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The effect of inequality on poverty and severity of poverty in SSA: the role of financial development institutions

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The effect of inequality on poverty and severity of poverty in SSA: the role of financial development institutions**Simplice A. Asongu & Nicholas M. Odhiambo****Abstract**

The present study investigates the incidence of financial institutions' dynamics of depth and access in the effect of income inequality on poverty and the severity of poverty in 42 Sub-Saharan African countries from 1980 to 2019. The Gini index is used to measure income inequality while poverty is measured as the poverty headcount ratio, and the severity of poverty is generated as the squared of the poverty gap index. An interactive quantile regression approach is used as an empirical strategy. Income inequality unconditionally increases poverty dynamics while the financial institutions' depth and access mitigate the adverse effects of income inequality on poverty dynamics. Financial institutions' policy thresholds or minimum financial institutions levels needed to completely dampen the adverse effects of income inequality on poverty dynamics are provided. The findings are contingent on existing levels of poverty, poverty measurement and proxies for financial institutions. Policy implications are discussed.

Keywords: financial development; poverty alleviation; Africa

JEL Classification: G20; I10; I20; I30; O10

1. Introduction

The elements of style in motivating this study are tailored such that, in this introduction, the relevance of assessing the role of financial development institutions in the effect of income inequality on poverty¹ is substantiated with three main policy and scholarly foundations, notably: (i) the importance of achieving poverty and inequality-related sustainable development goals (SDGs) in sub-Saharan Africa (SSA); (ii) the role of finance in reducing poverty and inequality; (iii) the specificity of SSA and (iv) gaps in the extant contemporary inequality and poverty literature. The underlying four factors are put in more perspective in the paragraphs that follow.

First, consistent with contemporary poverty-related studies (Nwani & Osuji, 2020; Asongu *et al.*, 2021a), the policy issue about poverty has been existing since time immemorial. The consensus within the policy and scholarly circles has been that addressing the root causes of poverty entails a combination of political and socio-economic policies with the ultimate aim of reaching development outcomes, such as the goals surrounding the achievement of the post-2015 sustainable agenda, notably: (i) SDG1 which is focused on the eradication of extreme poverty; and (ii) SDG10 which is concerned with the mitigation of income inequality. While the main outcome variable employed in this study is poverty (i.e., focused on SDG1), the main channel is inequality (i.e., related to SDG10). These two goals are fundamental in the achievement of other SDGs in the United Nation's agenda on sustainable development. According to the attendant inclusive development literature, economic and financial instruments are essential for the reduction of extreme poverty (Tchamyou, 2020, 2021).

Second, financial institutions are, by definition, instruments through which inequality can be moderated, poverty mitigated, and the incidence of inequality on poverty mitigated. It is for this reason that this study is tailored such that financial institutions (depth and access) moderate the incidence of income inequality on poverty and the severity of poverty. The importance of financial institutions in promoting inclusive development has been substantially documented in the extant literature (Uddin *et al.*, 2014; Abosedra *et al.*, 2016; Tchamyou *et al.*, 2019; Asongu & Nting, 2022), especially in regions and continents in the world which are characterized by comparatively low levels of financial access and at the same time high levels of extreme poverty such as SSA.

¹ Poverty is measured as the poverty headcount ratio at national poverty line of living on less than US\$1.90 a day (% of population), and the severity of poverty is generated as the squared of the poverty gap index (Ofori *et al.*, 2021; Asongu *et al.*, 2021a).

Third, the specificity of SSA is premised on its comparatively high poverty and financial exclusion rates. As documented in the extant literature (Asongu & Nwachukwu, 2016; Tchamyou, 2019), the substantial rate of poverty in SSA has led to millions of inhabitants in the region lacking decent mechanisms of subsistence, especially in the light of the growing unequal distribution of fruits from economic development. While some efforts have been devoted to tackling the concern of extreme poverty in SSA, unfortunately, from an absolute standpoint, the number of poor is growing, not least because the population appears to be increasing faster than the rate at which poverty is being reduced (Asongu & le Roux, 2017). As substantiated by Nwani and Osuji (2020), in light of the contemporary poverty line, which is now about 1.90 USD per person daily, SSA has surpassed Asia in becoming the region with the highest number of poor people in the world. This trend has been attributed to, *inter alia*, worsening poverty in the form of growing inequality in terms of people's livelihoods and disposal incomes. In light of this policy syndrome, the positioning of this study on how poverty and extreme poverty can be mitigated contingent on income inequality and financial institutions dynamics is also motivated by an apparent gap in the extant contemporary literature on the subject.

