Inflation Thresholds, Financial Inclusion, and the Access to Clean Energy in the Household: Evidence from Africa Using Quantile Regression

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ABSTRACT: This study estimates inflation thresholds that nullify the positive impact of financial inclusion on access to clean cooking fuels in sub-Saharan Africa (SSA). Using data from 40 SSA economies between 2002 and 2022 and the Quantile Regression as an estimation strategy, the findings reveal that financial inclusion enhances access to clean cooking fuels, particularly when measured by bank account ownership and bank branch availability. The result also finds that rural areas benefit more from financial inclusion than their urban counterparts. Additionally, the findings show that above certain thresholds, inflation erodes the benefits of financial inclusion. These thresholds are also heterogeneous based on the existing levels of access to clean cooking fuels. Nonetheless, results based on the Prais–Winsten estimator revealed that inflation nullifies the impact of bank account ownership when it surpasses 20.95%, on average. These results are particularly essential for policy, as they offer insights for the design of inflation-targeting policies that can safeguard the role financial inclusion plays in fostering the transition to clean cooking fuels for households in the region.

JEL classification: E31, G21, O13, Q42, C21, C23.

Keywords: Inflation, Financial Inclusion, Energy Transition, Cooking Fuel, Sub-Saharan Africa.

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1 Introduction

According to World Bank (2025a), Sub-Saharan Africa (SSA) has the lowest access to clean cooking fuels. The region significantly lags in household adoption of clean cooking energy. The disparity is more pronounced in rural areas, where access remains critically low (see Figures 1, 2, and 3). The consequences of this limited access are far-reaching and multifaceted. According to Chillrud et al. (2021), the use of dirty fuels increases the exposure to air pollution. This can potentially increase illness and deaths attributed to indoor air pollution. World Health Organization (2024) has revealed that about 3.2 million people die prematurely from various illnesses that are associated with the use of dirty fuel for cooking in the household. Several studies have also revealed the health implications of using dirty fuels for cooking by households (Rasel et al., 2024; Byaro et al., 2024; Puzzolo et al., 2024; Wang et al., 2023b; Azorliade et al., 2022).

Beyond the health implications of the poor access to clean fuels for cooking is the environmental impact. According to Marot (2023), using dirty fuel for cooking in the household implies a direct consequence of deforestation and accelerates climate change due to the emissions of greenhouse gases. Wood fuel used for cooking accounts for about 1 gigaton of yearly CO_2, or around 2% of global emissions. World Bank (2020) has further estimated the environmental and local economies cost of using dirty fuels for cooking in households to be around US$2.4 trillion. Moreover, over half of global black carbon emissions originate from the household burning of solid fuels for cooking and heating. According to Cho (2016), black carbon is the second-largest driver of climate change after CO_2, making the transition to cleaner cooking fuels critical for both environmental sustainability and public health.

The transition to clean energy from fossil-fuel for cooking is also essential in achieving Sustainable Development Goal (SDG) 7, which seeks to ensure universal access to affordable, reliable, sustainable, and modern energy by 2030. However, progress in SSA has been slow. As of 2022, only 22% of the region's population had access to clean cooking fuels (World Bank, 2025a), underscoring a significant gap in the region's transition to cleaner energy sources. While some progress has been made over time, SSA continues to lag far behind other regions. In contrast, Europe and Central Asia, as well as the Middle East and North Africa, have achieved clean energy access rates exceeding 90%, highlighting the stark disparities in global energy transition efforts.

Existing literature on financial inclusion largely highlights its positive impact on access to finance, particularly for low-income and vulnerable households, and its role in facilitating the shift to clean cooking fuels (Abokyi et al., 2024; Gu, 2024; Zhao, 2025; Osuma et al., 2025; Qamruzzaman, 2025). However, while financial inclusion is at the forefront of improving access to cleaner cooking fuels and household energy transition, inflation can erode the potential benefits by reducing households' purchasing power, limiting the effectiveness of financial inclusion. This demand-side phenomenon can further be aggravated by supply-side constraints. The rise in price level often causes monetary authorities to raise interest rates, which in turn raises the cost of borrowing. This leads to a fall in the supply of financial services, even when households are financially included. World Bank (2025c) has revealed a marked increase in consumer price inflation in SSA post-pandemic, reaching 9.39% in 2022 from 2.83% in 2019. To this end, this study firstly examines the nexus between financial inclusion and household access to clean fuels for cooking and then estimates the level of inflation that erodes the impact of financial inclusion on access to clean fuels for cooking, following Asongu and Nwachukwu (2018) and Asongu and Odhiambo (2020) threshold computation procedure.

The novelty and justification of this study stem from the following criteria: (1) by identifying the inflation threshold, policymakers can design effective inflation control measures to prevent the undermining of financial inclusion efforts on improving access to clean fuel for cooking, and (2) policymakers and stakeholders in the financial inclusion environment can effectively understand the inflationary conditions where financial products and interventions remain effective. Moreover, the policy relevance of this study is enhanced using the Quantile Regression (QR). QR can assess the effect of inflation on the nexus between financial inclusion and the access to clean fuels for cooking based on the conditional distribution of the access to clean fuels for cooking, i.e., the study improves on the policy relevance by examining the nexuses based on initial levels of access to clean fuels for cooking. This is essential because SSA economies have different access rates in using clean cooking fuel, as such, mean estimates might not be as policy relevant as when the estimates are conditioned on initial levels of access to clean fuels. Additionally, further novelty arises from disaggregating the impact by considering location heterogeneity to understand rural-urban dynamics. The study employed data across forty (40) SSA economies from 2002 to 2022. The remainder of this study is the literature review section, the methodology and data section, the presentation and discussion of results section, and the conclusion with relevant policy recommendations.

2 Literature review

The theoretical underpinning of this study stems from two theories, the energy ladder hypothesis (Leach, 1992) and the credit rationing theory (Stiglitz and Weiss, 1981). Accordingly, the energy ladder hypothesis posits that the evolution of household energy consumption is in relation to income levels. The hypothesis reveals that households gradually transition from traditional, low-efficiency biomass fuels—such as firewood, dung, and charcoal—to modern, cleaner, and more efficient energy sources like kerosene, liquefied petroleum gas (LPG), and electricity as their financial status improves. This transition is predicated on the assumption that increased income leads to better access to modern energy infrastructure, consequently enhancing the adoption of more advanced energy solutions. However, Waleed and Mirza (2023) revealed that the transition to cleaner energy in the household is not necessarily linear, which introduces a concept known as energy stacking. This concept emphasizes that households use multiple energy sources simultaneously instead of fully abandoning traditional fuels in favour of cleaner and modern alternatives. In many SSA countries, unreliable energy supply, fluctuating income levels, and inflation prevent households from completely shifting to modern energy sources. Instead, these households adopt a hybrid approach, utilizing both traditional biomass and modern energy. The energy ladder hypothesis signifies that as income levels increase, households transition to clean fuel for cooking. However, inflation reduces the real income and purchasing power that arise from financial inclusion, making it difficult for households to afford clean cooking fuels. This demand-side phenomenon dampens the positive influence of financial inclusion on household energy transition.

Moreso, the credit rationing theory offers a supply-side perspective, explaining how inflation can lead financial institutions to restrict access to financial services, particularly credit. According to Greenbaum et al. (2019), rising inflation results in the increase in interest rates, which leads banks to lend less, irrespective of customers' will to maintain loan demands. Thus, credit will be constrained by the availability of credit to banks, with credit allocation following a non-price means. Stiglitz and Weiss (1981) noted that even at a prevailing market rate, lenders are unwilling to advance funds to borrowers. According to Boyd et al. (2001), inflation leads to credit rationing by creating uncertainty about future returns for lenders, making them more risk-averse with lesser likelihood of extending credit, particularly to higher perceived risk households such as those in rural communities.

