be completely eliminated. Inflation, inequality, energy poverty, and institutional arrangements may be jointly influenced by broader political economy conditions that are difficult to observe and measure. Second, the de jure Central Bank Independence index is inherently persistent over time, implying relatively limited within-country variation. This may reduce the precision of estimates involving interaction effects under a fixed-effects framework. Third, although the quantile analysis uncovers important heterogeneity, the results should not be interpreted as evidence of causal mechanisms.

Nevertheless, future studies may benefit from employing instrumental-variable approaches, natural experiments, or institutional reforms that provide stronger identification of causal effects.

5. Conclusion and Policy Recommendations

This paper contributes to the literature on inflation and income inequality by bringing the issue of energy deprivation into the picture. The study assesses the interconnections between inflation, energy poverty, and income inequality across SSA countries while accounting for the potentially moderating role of CBI in a panel of 24 countries spanning from 2005 to 2022. We employ Driscoll-Kraay fixed effects and Method of Moments Quantile Regression (MMQR) estimators to control for cross-sectional dependence and distributional heterogeneity in the data. The results show that inflation significantly increases income inequality, stressing its regressive effects in the region. In turn, higher income inequality is found to exacerbate energy poverty by reducing households' access to clean fuels and modern energy technologies. Institutional governance consistently reduces inequality and improves energy access, emphasizing its importance in development outcomes. Central bank independence plays a dual role: while it is associated with lower average income inequality, it amplifies the inequality-increasing effect of inflation. However, its moderating effect on the inflation-energy poverty nexus is weak in mean regressions but becomes more relevant in highly deprived situations. The heterogeneity analysis reveals that these relationships vary across the distribution of inequality and energy poverty. The effect of inequality on energy poverty is stronger at lower and median quantiles, while institutional effects become more pronounced at higher deprivation levels. Similarly, the role of central bank independence and inflation differs across quantiles, confirming substantial distributional asymmetries.

The findings from this study offer a number of policy prescriptions to the stakeholders. First, the findings suggest that monetary institutions may play an important role in determining distributional and welfare outcomes in Sub-Saharan Africa. However, given the associational nature of the empirical evidence, the results indicate that countries characterised by stronger monetary institutions tend to exhibit different inflation–inequality and inflation–energy poverty relationships. Consequently, policy discussions concerning central bank reforms may benefit from considering their potential distributional implications alongside broader fiscal, social protection, and energy-access policies. Second, our findings suggest that institutional quality consistently matters in improving energy access and reducing inequality. Therefore, policy-makers should promote institutional governance as means to amplify the effectiveness of both monetary and fiscal policy. A higher quality of governance can improve policy transparency and effectiveness, increasing the likelihood that macroeconomic stability will lead to better distributional outcomes. Policy efforts should also be directed towards fighting corruption. Third, given that income inequality has positive effects on energy poverty, energy access policies should take potential redistributive impacts into account. Providing access to clean fuels and modern energy services requires that households can afford to pay for these services. Policies that aim to close the income inequality gap, whether through progressive taxation, income support, or financial inclusion, can contribute to increasing energy access. Improving access alone in the absence of redistributive policies will not address energy poverty if low-income households remain unable to afford energy services.

Fourth, results indicate that economic growth is not enough to spur reductions in inequality or achieve improved access to clean fuels and modern energy services. To this end, policies should focus on facilitating inclusion in growth-enhancing processes. Investments in rural energy infrastructure are needed to connect those relatively deprived to the grid. Moreover, job creation should accompany growth policies to boost household income. Fifth, policymakers should account for the heterogeneity in our results. The conditional effect of inequality on energy poverty indicates that countries with high levels of energy poverty should focus policy efforts on structural constraints first. However, in countries that are relatively better off, reducing income inequality could yield larger gains in improving energy access. In sum, policies should be distribution-sensitive and tailored to country-specific circumstances rather than formulated with the region in mind. Sixth, our findings suggest that central banks should adopt a more development-friendly outlook. Though independence is still likely necessary to avoid political interference and maintain price stability, central banks should work with fiscal agencies and development banks to reduce the negative distributional side-effects of monetary policy. For instance, promoting universal access to the formal financial sector and access to credit would help ameliorate some of these spillovers.

Nevertheless, the finding points to a complex interaction between inflation, inequality, energy poverty, and monetary institutions. While central bank independence is associated with lower inequality on average, its moderating role differs across empirical specifications and across different points of the inequality and energy-poverty distributions. These findings underscore the importance of cautious interpretation and suggest that future research should further investigate the underlying mechanisms through stronger identification strategies and more detailed measures of institutional effectiveness.

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