The extant literature on which this study is positioned has been discussed extensively in Section 2.2. Among the documented studies in this strand of the literature, two studies are closest to the present positioning, notably: Asongu *et al.* (2021a) and Ofori *et al.* (2021). It is essential to provide more perspective to these two studies in order to better articulate the contribution of the present study to the extant literature. On the one hand, Asongu *et al.* (2021) have assessed how financial institutions affect poverty in SSA. On the other hand, Ofori *et al.* (2021) have investigated how information and communication technology (ICT) is effective in reducing poverty in SSA. The present study departs from the two studies by assessing the nexus between financial institutions and poverty, contingent on the income inequality channel. Hence, contrary to Asongu *et al.* (2021a), inequality is used as the main channel while financial institutions are employed as modulating variables. We argue that simply providing nexuses between financial institutions and poverty, as done in Asongu *et al.* (2021a), engenders blanket policy implications owing to the corresponding linear additive model that is adopted. The present study is non-linear in terms of the empirical framework because the problem statement is assessed within an interactive regression framework such that the effect of inequality on poverty is contingent on some critical levels of financial institutions. Hence, the policy relevance of the study is also articulated by the fact that actionable critical masses of financial institutions or thresholds that policy makers can act

upon in order to mitigate both income inequality and poverty are provided. In the light of these insights, the departure of the present study from Ofori *et al.* (2021) is self-evident.

The rest of the study is structured as follows. The theoretical underpinnings and a review of extant literature are engaged in Section 2, while the data and corresponding estimation method are provided in Section 3. Section 4 discloses the empirical results, while Section 5 concludes with implications and future research directions

2. Theoretical underpinnings and literature review

2.1 Theoretical underpinnings

The theoretical foundations informing the nexus between financial institutions and poverty substantially draw from Tchamyou *et al.* (2019). According to the attendant literature, financial access mitigates poverty and income inequality on two main grounds: (i) on the one hand, financial institutions enable the previously unbanked population to have access to financial services (i.e., the extensive margin theory) and (ii) on the other hand, financial institutions can enable existing customers in the banking sector to have access to more financial services (i.e., the intensive margin theory). The contemporary narrative is in accordance with insights from non-contemporary studies on the subject, notably: Greenwood and Jovanovic (1990), Galor and Zeira (1993), Galor and Moav (2004) and Aghion and Bolton (2005). The underlying literature is in line with the corresponding inclusive development literature in the perspective that enhanced financial access is fundamental in driving inclusive development because it provides the population with avenues along which its wellbeing can be improved (Beck *et al.*, 2017; Tchamyou & Asongu, 2017a; Asongu & Odhiambo, 2018). In what follows, the extensive and intensive margin theories are put into more perspective.

As documented in Tchamyou *et al.* (2019), the nexus between financial development and poverty reduction can be theoretically underpinned by intensive and extensive margin theories. On the one hand, according to the intensive margin theory, financial institutions can provide opportunities through which poverty is mitigated because the already banked fraction of the population is provided with more banking facilities. Such a promising perspective is even more apparent when financial institutions dynamics of depth and access are at play. This theoretical strand is supported by Chipote *et al.* (2014). In summary, providing the existing bank customer base with access to more financial opportunities improves the opportunities for poverty reduction on the part of the attendant existing customers. On the other hand, when financial services are extended to the previously unbanked population, the extensive margin

theory becomes apparent because the fraction of the population which was previously not using formal banking sector services is now provided with more financial access opportunities, which are logically and intuitively associated with more avenues of poverty and inequality mitigation. The extensive margin stance of the theoretical literature is consistent with a growing stream of financial development literature, *inter alia*: Odhiambo (2014), Orji *et al.* (2015), and Chiwira *et al.* (2016).

In the light of the above, compared to the intensive margin theory, the extensive margin theory is associated with more externalities of poverty reduction, not least because the previously unbanked population that is brought on board formal financial services is, for the most part, poor, compared to the intensive margin theory which provides more financial opportunities to those that are already comparatively less poor. This perspective is consistent with contemporary and non-contemporary literature on the subject, *inter alia*: Evans and Jovanovic (1989), Holtz-Eakin *et al.* (1994), Black and Lynch (1996), Bae *et al.* (2012) and Batabyal and Chowdhury (2015).

2.2 Literature review

Consistent with the extant literature, monetary and non-monetary measurements of poverty are not very likely to engender distributions in welfare that are correlated in a perfect manner, not least, because distinctions can be apparent from a multitude of features (Evans *et al.*, 2020). According to the attendant literature, non-monetary features of poverty, such as the features linked to global multidimensional poverty index (MPI) (i.e. related to education, health and living standards) is contingent on features that are different from the purchasing power of people (OPHI, 2018; Asongu & Nwachukwu, 2018 ; Alkire & Santos, 2014; Evans *et al.*, 2020). Many indicators that are observable in these dimensions (i.e. adequate sanitation, access to school, drinkable water access) are availed with access to heavily subsidized free public services. Even with the remit of indicators that are linked to purchasing power, varying assumptions are reflected with respect to time. Accordingly, monetary welfare is appreciated as flow variable, with a feature of varying over different points in time (Jolliffe & Ziliak, 2008). Conversely, non-monetary policy measures are not stock variables that are not elastic and hence, are not very likely change as time unfolds (e.g. stunting of children and adult level of education).