Empirical literature on the nexus between financial inclusion and the access to clean fuels for cooking have documented the explicit importance of financial inclusion on household energy transition. For clarity purposes, the empirical discussions will start with studies adopting a systematic literature review and cross-sectional analysis and conclude with studies that used panel data as estimation strategies. The study of Ocen et al. (2024), employing a systematic literature review methodology to examine the factors that determine the choice of clean cooking fuel among households and using seventy-four peer-reviewed articles, revealed that among other factors, financial inclusion is a key factor that influences the use of clean cooking fuels. Furthermore, Immurana et al. (2023) using the Ghana Living Standards Survey round 7 (GLSS7) and the binary logistic regression technique revealed that households that are financially included have higher probability of adopting healthier source of energy for cooking compared to households that are financially excluded. The results further revealed that the effect of financial inclusion on the choice of cooking energy is greater among rural households than their urban counterparts. The findings were robust to changes in the estimation method and financial inclusion indicator.

Moreover, Twumasi et al. (2020), using an instrumental variable Probit and Tobit estimation technique for survey data from four regions in Ghana, revealed that financial inclusion in rural households significantly influences the likelihood of improved access to clean energy use for cooking. The result further finds heterogeneity across regions. Abokyi et al. (2024) using the GLSS round 6 and 7 and a two-stage least squares probit regression to account for potential endogeneity revealed that financial inclusion increases the access to clean fuel for cooking, with additional findings showing that the impact of financial inclusion on the use of clean cooking fuel is more pronounced in rural households than in urban households. In Kenya, Hsu et al. (2021) employed survey-based methodologies which used a pilot microfinance initiative to understand the impact of loan financing for low-income rural households on the access to cleaner fuels for cooking. Using a sample of 69 rural households as treatment and 332 rural households as the control group, the result revealed that beneficiaries of the loan financing, i.e., the treatment, were more likely to use cleaner energy for cooking compared to the non-beneficiaries, i.e., the control group. Gu (2024) using a spatial simultaneous equation model for 2,615 Chinese rural households in 2020 revealed a significant positive interaction between financial inclusion and energy poverty.

Within the panel data framework, Kwakwa (2024), using data from 32 African economies between 2002 and 2021 and employing the fully modified ordinary least squares (FMOLS) and the QR estimation techniques, revealed that access to credit significantly increased the use of clean fuels for cooking in African households. However, Acheampong (2023) using the two-step dynamic GMM for a panel of SSA economies revealed that the access to credit, which is a measure of financial inclusion do not facilitate the access to clean fuel for cooking—an indication that the impact of financial inclusion is sensitive to the proxy used. Murshed (2025), using data for 40 developing countries in SSA and Latin America and the Caribbean (LAC) from 2002 to 2018 using the cross-sectional augmented autoregressive distributed lag (CS-AARDL) estimation technique, revealed that better access to credit improves the use of clean cooking fuels in upper-middle-income countries in both the short and long run but not in lower-income countries and SSA. However, a disaggregated empirical analysis within SSA by Murshed (2022) using data from 34 economies between 2000 and 2016 and employing the augmented mean group (AMG) procedure, which accounts for slope heterogeneity and cross-sectional dependence, revealed that higher access to credit increases the use of clean fuel for cooking in both lower middle and upper middle-income SSA economies but not in lower-income SSA economies. Wang et al. (2023a), using data across SSA economies between 2004 and 2019 and the pooled OLS, FE regression, and the Driscoll and Kraay method to account for several biases in econometric modelling, revealed that financial inclusion is essential for households to transition to clean fuel for cooking in the region. Additionally, Mperejekumana et al. (2024) highlight that achieving sustainable development in SSA requires a transition to cleaner fuels to curb greenhouse gas emissions and mitigate environmental degradation, with financial inclusion playing a central role in facilitating this shift.

Furthermore, Qamruzzaman (2025) used the fourier-augmented machine learning framework between 2003 and 2023 and the CS-ARDL model for 36 SSA economies revealed that financial services are essential for optimising the positive effect of remittances in improving the access to clean fuels. Nonetheless, Mawutor et al. (2024) employing the system GMM estimator using data from 2000 to 2019 for 40 African economies revealed that inflation has a negative and statistically significant effect on household adoption of clean cooking fuels in the region. Similarly, Memis and Aydin (2025), analysing 32 developing economies with both the GMM and three-stage least squares (3SLS) estimators, report that higher inflation rates are negatively associated with energy poverty. In addition, Bardazzi et al. (2024) document the adverse effects of inflation on energy poverty among Italian households.

The existing literature largely concludes that financial inclusion enhances household access to clean cooking fuels, while the few studies on the inflation-energy poverty nexus shows a clear negative nexus. However, studies on the role of inflation on the financial inclusion and energy poverty nexus is sparse. This study aims to address this gap by identifying the inflation thresholds beyond which financial inclusion ceases to improve access to clean cooking fuels. Accordingly, this study proposes the following hypotheses:

Hypothesis 1. *Inflation does not nullify the positive impact of financial inclusion on access to clean cooking fuels once it exceeds a certain threshold in SSA.*

Hypothesis 2. *The effect of inflation on the financial inclusion–clean cooking fuel nexus does not vary depending on the existing level of access to clean cooking fuels in SSA.*

3 Methodology and data

3.1 Methodology

In assessing the inflation threshold for financial inclusion and the household energy transition nexus, an interactive QR is employed. Accordingly, the effect of inflation on the financial inclusion and household cooking energy transition nexus is examined throughout the conditional distribution of the share of the population that has access to clean fuels for cooking. While mean regressions such as the OLS are essential, QR examine the nexuses contingent on the initial levels of the outcome variable. As such, we examine the effect of inflation on the nexus between financial inclusion and household energy transition in countries with low, intermediate, and high initial levels of the regressand. QR enhances the policy relevance of the nexus as policies are better tailored and offered based on the existing levels of household cooking energy transition in SSA. According to Koenker and Bassett (1978), Billger and Goel (2009), and Asongu (2024), when compared to the OLS, which is based on the assumption of normally distributed error terms, QR does not require the assumption that the error terms follow a normal distribution. Moreover, as revealed, QR captures heterogeneous effects and is robust to outliers and skewed distributions, making it a preferred estimation procedure when compared to mean regressions.

Accordingly, the traditional OLS equation is given such that:

$$\mathrm{cf}_{i,t} = \sigma_0 + \sigma_1 \mathrm{fi}_{i,t} + \sigma_2 \mathrm{inf}_{i,t} + \sigma_3 \mathrm{fi}_{i,t} \times \mathrm{inf}_{i,t} + \sigma_4 X_{i,t} + u_t + e_{i,t}, \tag{1}$$

In Equation 1, $\mathrm{cf}_{i,t}$ is the access to clean fuels for cooking, which includes the aggregated and location-specific indicators, $\mathrm{fi}_{i,t}$ includes three indicators for financial inclusion: bank account ownership, bank branches, and bank credit, $\mathrm{inf}_{i,t}$ is inflation. $X_{i,t}$ is a set of control variables including remittances, per capita GDP, and education. u_t is time FE, and $e_{i,t}$ is the error term in country i at time t. Furthermore, QR is tailored such that the θ^{th} quantile estimate of household cooking energy transition is derived by optimising Equation 2, which is provided without subscripts for simplicity, as follows:

$$\min_{\beta \in \mathbb{R}^k} \left[\sum_{i \in \{i:\, y_i \geq x_i\beta\}} \theta \left| y_i - x_i\beta \right| + \sum_{i \in \{i:\, y_i < x_i\beta\}} (1-\theta) \left| y_i - x_i\beta \right| \right], \tag{2}$$

where $\theta \in (0,1)$. Compared to the OLS that minimises the error sum of square, QR minimises the weighted sum of absolute deviation (Asongu et al., 2023). For better clarity, the 10^{th} and 90^{th} quantiles, i.e., $\theta = 0.10$ and $\theta = 0.90$ are examined via weighing approximately the error terms. Thus, the conditional quantile of household energy transition with respect to the regressors (x_i) is:

$$Q_y\left(\frac{\theta}{x_i}\right) = x_i\beta\theta, \tag{3}$$

where the slope parameters are examined for each θ^{th} unique quantile. The outcome variable y_i is access to clean fuels and technologies for cooking, while financial inclusion, inflation, the interaction between financial inclusion and inflation, the control variables in the model, and a constant term are elements of x_i, i.e., the explanatory variables. It is further essential to highlight that the QR in this study includes year FE to control for time invariant factors. We present the OLS estimates with year FE to further validate the use of QR by comparing the coefficients, statistical significance, and effect magnitudes across both methods. The observed differences in these estimates highlight the importance of adopting QR.

3.2 Data

The study uses data from 40 SSA economies covering the period 2002–2022. The selected timeframe is determined by data availability. Consistent with the objective of this study, three variables capture the outcome variable, and they include access to clean fuels and technologies for cooking (% of population), rural access to clean fuel and technologies for cooking (% of rural population), and urban access to clean fuels and technologies for cooking (% of urban population). These variables are presented in Table 1. The use of these three variables is to capture general effects and rural-urban dynamics. Furthermore, the study captures financial inclusion using three variables that can capture various dimensions of financial inclusion. They include bank accounts per 1,000 adults, bank branches per 1,000 adults, and bank credit to bank deposits (%). To avoid omitted variable bias, three control variables are included in the models, which include personal remittances received (% of GDP), the natural logarithm of gross domestic product (GDP) per capita, constant $US, and secondary school enrolment (% gross) to capture education.

Table 1: Variables and sources

Variables		Source
Dependent variables		
Access to clean fuels and technologies for cooking (% of population)	ACF	WDI
Rural access to clean fuels and technologies for cooking (% of rural population)	ACFR	WDI
Urban access to clean fuels and technologies for cooking (% of urban population)	ACFU	WDI
Explanatory variables		
Bank accounts per 1,000 adults	BA	GFDD
Bank branches per 1,000 adults	BB	GFDD
Bank credit to bank deposits (%)	BC	GFDD
Inflation (%)	INF	WDI
Personal remittances received (% of GDP)	REM	WDI
GDP per capita, constant US$	GDP	WDI
Secondary school enrolment (% gross)	EDU	WDI

Source: Authors' compilation. Notes: WDI is World Development Indicators; GFDD is Global Financial Development Database.

All the variables utilized in this study are derived from the World Development Indicators (World Bank, 2024), except the financial inclusion variables derived from the World Bank Global Financial Development Database (World Bank, 2025b). The inclusion of the control variables is largely based on existing literature on the determinants of access to clean fuel and technologies for cooking (Gould et al., 2020; Barkat et al., 2023; Osei-Gyebi, 2023; Haider et al., 2024; Maniriho, 2024). Additionally, the data is reconstructed into a three-year non-overlapping interval to account for measurement error and business cycle fluctuations. The countries involved in this study include Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Chad, Comoros, the Democratic Republic of the Congo, the Republic of the Congo, Côte d'Ivoire, Djibouti, Equatorial Guinea, Eswatini, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé and Príncipe, Senegal, Seychelles, Sierra Leone, South Africa, Tanzania, Togo, Uganda, Zambia, and Zimbabwe.

4 Presentation and discussion of results

This section begins with a discussion of the model's summary statistics before presenting the empirical results from QR. Consequently, Table 2 presents the summary statistics of the variables used in the models. A key observation from the table is the unbalanced nature of the dataset, however, QR, like traditional estimators such as the OLS, is well-suited to handle unbalanced panel data. The statistics reveal that access to clean cooking fuel ranges from a minimum value of 1% to a maximum of 100%. When disaggregated by location, rural access to clean cooking fuel varies from 0% to 100%, while urban access ranges from 0.16% to 100%. The significant gap between these minimum and maximum values highlights substantial heterogeneity in access to clean cooking fuels across SSA. This variability further justifies the use of QR. Furthermore, on average, there are 311 bank accounts per 1,000 adults and 8 bank branches per 1,000 adults across the sample. The proportion of bank credit to total deposits, representing the share of financial resources allocated to the private sector, averages 72.35%.

Table 2: Summary statistics of variables

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
ACF	280	22.2643	28.6362	1.0000	100.00
ACFR	280	11.7415	23.7369	0.0000	100.00
ACFU	280	34.1463	34.4437	0.1667	100.00
BA	224	311.1463	465.8301	0.0000	3,392.43
BB	258	7.4607	11.3701	0.1400	56.68
BC	263	72.3518	23.9542	25.6833	145.46
INF	269	7.4727	16.7252	−2.8497	253.48
REM	258	3.5689	5.5311	0.0000	46.57
GDP	277	2,312.214	2,988.379	263.3036	16,180.82
EDU	209	44.4270	22.1265	7.0612	110.91

Notes: All statistics are based on authors' computations.

Inflation has a mean value of 7.47%, with a minimum of −2.85% and a maximum of 253.48%, the latter recorded in Zimbabwe. GDP per capita averages \$2,312.2, ranging from a low of \$263.3 to a high of \$16,181. The share of personal remittances in GDP stands at 3.57% on average, with values ranging from 0% to 46.57%. Additionally, gross secondary school enrolment averages 44.42%, with a minimum of 7.06% and a maximum of 110.91%. The wide disparities in minimum and maximum values across these control variables reflect the significant heterogeneity in economic, financial, and social conditions across SSA.

In Table 3, the results on the relationship between bank account ownership, inflation, and access to clean fuel for cooking are presented. The findings revealed that the unconditional effect of bank account ownership on access to clean fuel for cooking is positive and significant in the general model across all quantiles. Additionally, the effect of bank account ownership in rural areas on access to clean fuel for cooking is significant in all quantiles except for the 90th quantile, while the nexus is only positive and significant in the 10th and 25th quantiles in urban areas. The positive and significant effect of bank account ownership on access to clean fuel for cooking is supported by previous findings where barriers to financial products can limit access to clean fuel use (Puzzolo et al., 2016; Hsu et al., 2021). Furthermore, disparities exist in terms of the coefficient values across rural and urban areas. Moreover, in rural areas, countries where initial levels of the access to clean fuel for cooking is high, i.e., the 75th quantile, have higher positive effect when compared to countries where the initial levels of the access to clean fuel for cooking is low. The unconditional effect of inflation on access to clean fuel for cooking is insignificant across all quantiles. However, the interaction between bank account ownership and inflation is revealed to be negative and insignificant across all quantiles in the general and rural models, apart from the 90th quantile, but only significant in the 10th quantile, i.e., in countries where the initial levels of access to clean fuel for cooking are low, for the urban model. Following threshold studies (Asongu and Nwachukwu, 2018; Asongu and Odhiambo, 2020; Nchofoung and Asongu, 2022; Nchofoung et al., 2022), thresholds for which inflation nullifies the positive impact of bank account ownership on the access to clean cooking fuel are computed. Accordingly, given a positive unconditional effect and a negative interactive effect, the threshold is computed where the coefficient of the unconditional effect is divided by the coefficient of the interactive effect in absolute values. In the general model, the inflation threshold at which bank account ownership no longer enhances access to clean cooking fuel is estimated at 12.2% based on the OLS results. However, significant heterogeneity is observed in the QR estimates. Specifically, the threshold varies across quantiles: 9.89% in the 10th quantile, 14.3% in the 25th quantile, 11.6% in the 50th quantile, and 14.7% in the 75th quantile. Furthermore, the findings indicate that rural areas exhibit higher inflation threshold values, suggesting that households in these regions require greater inflationary pressure before the positive impact of bank account ownership on clean fuel access is completely nullified. While this finding may appear counterintuitive, it could be attributed to the nature of financial inclusion, which is often designed to benefit the poor and vulnerable, particularly those in rural areas. As a result, rural households may have stronger financial support mechanisms, such as targeted government programs or community-based financial initiatives, that help them sustain access to clean cooking fuels even in the face of inflation. In urban areas, the thresholds are only computed in the OLS estimate and the 10th quantile because at least one variable used in the computation of the threshold is not significant. Accordingly, we find that in countries where the initial level of access to clean fuel for cooking is low, an inflation rate above 10.1% nullifies the positive effect of bank account ownership on the access to clean cooking fuels in urban areas.