Consistent with the extant policy and scholarly literature (Aikins & Mclachlan, 2022; Diop & Asongu, 2023), it is very likely that the continent will miss the poverty target of the United

Nations 2030 agenda, unless relevant policies are implemented. For instance, it is estimated that when COVID-19 started approximately 30 million of African became extremely poor (i.e. living on below US\$1.90 a day). According to the narrative, even before the advent of the pandemic, more than 445 million consisting of about 34% of the population in Africa was already living below the poverty line. According to the narrative, the African continent is host to the largest number of those living in extreme poverty which 23 of the 28 countries exhibiting rates of poverty that are above 30%. Much of the underlying poverty is concentrated in sub-Saharan Africa (SSA), with Central Africa reflecting the most significant poverty rates of 54.8%, the region of Southern Africa is next with about 45.1%. Western Africa has a rate of 36.8% while the rate of Eastern Africa stood at 33.8%. In 2019, the extreme poverty target of below 3% was met in North Africa. The above stylized facts are consistent with the extant African-centric poverty literature (Nwani & Osuji, 2020; Asongu et al., 2021a; Ofori et al., 2021; Asongu & Eita, 2023).

The extant literature on the nexus between financial sector activities and poverty is mixed, not least because the attendant results are from different regions and continents of the world (Asongu *et al.*, 2021a). Accordingly, while some findings are consistent with a positive nexus, others show a negative relationship, as we shall observe in the expanded literature below.

Odhiambo (2010) has investigated how financial development affects poverty in Kenya by employing cointegration and error-correction empirical techniques within a trivariate causality framework. The author has established a distinct causal flow to poverty mitigation from poverty reduction. He also finds that there is bi-directional causality between poverty reduction and savings. Jalilian and Kirkpatrick (2005) have also performed a study on how financial development contributes to poverty mitigation in developing nations. Their findings show that through enhanced economic prosperity, poverty is mitigated by financial development.

Uddin *et al.* (2013) have assessed linkages between economic growth, financial development and the reduction of poverty in Bangladesh by employing quarterly data for the period 1975 to 2011. The empirical evidence is based on a plethora of regression techniques, notably: the autoregressive distributed lag (ARDL) approach, vector error correction model (VECM), error correction model (ECM) and ordinary least squares (OLS). The findings show that long-term nexuses are apparent between poverty, financial development and economic growth in the country. In another study, Fowowe and Abidoye (2013) examined the incidence of financial development on inequality and poverty in Africa and established that inequality

and poverty in Africa are not significantly influenced by financial development. The empirical evidence is based on the generalized method of moments (GMM) estimator.

Chemli (2014) has investigated the nexus between poverty and financial development in eight Middle East and North Africa (MENA) countries, namely: Yemen, Tunisia, Morocco, Mauritania, Jordan, Iran, Egypt and Algeria. The author has employed data for the period 1990 to 2012 and the ARDL technique. The empirical results reveal that financial development improves the livelihood of the poor though credit access still persists as a major problem. Danduane (2014) has assessed linkages between poverty, economic growth and financial development in Nigeria for the period 1970 to 2011. The ARDL and the Toda and Yamamoto causality tests are adopted. The findings show that poverty reduction is not sensitive to financial development in Nigeria. The author thus concludes that financial development is a necessary but not a sufficient condition for poverty reduction in the country. Abosedra *et al.* (2015) have investigated the nexuses between poverty and financial development in Egypt using quarterly data from 1975Q1 to 2011Q4 and employing the ARDL bounds approach contingent on structural breaks. Their findings revealed that financial development by means of domestic credit to the private sector mitigates poverty. It implies that a financial sector development represents a direct mechanism by which more poverty mitigation opportunities can be provided to the poor. Moreover, financial development mitigates poverty via economic growth in the country and as translates the indirect mechanism in the nexus between poverty and financial development.

Zahonogo (2016) has assessed how financial development influences indicators of poverty in 42 countries in SSA for the period 1980-2012 by employing the GMM estimation approach that is relevant in addressing some concerns of simultaneity. The findings showed that a financial development threshold is apparent at which financial development mitigates poverty. It follows that below the attendant threshold, financial development promotes poverty instead of decreasing poverty. Moreover, the nexus between financial development and poverty is heterogeneous across SSA countries.

Rashid and Intartaglia (2017) have investigated the effect of financial development on poverty for the period 1985 to 2008 in developing countries. The GMM estimation approach is employed and the findings show that absolute poverty is reduced significantly by financial development while the corresponding effect relative to poverty is not significant. According to the findings, poverty is more negatively affected by financial development when economic growth is high. Hence, a plethora of policies and measures are recommended by the authors in the process of reducing absolute and relative poverty in developing countries.

Majid *et al.* (2019) focus on Indonesia in their assessment of when financial development negatively influences poverty. The data used is for the period 1980 to 2014 and the empirical evidence is based on the ARDL approach, which captures the long-term nexus between poverty and financial development. The authors equally employed the VECM to establish the direct causality between poverty and financial development in the country. The study also establishes that there is a long-term nexus between poverty and financial development. In another study, Keho (2017) has assessed linkages between poverty, economic growth and financial development for the period 1970 to 2013 in selected African countries. Using the ARDL method, the author finds that a long-term nexus is apparent between the variables, while financial deepening has a positive incidence on the mitigation of poverty in the sampled countries.