Additional results from the control variables find evidence that remittances significantly increase access to clean fuel for cooking in urban areas, particularly in countries where existing levels of access to clean fuels are high, supporting previous findings on the positive effect of remittances on household cooking energy transition (Wijayarathne et al., 2022; Barkat et al., 2023; Osei-Gyebi, 2023; Bautista et al., 2024). The study also finds evidence that economic growth significantly drives the access to clean cooking fuel in households with the coefficient revealing that GDP has the greatest impact on the transition to clean energy for cooking. This result is supported by the study of Onyeneke et al. (2023). Also, while education is revealed to improve the transition to cleaner energy for cooking in 25th and 50th quantiles in urban areas, the results are insignificant in rural areas.

In Table 4, the nexus between bank branches, inflation and the access to clean fuels for cooking are presented. The findings showed that the increase in the share of bank branches per 1,000 adults significantly increases access to clean fuel for cooking. This unconditional positive effect is significant in the general specification and the rural specification across all quantiles. These findings can be observed with regard to the fact that the increase in bank branches can improve the mobilization of finance, particularly for rural areas, fostering access to clean fuels for cooking. According to Ntegwa and Olan'g (2024), the lack of finance has hindered the transition to clean cooking fuels, particularly in rural areas. However, the result is only significant in the 10th and 25th quantiles for the urban estimates. Further, the results show that the interactive effect is negative and significant in the 10th to 50th quantile in the general and rural specifications, and in the 10th and 25th quantiles in the urban specification. Consequently, the computation of the threshold value for inflation in the general specification is: 10.8% in the 10th quantile, 14.1% in the 25th quantile, and 13.02% in the 50th quantile. In the rural specification, the following thresholds are apparent: 11.4% in the 10th quantile, 25% in the 25th quantile, and 37.3% in the 50th quantile, while in urban areas, the following inflation thresholds are apparent in the 10th and 25th quantiles: 10.2% and 7.9%, respectively. Additionally, we find evidence of a significant relationship between remittances and access to clean cooking fuels in urban areas.

However, in rural areas, the nexus between remittances and the access to clean fuel for cooking is insignificant, similar to the findings reported in Table 3. Moreso, we find GDP and education to heavily influence access to clean fuels for cooking in urban areas and find both variables to be only significant in the 90th quantile in the rural areas. These findings differ from those of the findings in Table 3, which arise from the model specifications.

In Table 5, the nexus between bank credit, inflation, and access to clean fuel for cooking is examined. The findings largely revealed that bank credit does not have significant influence in improving access to clean fuels for the household, particularly in the general and rural specifications. We find evidence that bank credit increases access to clean fuel for cooking in the 50th and 90th quantiles in urban areas.

Furthermore, the interactive coefficients are all insignificant, which limits the ability to compute inflation thresholds. In other words, policy decisions cannot be made when bank credit is employed as a measure of financial inclusion because of its insignificance in

Table 3: Bank account ownership, inflation and access to clean cooking energy

(a) General

Variables	OLS	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90
BA	0.0244***	0.0376***	0.0416***	0.0325***	0.0235***	0.0098*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.069)
INF	−0.0350	0.1154	0.3499	−0.0334	0.0606	0.1846
	(0.882)	(0.640)	(0.316)	(0.899)	(0.861)	(0.601)
BA×INF	−0.0020***	−0.0038***	−0.0029***	−0.0028***	−0.0016**	−0.0009
	(0.000)	(0.000)	(0.000)	(0.000)	(0.024)	(0.173)
REM	0.2429	−0.0038	0.0163	0.2008	0.4879**	0.5329**
	(0.147)	(0.111)	(0.947)	(0.284)	(0.048)	(0.034)
GDP	18.5635***	5.8553***	7.2344***	13.0776***	18.5719***	25.6774***
	(0.000)	(0.006)	(0.016)	(0.000)	(0.000)	(0.000)
EDU	0.1035	0.0244	0.2103	0.1772*	0.0395	0.0690
	(0.276)	(0.806)	(0.135)	(0.098)	(0.777)	(0.627)
Constant	−118.6071***	−40.5765***	−53.3105***	−85.2167***	−112.7037***	−148.0569***
	(0.000)	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)
Threshold	12.20	9.8947	14.3448	11.6071	14.6875	N/A
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2/Pseudo R^2	0.8292	0.1949	0.3286	0.5562	0.6782	0.7443
VIF	2.48					
Observations	153	153	153	153	153	153

Table 3 continued

(b) Rural

Variables	OLS	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90
BA	0.0284***	0.0225***	0.0239***	0.0262***	0.0530***	0.0126
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.266)
INF	0.2793	0.1009	0.1642	0.2067	0.3768	0.1651
	(0.286)	(0.350)	(0.165)	(0.364)	(0.170)	(0.824)
BA×INF	−0.0016***	−0.0019***	−0.0014***	−0.0014***	−0.0032***	0.0002
	(0.003)	(0.000)	(0.000)	(0.003)	(0.000)	(0.872)
REM	−0.1205	0.0540	0.1100	0.0924	0.0064	−0.3791
	(0.515)	(0.479)	(0.188)	(0.566)	(0.974)	(0.470)
GDP	15.4619***	0.9609	1.4779	6.0433***	6.2671***	23.4773***
	(0.000)	(0.296)	(0.142)	(0.002)	(0.008)	(0.000)
EDU	−0.0948	−0.0200	0.0330	−0.0660	−0.0453	0.0512
	(0.368)	(0.645)	(0.486)	(0.472)	(0.681)	(0.864)
Constant	−98.8936***	−7.3868	−11.8086*	−39.2962***	−39.9144***	−135.8444***
	(0.000)	(0.212)	(0.068)	(0.002)	(0.008)	(0.001)
Threshold	17.75	11.8421	17.0714	18.7142	16.5625	N/A
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2/Pseudo R^2	0.7377	0.1142	0.2157	0.3589	0.5831	0.6739
VIF	2.48					
Observations	153	153	153	153	153	153

Table 3 continued

(c) Urban

Variables	OLS	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90
BA	0.0124**	0.0444***	0.0326***	0.0121	0.0036	−0.0008
	(0.025)	(0.000)	(0.001)	(0.129)	(0.544)	(0.917)
INF	−0.3899	0.0902	0.3448	−0.8445	−0.3296	−0.2255
	(0.278)	(0.792)	(0.579)	(0.105)	(0.405)	(0.690)
BA×INF	−0.0017**	−0.0044***	−0.0018	−0.0010	−0.0007	−0.0008
	(0.021)	(0.000)	(0.146)	(0.316)	(0.365)	(0.445)
REM	1.2178***	−0.3669	0.3530	0.9254**	1.6162***	2.3487***
	(0.000)	(0.131)	(0.423)	(0.013)	(0.000)	(0.000)
GDP	22.6043***	6.6316**	7.7444	16.3053***	25.5608***	31.3052***
	(0.000)	(0.024)	(0.145)	(0.000)	(0.000)	(0.000)
EDU	0.2708*	0.0831	0.4260*	0.5206**	0.2159	0.0388
	(0.062)	(0.546)	(0.090)	(0.014)	(0.177)	(0.865)
Constant	−141.6977***	−46.1564**	−60.4557*	−99.1484***	−147.1612***	−177.2444***
	(0.000)	(0.015)	(0.077)	(0.001)	(0.000)	(0.000)
Threshold	7.2941	10.0909	N/A	N/A	N/A	N/A
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2/Pseudo R^2	0.7328	0.1732	0.2781	0.5048	0.6279	0.6092
VIF	2.48					
Observations	153	153	153	153	153	153

Notes: Probability values are in parentheses. ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively. VIF is Variance Inflation Factor. Year FE is Year Fixed Effect. N/A represents not available because at least one variable used in the computation of threshold is insignificant. Source: Authors' computations.

Table 4: Bank branches, inflation, and access to clean cooking energy

(a) General

Variables	OLS	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90
BB	0.7532***	1.4431***	1.5040***	1.0823***	0.8000***	0.1922
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.304)
INF	−0.4006*	0.0620	0.3533	−0.2920	−0.3808	−0.4896*
	(0.068)	(0.865)	(0.248)	(0.278)	(0.195)	(0.077)
BB×INF	−0.0216	−0.1335***	−0.1067***	−0.0831***	0.0079	0.0034
	(0.147)	(0.000)	(0.000)	(0.000)	(0.688)	(0.853)
REM	0.2511	−0.6467**	0.2667	0.2349	0.4451**	0.2067
	(0.135)	(0.023)	(0.256)	(0.256)	(0.049)	(0.329)
GDP	15.6790***	3.0385	6.5688**	9.5698***	12.9602***	20.7985***
	(0.000)	(0.342)	(0.014)	(0.000)	(0.000)	(0.000)
EDU	0.2931***	0.2410	0.3311***	0.4235***	0.3271***	0.4066***
	(0.001)	(0.100)	(0.007)	(0.000)	(0.006)	(0.000)
Constant	−103.4044***	−26.4132	−54.3065***	−66.0179***	−79.6848***	−120.6507***
	(0.000)	(0.193)	(0.002)	(0.000)	(0.000)	(0.000)
Threshold	N/A	10.8097	14.0955	13.0240	N/A	N/A
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2/Pseudo R^2	0.8474	0.2149	0.3881	0.5970	0.7129	0.7553
VIF	2.39					
Observations	174	174	174	174	174	174

Table 4 continued

(b) Rural

Variables	OLS	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90
BB	0.8870***	1.0398***	1.2494***	1.4404***	1.7537***	0.6808*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.098)
INF	−0.0629	0.1182	0.1510	0.1285	−0.1572	−0.2772
	(0.802)	(0.575)	(0.305)	(0.560)	(0.663)	(0.647)
BB×INF	−0.0078	−0.0909***	−0.0499***	−0.0386**	0.0047	−0.0061
	(0.645)	(0.000)	(0.000)	(0.011)	(0.848)	(0.881)
REM	−0.0754	−0.1743	−0.0780	0.1267	0.1087	−0.2956
	(0.696)	(0.282)	(0.490)	(0.455)	(0.695)	(0.525)
GDP	13.0103***	1.0076	1.2533	2.5836	2.7974	13.7695**
	(0.000)	(0.584)	(0.329)	(0.180)	(0.375)	(0.010)
EDU	0.1140	0.0889	0.0282	0.0140	0.1934	0.5665**
	(0.254)	(0.290)	(0.630)	(0.872)	(0.179)	(0.020)
Constant	−87.6621***	−10.4920	−10.3126	−18.2476	−19.6646	−84.2255**
	(0.000)	(0.368)	(0.205)	(0.135)	(0.324)	(0.012)
Threshold	N/A	11.4389	25.0380	37.3160	N/A	N/A
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2/Pseudo R^2	0.7564	0.1017	0.2563	0.4351	0.6273	0.7182
VIF	2.39					
Observations	174	174	174	174	174	174

Table 4 continued

(c) Urban

Variables	OLS	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90
BB	0.3262	1.6644***	0.9407**	0.1872	−0.1309	−0.1661
	(0.118)	(0.000)	(0.015)	(0.513)	(0.389)	(0.642)
INF	−0.6733**	0.0166	0.7058	−0.9456**	−0.6529***	−0.5253
	(0.029)	(0.973)	(0.215)	(0.026)	(0.004)	(0.320)
BB×INF	−0.0233	−0.1630***	−0.1189***	−0.0267	0.0093	0.0022
	(0.263)	(0.000)	(0.002)	(0.353)	(0.538)	(0.950)
REM	1.1412***	−0.9649**	0.7223*	0.9138***	1.5788***	2.0883***
	(0.000)	(0.011)	(0.099)	(0.005)	(0.000)	(0.000)
GDP	19.9349***	4.2540	11.3712**	17.8252***	21.5241***	24.4741***
	(0.000)	(0.317)	(0.023)	(0.000)	(0.000)	(0.000)
EDU	0.4206***	0.4021**	0.7300***	0.6059***	0.4585***	0.3396
	(0.001)	(0.039)	(0.001)	(0.000)	(0.000)	(0.107)
Constant	−126.0094***	−37.9305	−96.4863***	−110.8987***	−124.4234***	−138.2748***
	(0.000)	(0.160)	(0.002)	(0.000)	(0.000)	(0.000)
Threshold	N/A	10.2110	7.9116	N/A	N/A	N/A
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2/Pseudo R^2	0.7718	0.1986	0.3449	0.5665	0.6684	0.6252
VIF	2.39					
Observations	174	174	174	174	174	174

Notes: Probability values are in parentheses. ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively. VIF is Variance Inflation Factor. Year FE is Year Fixed Effect. N/A represents not available because at least one variable used in the computation of threshold is insignificant. Source: Authors' computations.

Table 5: Bank credit, inflation, and access to clean cooking energy

(a) General

Variables	OLS	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90
BC	0.0204	0.0763	0.0424	0.1112	0.0282	0.0770
	(0.722)	(0.246)	(0.619)	(0.156)	(0.637)	(0.176)
INF	−0.0931	0.3038	0.2679	−0.1307	−0.4563	0.0542
	(0.838)	(0.562)	(0.693)	(0.834)	(0.338)	(0.904)
BC×INF	−0.0082	−0.0112	−0.0112	−0.0079	0.0009	−0.0021
	(0.191)	(0.121)	(0.231)	(0.359)	(0.881)	(0.731)
REM	0.0999	−1.1236***	−0.0168	0.2788	0.0284	0.0996
	(0.585)	(0.000)	(0.951)	(0.265)	(0.882)	(0.582)
GDP	18.2780***	6.6969***	11.6023***	12.0414***	20.4384***	24.0443***
	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)
EDU	0.5068***	0.4146***	0.5402***	0.6938***	0.5057***	0.3466***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	−124.797***	−58.5834***	−89.9110***	−93.9049***	−128.684***	−148.9239***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Threshold	N/A	N/A	N/A	N/A	N/A	N/A
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2/Pseudo R^2	0.8291	0.1261	0.2942	0.5276	0.6915	0.7530
VIF	2.65					
Observations	178	178	178	178	178	178

Table 5 continued

(b) Rural

Variables	OLS	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90
BC	−0.0743	0.0176	0.0204	0.0246	−0.1803	0.0237
	(0.276)	(0.121)	(0.665)	(0.764)	(0.194)	(0.627)
INF	−0.0359	0.0847	0.0855	−0.1481	−0.4093	0.2533
	(0.947)	(0.348)	(0.820)	(0.820)	(0.710)	(0.514)
BC×INF	−0.0036	−0.0019	−0.0014	0.0011	0.0017	−0.0033
	(0.629)	(0.116)	(0.780)	(0.902)	(0.911)	(0.536)
REM	−0.3245	−0.0913**	0.2055	0.1163	−0.4730	−0.4414***
	(0.137)	(0.012)	(0.174)	(0.656)	(0.911)	(0.005)
GDP	15.1226***	0.7691**	2.0431	5.0243*	−0.4730	21.5918***
	(0.000)	(0.033)	(0.173)	(0.054)	(0.285)	(0.000)
EDU	0.4216***	0.0427**	0.2038***	0.4347***	20.3899***	0.4417***
	(0.000)	(0.010)	(0.003)	(0.000)	(0.000)	(0.000)
Constant	−102.3239***	−7.0479***	−20.7282**	−42.6816**	0.3262	−130.3306***
	(0.000)	(0.006)	(0.049)	(0.020)	(0.105)	(0.000)
Threshold	N/A	N/A	N/A	N/A	N/A	N/A
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2/Pseudo R^2	0.6990	0.0280	0.0841	0.2674	0.5077	0.7010
VIF	2.65					
Observations	178	178	178	178	178	178