The finance-poverty relationship has been examined by Tsauroi (2020) in the BRICS (Brazil, Russia, India, China and South Africa) using the fully modified ordinary least squares (FMOLS), fixed effects and pooled ordinary least squares (POLS) regressions for the period 1994 and 2013. The findings reveal that poverty reduction is jointly affected by foreign direct investment and financial development.

In light of the narrative above, two main testable hypotheses will be assessed in the empirical section of this study.

Hypothesis 1: income inequality increases poverty and the severity of poverty in SSA.

Hypothesis 2: the positive incidence of income inequality on poverty dynamics is moderated by financial institutions' dynamics of depth and access.

3. Data and methodology

3.1 Data

The study is based on 42 SSA countries for the period 1980 to 2019. The time period and the corresponding number of countries are contingent on data availability constraints at the time of the study². As shown in Appendix 1, there are two main sources for the variables,

²The 42 countries are: “Angola; Benin; Botswana; Burkina Faso; Burundi; Cabo Verde; Cameroon; Central African Republic; Chad; Comoros; Congo Democratic Republic; Congo Republic; Cote d'Ivoire; Ethiopia; Gabon; Gambia, The; Ghana; Guinea; Guinea-Bissau; Kenya; Lesotho; Liberia; Madagascar; Malawi; Mali; Mauritania; Mauritius; Mozambique; Namibia; Niger; Nigeria; Rwanda; Sao Tome and Principe; Senegal; Seychelles; Sierra Leone; South Africa; Sudan; Tanzania; Togo; Uganda and Zambia”.

notably: (i) the World Bank's World Development Indicators (WDI) and (ii) the Global Findex database of the World Bank. In accordance with the corresponding literature motivating this study, as apparent in the introduction, two main outcome variables are employed, namely: (i) the poverty headcount ratio at national poverty lines (% of population) to proxy for poverty and (ii) the severity of poverty generated as the squared of the poverty gap index (Ofori *et al.*, 2021).

Consistent with the contemporary financial development literature, two main financial institutions variables are adopted, namely: financial institutions depth (FID) index and financial institutions access (FIA) index (Asongu *et al.*, 2021a). The choice of the two financial development variables is also motivated by the need to engage more financial development dynamics in order to provide more room for policy implications (Asongu & Nting, 2022). Income inequality is measured with the Gini index in accordance with contemporary inequality literature (Tchamyou, 2020, 2021).

To account for variable omission bias, a number of control variables are considered in the conditioning information set, namely: financial institutions efficiency, inflation, foreign aid, government expenditure, gross domestic product (GDP) growth, foreign direct investment, trade and remittances. The choice of the underlying control variables is informed by contemporary financial development literature (Tchamyou *et al.*, 2019; Asongu & Nting, 2022; Ofori *et al.*, 2021). On the expected signs, inflation, foreign aid, remittances and foreign direct investment (FDI) are anticipated to increase poverty, while the other variables are projected to have the opposite effect. In what follows, the expected signs are discussed in more detail.

Concerning the positive nexuses from the control variables, it is important to clarify that: (i) consumer price inflation is anticipated to decrease purchasing power and, by extension, increase poverty (Chani *et al.*, 2011); (ii) Asongu (2014) has concluded that development assistance is perilous to inclusive human development; (iii) FDI according to Yaseen and Mishal (2017) promotes exclusive growth while (iv) Meniago and Asongu (2018) argue that remittances increase poverty because most of those moving to developed countries are from wealthy households; households which have the financial means with which to fund the expensive visa proceedings. (v) Trade openness and economic growth are anticipated to reduce extreme poverty (Tahir *et al.*, 2014) while the incidence of financial development

dynamics is contingent on, *inter alia*, the correlation with other variables in the conditioning information set in the light of the interactive framework used in the present study.

In the light of the above, given the concern of multicollinearity in interactive regressions, net effects and/or thresholds are computed in order to take on board both the conditional or interactive and the unconditional incidence of the main channel (i.e., inequality) on poverty. Accordingly, such a comprehensive computation is consistent with an approach that is in line with contemporary studies based on interactive regressions (Nchofoung *et al.*, 2021; Nchofoung & Asongu, 2022a) in order to account for the pitfalls of interactive regressions documented by Brambor *et al.* (2006).

The definitions and corresponding sources of the variables are provided in Appendix 1, while the summary statistics (employed for the computation of net effects and thresholds) are disclosed in Appendix 2. The correlation matrix in Appendix 3 is employed to assess concerns of multicollinearity that can potentially affect the expected signs from the control variables (Asongu *et al.*, 2020, 2021b).

3.2 Estimation method

A quantitative estimation method is adopted for the study because the study is based on secondary data, on the one hand, and on the other hand, consistent with the testable hypotheses being examined. Building on the motivation of this study, in perspective that the study is tailored to assessing nexuses between financial institutions, inequality and poverty throughout the conditional distributions of poverty dynamics, the estimated approach adopted in this study is the quantile regression (QR) technique. In essence, the QR approach is tailored to articulate existing levels of the outcome variable or poverty (Billger & Goel, 2009; Asongu, 2017; Tchamyou & Asongu, 2017b; Boateng *et al.* 2018; Asongu *et al.*, 2021c).

It is worth emphasizing that compared to the OLS approach, which is founded on error terms that are normally distributed, in the QR method, the residuals are not normally distributed. Moreover, with the QR strategy, parameters that are estimated are derived at multiple points of the conditional distribution of the outcome variable (Koenker & Bassett, 1978; Keonker & Hallock, 2001).

In the light of Equation (1) below, the θ^{th} quantile estimator of poverty is obtained by solving for the underlying optimization problem, which is provided without subscripts for simplicity in the presentation.

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

where $\theta \in (0,1)$. Compared to the OLS approach that is fundamentally based on minimizing the sum of squared residuals, in QR multiple quantiles are estimated based on the sum of absolute deviations. For example, in the QR approach, many quantiles, such as 25th and 75th quantiles (with $\theta=0.25$ or 0.75 , respectively), are minimised by approximately weighing the residuals. The conditional quantile of poverty or y_i given x_i is:

$$Q_y(\theta / x_i) = x_i' \beta_\theta \quad (2)$$

where for the respective θ th specific quantile, parameters with unique slopes are estimated. This formulation is parallel to $E(y / x) = x_i' \beta$ in the OLS slope for which parameters are examined exclusively at the mean of the conditional distribution of the outcome variable or poverty. For the model in Eq. (2), the outcome variable y_i is the poverty or severity of poverty indicator while x_i contains a constant term, *financial institutions depth; financial institutions access, financial institutions efficiency, inequality, inflation, foreign aid, government expenditure, gross domestic product (GDP) growth, foreign direct investment, trade and remittances*.

4. Presentation and discussion of results

4.1 Presentation of results

The empirical results are disclosed in Tables 1 and 2 below. While Table 1 is concerned with nexuses among financial depth, inequality and poverty, Table 2 is focused on linkages between financial access, inequality and poverty. In either table, the left-hand side uses poverty as the outcome variable, whereas the right-hand side employs the severity of poverty as the outcome variable. From a preliminary observation of the findings, it is apparent that the QR approach is justified because when the QR estimates are compared with the OLS estimates throughout the conditional distribution of the outcome variables, the estimates are different in terms of significance, signs and magnitude of estimated coefficients.

Consistent with the narrative in the data section, in order to assess the overall incidence of inequality on poverty, contingent on financial development dynamics of depth and access, net effects are computed in accordance with contemporary interactive regressions literature (Nchofoung *et al.*, 2021; Nchofoung & Asongu, 2022a). Accordingly, in order to assess how

financial development dynamics modulate the incidence of income inequality on poverty dynamics, the overall effect is the sum of the unconditional incidence of income inequality and the conditional or interactive incidence of income inequality. The latter is the interactive estimated coefficient multiplied by the mean value of the modulating variables or financial institutions' dynamics.

To put the above net effect narrative into perspective, an illustration of how the net effect is obtained in the third column of Table 1 is provided below. Accordingly, the overall effect of the role of the financial institutions depth in modulating the effect of income inequality on poverty at the 10th quantile of the conditional distribution of poverty is $0.097 = [-0.240 \times 0.097] + [0.121]$. In the corresponding calculation, 0.097 is the mean value of financial institutions depth, 0.121 is the unconditional incidence of income inequality on poverty, while -0.240 is the conditional or interactive incidence of income inequality on poverty.