Table 5 continued

(c) Urban

Variables	OLS	Q0.10	Q0.25	Q0.50	Q0.75	Q0.90
BC	0.1598^{**}	0.1370	0.0785	0.1614^{*}	0.0889	0.2586^{**}
	(0.029)	(0.224)	(0.606)	(0.052)	(0.169)	(0.013)
INF	0.0123	0.4732	0.2273	-0.1646	-0.0861	0.0699
	(0.983)	(0.597)	(0.851)	(0.802)	(0.867)	(0.932)
BC×INF	-0.0120	-0.0162	-0.0066	-0.0147	-0.0022	-0.0023
	(0.133)	(0.190)	(0.690)	(0.106)	(0.756)	(0.835)
REM	1.2000^{***}	-1.5361^{***}	0.2236	1.1002^{***}	1.8880^{***}	2.5317^{***}
	(0.000)	(0.000)	(0.645)	(0.000)	(0.000)	(0.000)
GDP	21.0918^{***}	8.5885^{**}	18.6394^{***}	18.2153^{***}	22.6406^{***}	25.6738^{***}
	(0.000)	(0.017)	(0.000)	(0.000)	(0.000)	(0.000)
EDU	0.4912^{***}	0.6288^{***}	0.7041^{***}	0.6030^{***}	0.3762^{***}	0.1515
	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.311)
Constant	-146.2701^{***}	-79.7524^{***}	-141.2464^{***}	-120.5243^{***}	-140.1716^{***}	-157.3246^{***}
	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)
Threshold	N/A	N/A	N/A	N/A	N/A	N/A
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2/Pseudo R^2	0.7919	0.1432	0.3325	0.5903	0.6867	0.6542
VIF	2.65					
Observations	178	178	178	178	178	178

Notes: Probability values are in parentheses. ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively. VIF is Variance Inflation Factor. Year FE is Year Fixed Effect. N/A represents not available because at least one variable used in the computation of threshold is insignificant. Source: Authors' computations.

understanding how inflation drives the nexus between financial inclusion and household cooking energy transition. Moreover, it is revealed from the control variables the implications of remittances, GDP, and education on access to clean cooking fuels in SSA. Across Tables 3, 4, and 5, we do not find evidence that multicollinearity exists, as the variance inflation factor (VIF) reveals the models are free from multicollinearity.

In conclusion, it is essential to highlight some key insights from the empirical analysis. Firstly, the impact of financial inclusion depends on the proxy of financial inclusion used. Policies that support the improvement in bank account ownership and improving the number of bank branches are essential in improving access to clean fuels for cooking. Secondly, heterogeneity is discovered in terms of the nexus. Accordingly, in rural areas, financial inclusion is better positioned to improve access to clean fuels in SSA economies where access to clean fuels is high, compared to their counterparts with lower access. Additionally, financial inclusion is beneficial in SSA economies where the initial levels of access to clean fuel are low. Thirdly, the significant heterogeneity in inflation thresholds underscores the need for specific inflation-targeting policies across the sampled SSA economies.

5 Robustness analysis

Table 6 presents Prais–Winsten regression with panel corrected standard errors as additional results for robustness. The Prais–Winsten estimator accounts for cross-sectional dependence, serial correlation, and heteroskedasticity (Bottomley et al., 2023; Damane and Ho, 2025). The findings in Table 6 show that all three indicators of financial inclusion have a positive and significant influence on the access to clean fuel for cooking in the general sample, supporting the previous findings, especially in Tables 3 and 4.

Location-specific results also showed that while the increase in bank account ownership and bank branches significantly raise the access to clean cooking fuel in rural areas, the increase in bank branches and bank credit increases the access to clean cooking fuels in urban locations. Consequently, the computed threshold at which inflation nullifies the positive impact of bank account ownership on the access to clean fuel is 20.95% for the general specification and 22.74% in rural areas, on average.

6 Conclusion

The research findings underscore the significant role of financial inclusion in improving access to clean cooking fuels across SSA economies. The empirical analysis reveals that increased bank account ownership and a higher number of bank branches per 1,000 adults significantly enhance access to clean fuel for cooking, particularly in rural areas. This finding aligns with prior studies suggesting that financial constraints limit households' ability to transition to cleaner energy sources. The results also highlight that remittances

Table 6: Prais–Winsten regression with panel-corrected standard errors

(a) General

Variables	(1)	(2)	(3)
BA	0.0155***		
	(0.000)		
BB		0.5747***	
		(0.001)	
BC			0.0775**
			(0.038)
INF	0.1897	0.0791	0.1814
	(0.160)	(0.538)	(0.221)
BA×INF	−0.0007***		
	(0.040)		
BB×INF		−0.0022	
		(0.720)	
BC×INF			−0.0028
			(0.211)
REM	0.4776***	0.2886**	0.2946***
	(0.001)	(0.046)	(0.002)
GDP	25.1433***	23.9844***	23.7669***
	(0.000)	(0.000)	(0.000)
EDU	0.0050	0.0190	0.2934***
	(0.928)	(0.721)	(0.001)
Constant	−170.4897***	−160.0486***	−166.2509***
	(0.000)	(0.000)	(0.000)
Threshold	20.95%	N/A	N/A
Wald	593.36***	1,097.84***	2,267.22***
	(0.000)	(0.000)	(0.000)
R^2	0.8933	0.9333	0.9043
Observations	153	174	156

Table 6 continued

(b) Rural

Variables	(1)	(2)	(3)
BA	0.0115***		
	(0.000)		
BB		0.3875***	
		(0.003)	
BC			0.0079
			(0.736)
INF	0.1822**	0.0297	0.1025
	(0.019)	(0.516)	(0.165)
BA×INF	−0.0005***		
	(0.007)		
BB×INF		−0.0005	
		(0.755)	
BC×INF			−0.0016
			(0.112)
REM	0.1584	0.0981	0.2596***
	(0.114)	(0.440)	(0.003)
GDP	5.8925***	3.0395***	9.9887**
	(0.000)	(0.003)	(0.021)
EDU	0.0385	0.0806***	0.0977
	(0.146)	(0.003)	(0.142)
Constant	−42.4867***	−24.2337***	−70.4933**
	(0.000)	(0.000)	(0.012)
Threshold	22.74%	N/A	N/A
Wald	64.42***	35.14***	9.32*
	(0.000)	(0.000)	(0.097)
R^2	0.4718	0.3193	0.6068
Observations	153	174	156

Table 6 continued

(c) Urban

Variables	(1)	(2)	(3)
BA	0.0009		
	(0.808)		
BB		0.3298*	
		(0.078)	
BC			0.1087**
			(0.015)
INF	0.0621	0.1093	−0.3235
	(0.731)	(0.529)	(0.153)
BA×INF	−0.0001		
	(0.718)		
BB×INF		−0.0042	
		(0.601)	
BC×INF			0.0007
			(0.723)
REM	1.2027***	1.0098***	1.0738***
	(0.001)	(0.002)	(0.001)
GDP	30.9949***	24.8868***	27.9863***
	(0.000)	(0.000)	(0.000)
EDU	0.0494	0.1941**	0.1762**
	(0.571)	(0.011)	(0.048)
Constant	−202.3275***	−165.6966***	−183.259***
	(0.000)	(0.000)	(0.000)
Threshold	N/A	N/A	N/A
Wald	4,199.73***	1,718.97***	3,401.75***
	(0.000)	(0.000)	(0.000)
R^2	0.9027	0.9211	0.9213
Observations	153	174	156

Notes: Probability values are in parentheses. ***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively. (1) BA model, (2) BB model, (3) BC model. N/A represents not available because at least one variable used in the computation of threshold is insignificant. Source: Authors' computations.

and economic growth positively impact the adoption of clean cooking fuels, reinforcing the idea that financial stability and access to credit play crucial roles in household energy choices.

However, the interaction between inflation and financial inclusion presents a complex dynamic. The study finds that while financial inclusion generally improves access to clean cooking fuels, its effect is nullified beyond certain inflation thresholds. Specifically, when inflation surpasses critical levels, the benefits of financial inclusion on clean fuel access become neutralized. This suggests that high inflation erodes households' purchasing power, making it difficult for them to afford cleaner energy alternatives despite having access to financial services. Furthermore, the study establishes that bank credit does not significantly impact access to clean fuel for cooking in rural areas, whereas its effects are only marginally significant in some urban contexts. This raises concerns about the efficiency of bank credit as a mechanism for promoting clean energy transition and suggests that other financial tools may be more effective in this regard. The results from the Prais–Winsten regressions are broadly consistent with the main findings, highlighting the importance of financial inclusion in improving access to clean cooking fuels, while also underscoring the role of inflation in shaping this relationship in certain contexts.

Another critical insight from the study is the heterogeneity in financial inclusion's effectiveness across different countries within SSA, implying that the benefits of financial inclusion may not be evenly distributed across all geography. This heterogeneity indicates that a one-size-fits-all approach may not be suitable for promoting clean energy transitions in SSA economies. We make the following recommendations based on our findings: (1) governments and financial institutions should expand access to bank accounts and financial services, particularly in rural areas. Given the study's findings, financial literacy programs and microfinance initiatives should be tailored to help rural households leverage financial services for clean energy adoption; (2) since inflation neutralizes the positive impact of financial inclusion on clean fuel adoption beyond certain thresholds, monetary policies should prioritize maintaining inflation below the identified critical levels. Consequently, central banks should implement inflation-targeting measures to sustain financial inclusion benefits; (3) the study suggests that bank credit does not significantly improve clean fuel access in most cases in the QR. Thus, alternative financial interventions such as government-backed loans, low-interest microcredit programs, and targeted subsidies should be considered to help households transition to clean energy; (4) the research highlights the importance of physical bank branches in increasing access to clean fuels. Hence, governments should incentivize banks to expand their presence in rural areas, potentially through public-private partnerships, digital banking services, or mobile banking solutions; and (5) given the heterogeneity in financial inclusion effectiveness, policies should be context-specific rather than uniform across all SSA economies. Policymakers should conduct country-specific assessments to determine the best financial strategies to enhance clean energy access.

These recommendations are key to ensuring the improvement in access to clean fuels for cooking, ultimately supporting SDG 7 and the broader sustainable development in Africa. However, this study has its limitations. The study did not explicitly discuss which countries are within the low, intermediate, and high ranges of access to clean fuels. Also, while some form of endogeneity can be addressed using a 3-year non-overlapping interval and time FE, it does not account for the possibility of reverse causation or simultaneity. As such, further studies can explicitly account for all the components of endogeneity.

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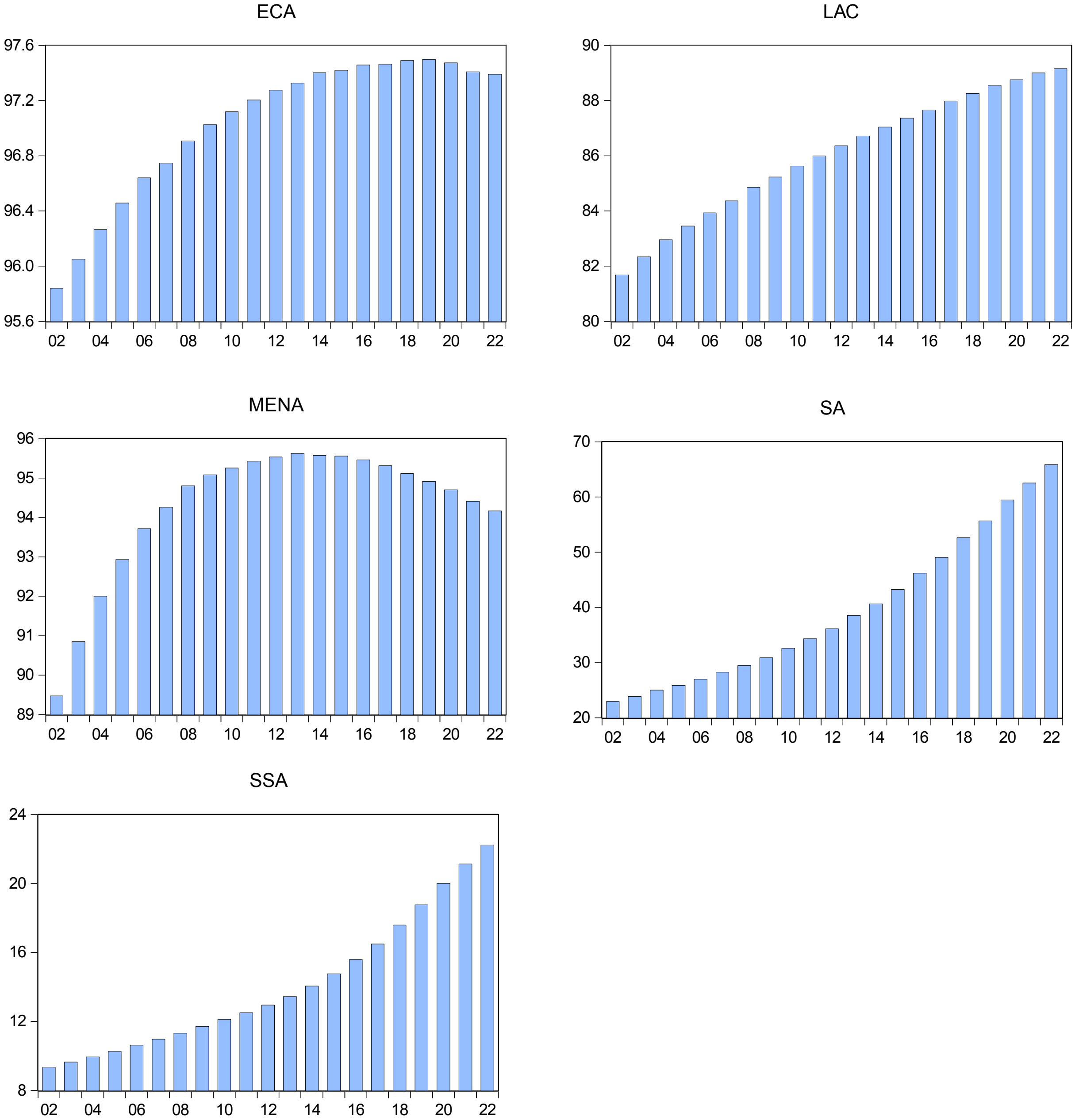
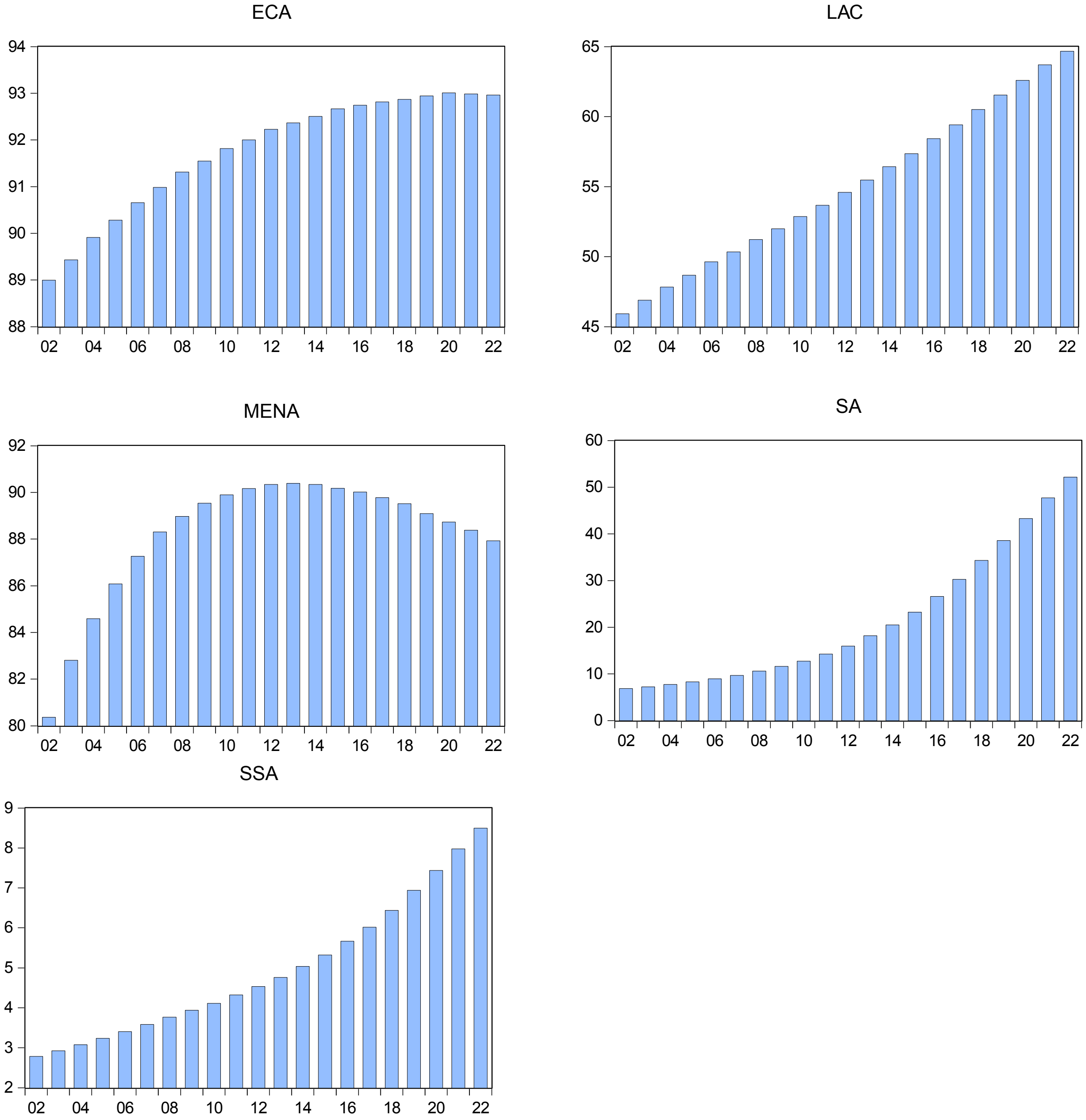
Appendix