Table 1: Financial depth, inequality and poverty

| | Poverty Headcount | | | | | | Severity of Poverty | | | | | |
|---------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| | OLS | Q.10 | Q.25 | Q.50 | Q.75 | Q.90 | OLS | Q.10 | Q.25 | Q.50 | Q.75 | Q.90 |
| Constant | 56.139*** (0.000) | 34.908*** (0.000) | 45.867*** (0.000) | 51.182*** (0.000) | 64.864*** (0.000) | 78.670*** (0.000) | 8.977*** (0.000) | -1.823** (0.010) | -2.420** (0.029) | 1.912 (0.350) | 10.255** (0.010) | 22.819** (0.016) |
| Gini | 0.010 (0.606) | 0.121*** (0.000) | 0.007 (0.774) | 0.021 (0.284) | -0.010 (0.724) | -0.088*** (0.001) | 0.202*** (0.000) | 0.006 (0.426) | 0.038*** (0.005) | 0.098*** (0.000) | 0.190*** (0.000) | 0.469*** (0.000) |
| FinDep | 4.281 (0.559) | 31.190*** (0.000) | - (0.000) | 7.222 (0.219) | 18.497** (0.035) | 1.725 (0.826) | 22.640*** (0.000) | 3.558 (0.166) | 3.954 (0.329) | 4.025 (0.590) | 37.693** (0.010) | 36.959 (0.283) |
| Gini xFinDep | 0.228** (0.045) | -0.240** (0.030) | 0.383 (0.001) | 0.334*** (0.000) | 0.216 (0.126) | 0.275** (0.030) | -0.702*** (0.000) | -0.035 (0.398) | -0.112* (0.087) | -0.254** (0.035) | -0.872*** (0.000) | -1.257** (0.024) |
| FinAcc | - (0.000) | - (0.000) | -5.283 (0.164) | -6.417** (0.037) | - (0.004) | - (0.000) | - (0.000) | - (0.000) | - (0.000) | - (0.000) | - (0.000) | - (0.000) |
| FinEff | 15.408*** (0.000) | 64.974*** (0.000) | -9.801*** (0.000) | - (0.000) | 13.097*** (0.000) | 19.601*** (0.000) | 45.087*** (0.000) | 10.412*** (0.000) | 17.739*** (0.000) | 23.316*** (0.000) | 34.608*** (0.000) | 68.528*** (0.000) |
| Inflation | 18.392*** (0.000) | 10.379*** (0.000) | 19.016*** (0.000) | 27.766*** (0.000) | 18.520*** (0.000) | - (0.000) | (0.324) (0.000) | (0.000) (0.000) | (0.000) (0.000) | (0.000) (0.000) | (0.469) (0.469) | (0.159) (0.159) |
| Foreign aid | 0.001*** (0.000) | 0.001** (0.022) | 0.001* (0.059) | 0.001** (0.028) | 0.0009 (0.253) | 0.0003 (0.588) | 0.002*** (0.000) | 0.002*** (0.000) | 0.002*** (0.000) | 0.001*** (0.006) | 0.007*** (0.000) | 0.001 (0.730) |
| Gov. Exp. | 0.384*** (0.000) | 0.375*** (0.000) | 0.470*** (0.000) | 0.400*** (0.000) | 0.339*** (0.000) | 0.196*** (0.000) | 0.002 (0.949) | 0.031** (0.014) | 0.088*** (0.000) | 0.152*** (0.000) | 0.308*** (0.000) | -0.167 (0.335) |
| GDPg | 0.012 (0.280) | -0.006 (0.661) | 0.006 (0.673) | 0.009 (0.476) | -0.001 (0.930) | 0.002 (0.869) | -0.011 (0.450) | 0.012** (0.028) | 0.015* (0.086) | 0.026* (0.096) | -0.043 (0.168) | 0.003 (0.962) |
| FDI | -0.226*** (0.004) | -0.288*** (0.000) | -0.297*** (0.000) | -0.199*** (0.002) | -0.114 (0.223) | -0.158 (0.060) | -0.098 (0.386) | -0.024 (0.368) | -0.121*** (0.005) | -0.153* (0.056) | -0.227 (0.146) | -0.112 (0.760) |
| Remit | 0.116** (0.024) | 0.085 (0.168) | 0.199*** (0.002) | 0.046 (0.383) | -0.014 (0.852) | 0.080 (0.259) | -0.033 (0.662) | 0.053** (0.023) | 0.060 (0.102) | 0.069 (0.302) | -0.084 (0.520) | -0.265 (0.395) |
| Trade | 0.062*** (0.000) | 0.098*** (0.000) | 0.096*** (0.000) | 0.006 (0.755) | -0.042 (0.136) | -0.037 (0.150) | -0.088*** (0.000) | 0.030*** (0.000) | 0.024* (0.069) | 0.028 (0.238) | -0.044 (0.347) | -0.263** (0.020) |
| Net Effects | -0.060*** (0.000) | -0.066*** (0.000) | -0.076*** (0.000) | -0.007 (0.515) | 0.008 (0.609) | -0.041*** (0.000) | 0.065** (0.014) | 0.009* (0.057) | 0.002 (0.696) | -0.032** (0.019) | 0.006 (0.810) | 0.244*** (0.000) |
| Thresholds | na | 0.097 | na | na | na | -0.061 | 0.133 | na | 0.027 | 0.073 | 0.105 | 0.347 |
| R ² /Pseudo R ² | na | 0.504 | na | na | na | nsa | 0.287 | na | 0.339 | 0.385 | 0.217 | 0.373 |
| Fisher | 0.281 | 0.247 | 0.157 | 0.192 | 0.184 | 0.099 | 0.127 | 0.027 | 0.075 | 0.094 | 0.105 | 0.167 |
| Observations | 60.74*** 1680 | 60.74*** 1680 | 60.74*** 1680 | 60.74*** 1680 | 60.74*** 1680 | 60.74*** 1680 | 40.51*** 1680 | 40.51*** 1680 | 40.51*** 1680 | 40.51*** 1680 | 40.51*** 1680 | 40.51*** 1680 |

*, **, ***: significance levels of 10%, 5% and 1% respectively. OLS: Ordinary Least Squares. R² for OLS and Pseudo R² for quantile regression. Lower quantiles (e.g., Q 0.1) signify nations where poverty headcount is least. Gini: Income Inequality. FinDep: Financial Institutions Depth. FinAcc: Financial Institutions Access. FinEff: Financial Institutions Efficiency. Gov. Exp: Government Expenditure. GDPg: Gross Domestic Product growth. FDI: Foreign Direct Investment. Remit: remittances. The mean value of Financial Institutions Depth is 0.097. na: not applicable because at least one estimated coefficient needed for the computation of the net effect and/or threshold is not significant. nsa: not specifically applicable because positive thresholds are apparent instead of negative thresholds.