Figure 1: Access to clean fuels and technologies for cooking (% of population), 2002–2022



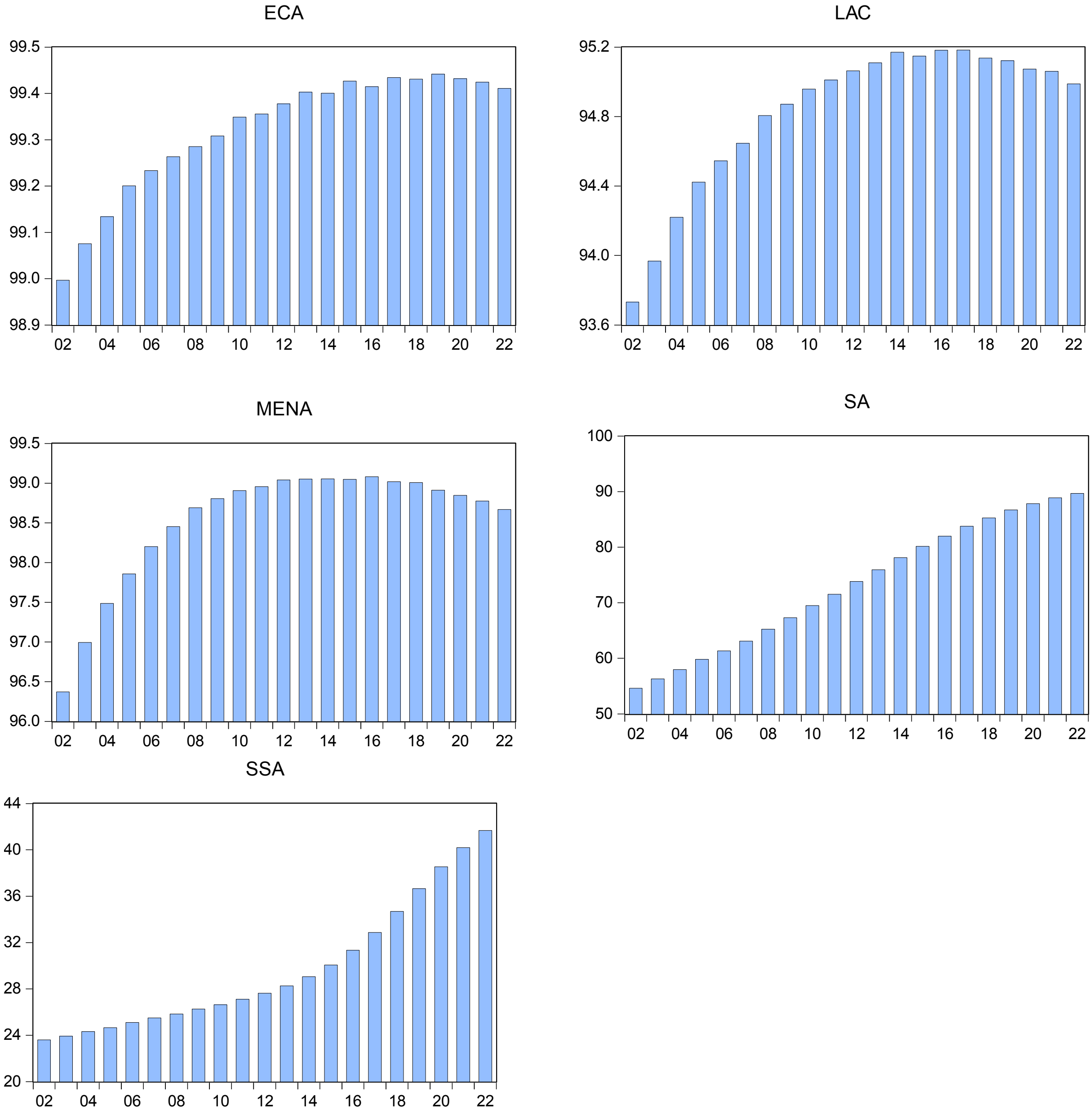
Notes: ECA is Europe and Central Asia, LAC is Latin America and the Caribbean, MENA is Middle East and North Africa, SSA is Sub-Saharan Africa, SA is South Asia. Source: World Bank (2025a).

Figure 2: Rural access to clean fuels and technologies for cooking (% of rural population), 2002–2022



Notes: ECA is Europe and Central Asia, LAC is Latin America and the Caribbean, MENA is Middle East and North Africa, SSA is Sub-Saharan Africa, SA is South Asia. Source: World Bank (2025a).

Figure 3: Urban access to clean fuels and technologies for cooking (% of urban population), 2002–2022



Notes: ECA is Europe and Central Asia, LAC is Latin America and the Caribbean, MENA is Middle East and North Africa, SSA is Sub-Saharan Africa, SA is South Asia. Source: World Bank (2025a).