The following findings are apparent in Tables 1-2: (i) income inequality increases poverty almost exclusively in the 10th quantile of the poverty distribution and overwhelmingly throughout the conditional distribution of the severity of poverty. (ii) With a slight exception in the 90th quantile of the conditional distribution of poverty in Table 1, the corresponding net effects are consistently positive. (iii) Most of the significant control variables have the expected signs.

Looking at the tested hypotheses, it is apparent that both *Hypothesis 1* and *Hypothesis 2* are valid in the light of the positive unconditional effects and the negative conditional or interactive effects. However, given that the corresponding net effects are positive, the negative interactive effect reflects the possibility of financial depth and financial access thresholds at which the unconditional positive incidence of income inequality on poverty and the severity of poverty can be completely mitigated. This mitigation tendency would be such that when the financial institution index penetration levels exceed the attendant thresholds, the incidences of income inequality on poverty and the severity of poverty are no longer positive but become negative.

Table 2: Financial access, inequality and poverty

| | Poverty Headcount | | | | | | Severity of Poverty | | | | | |
|---------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| | OLS | Q.10 | Q.25 | Q.50 | Q.75 | Q.90 | OLS | Q.10 | Q.25 | Q.50 | Q.75 | Q.90 |
| Constant | 53.791*** (0.000) | 33.863*** (0.000) | 43.576*** (0.000) | 49.678*** (0.000) | 62.056*** (0.000) | 75.079*** (0.000) | 7.689*** (0.007) | -2.549*** (0.000) | -3.004*** (0.007) | 0.517 (0.800) | 8.971** (0.033) | 19.887** (0.037) |
| Gini | 0.053*** (0.004) | 0.136*** (0.000) | 0.041 (0.151) | 0.055** (0.011) | 0.031 (0.287) | -0.022 (0.456) | 0.221*** (0.000) | 0.017** (0.034) | 0.047*** (0.001) | 0.113*** (0.000) | 0.198*** (0.000) | 0.538*** (0.000) |
| FinAcc | -9.612* (0.097) | - (0.000) | -3.329 (0.674) | -4.230 (0.475) | -8.457 (0.305) | -12.519 (0.129) | -2.469 (0.700) | -4.870** (0.029) | -7.010* (0.064) | -6.612 (0.341) | 4.230 (0.768) | 9.166 (0.777) |
| Gini xFinAcc | -0.147 (0.181) | -0.533*** (0.000) | -0.019 (0.899) | -0.038 (0.735) | -0.113 (0.468) | -0.154 (0.325) | -0.925*** (0.000) | -0.114*** (0.007) | -0.221*** (0.002) | -0.398*** (0.003) | -0.742*** (0.006) | -1.647*** (0.007) |
| FinDep | 17.298*** (0.000) | 16.096*** (0.000) | -5.260 (0.148) | 23.046*** (0.000) | 32.467*** (0.000) | 19.052*** (0.000) | - (0.000) | 1.412 (0.168) | -2.661 (0.124) | - (0.000) | -16.518** (0.012) | -26.892* (0.070) |
| FinEff | - (0.000) | -9.825*** (0.000) | -9.974*** (0.000) | - (0.000) | - (0.000) | - (0.000) | -3.237 (0.404) | 4.250*** (0.000) | 9.593*** (0.000) | 14.026*** (0.000) | 6.562 (0.155) | -15.452 (0.138) |
| Inflation | 0.001*** (0.000) | 0.001** (0.022) | 0.001* (0.098) | 0.001** (0.044) | 0.0009 (0.257) | 0.0003 (0.661) | 0.002*** (0.000) | 0.002*** (0.000) | 0.002*** (0.000) | 0.001*** (0.006) | 0.008*** (0.000) | 0.0006 (0.841) |
| Foreign aid | 0.380*** (0.000) | 0.374*** (0.000) | 0.481*** (0.000) | 0.393*** (0.000) | 0.340*** (0.000) | 0.206*** (0.000) | 0.012 (0.790) | 0.033*** (0.005) | 0.096*** (0.000) | 0.155*** (0.000) | 0.298*** (0.000) | -0.131 (0.447) |
| Gov. Exp. | 0.010 (0.320) | -0.008 (0.570) | 0.008 (0.638) | 0.008 (0.529) | -0.003 (0.837) | -0.004 (0.825) | -0.005 (0.718) | 0.008* (0.087) | 0.015* (0.066) | 0.024 (0.125) | -0.007 (0.816) | 0.015 (0.839) |
| GDPg | -0.220*** (0.005) | -0.293*** (0.000) | -0.288*** (0.001) | -0.206*** (0.002) | -0.109 (0.245) | -0.198** (0.035) | -0.103 (0.363) | -0.023 (0.357) | -0.113*** (0.008) | -0.147* (0.062) | -0.288* (0.077) | -0.327 (0.373) |
| FDI | 0.125** (0.018) | 0.141** (0.022) | 0.193** (0.011) | 0.048 (0.399) | 0.002 (0.971) | 0.189** (0.017) | -0.020 (0.787) | 0.055** (0.010) | 0.062* (0.085) | 0.064 (0.334) | -0.068 (0.619) | -0.282 (0.364) |
| Remit | 0.062*** (0.000) | 0.097*** (0.000) | 0.095*** (0.001) | 0.013 (0.503) | -0.040 (0.160) | -0.036 (0.200) | -0.097*** (0.000) | 0.031*** (0.000) | 0.021 (0.102) | 0.025 (0.293) | -0.045 (0.366) | -0.270** (0.016) |
| Trade | -0.059*** (0.000) | -0.066*** (0.000) | -0.074*** (0.000) | -0.009 (0.404) | 0.004 (0.774) | -0.048*** (0.003) | 0.065** (0.014) | 0.010** (0.022) | 0.004 (0.507) | -0.029** (0.032) | -0.001 (0.966) | 0.232*** (0.000) |
| Net Effects | na | 0.094 | na | na | na | na | 0.149 | 0.008 | 0.029 | 0.082 | 0.140 | 0.411 |
| Thresholds | na | 0.255 | na | na | na | na | 0.238 | 0.149 | 0.212 | 0.283 | 0.266 | 0.326 |
| R ² /Pseudo R ² | 0.279 | 0.251 | 0.153 | 0.189 | 0.183 | 0.095 | 0.131 | 0.029 | 0.078 | 0.098 | 0.109 | 0.170 |
| Fisher | 60.17*** | | | | | | 41.51*** | | | | | |
| Observations | 1680 | 1680 | 1680 | 1680 | 1680 | 1680 | 1680 | 1680 | 1680 | 1680 | 1680 | 1680 |

*, **, ***: significance levels of 10%, 5% and 1% respectively. OLS: Ordinary Least Squares. R² for OLS and Pseudo R² for quantile regression. Lower quantiles (e.g., Q 0.1) signify nations where poverty headcount is least. Gini: Income Inequality. FinDep: Financial Institutions Depth. FinAcc: Financial Institutions Access. FinEff: Financial Institutions Efficiency. Gov. Exp: Government Expenditure. GDPg: Gross Domestic Product growth. FDI: Foreign Direct Investment. Remit: remittances. The mean value of Financial Institutions

Access is 0.077.na: not applicable because at least one estimated coefficient needed for the computation of the net effect and/or threshold is not significant.

4.2 Policy thresholds

This section is important in the light of the premise that it provides insights into potential actions on the moderating or policy variables that policy makers can act upon in order to mitigate poverty and the severity of poverty in the sampled countries. Hence, we argue that at certain critical masses of the considered and engaged financial institutions policy variables, income inequality no longer drives poverty and the severity of poverty.

Still building on the illustrative example provided in the previous section, in the third column of Table 1, the financial depth threshold at which income inequality no longer has a positive effect on poverty is 0.504 (0.121/0.240). It follows that when the financial institutions depth index is 0.504, the overall effect of income inequality on poverty becomes zero or $0.000 = (-0.240 \times 0.540) + [0.121]$. Hence, when the financial institutions index is above 0.504 (say, 0.600), the corresponding net effect becomes negative or is $-0.023 = (-0.240 \times 0.600) + [0.121]$. The corresponding computation is consistent with contemporary studies based on interactive regressions, which argue for the relevance of engaging modulating variables in order to provide policy makers with actionable policy thresholds that are relevant in influencing policy mechanisms in the desired policy outcome (Nchofoung *et al.*, 2022; Nchofoung & Asongu, 2022b). Within the remit of this study, the main mechanism is income inequality; the outcomes are poverty dynamics, while the modulating variables are financial institutions depth and financial institutions access.

In order for the computed financial institutional thresholds of depth and access to be policy-relevant and make economic sense, these must also make statistical sense by being situated within the relevant statistical remit of the modulating or policy variables in the summary statistics. For instance, the computed threshold of 0.504 financial institutions depth index in the third column of Table 1 is policy-relevant and equally makes economic sense because it is situated between the 0.000 (i.e. minimum) and 0.880 (i.e., maximum) of the financial institutions depth index in Appendix 2 of the summary statistics.

5. Concluding implications and future research directions

Despite efforts that have been devoted so far in pushing for the end of poverty in sub-Saharan Africa, poverty in terms of numerical value has been increasing, not least because the poverty reduction rate is higher than the corresponding rate of population growth. The present study has investigated the incidence of financial institutions' dynamics (both depth and access) on

the effect of income inequality on poverty and the severity of poverty in 42 Sub-Saharan African countries from 1980 to 2019. The Gini index is used to measure income inequality while poverty is estimated from two main standpoints: (i) the poverty headcount ratio measures poverty while (ii) the severity of poverty is generated as the squared of the poverty gap index.

An interactive quantile regression approach is used as an empirical strategy. The importance of such an interactive quantile regression framework rests on two motivations: on the one hand, assessing linkages throughout the conditional distribution of the outcome variables reduces the likelihood of blanket policies compared to regressions based on the mean value of the outcome variables. It follows that the specifications are oriented to the extent that the effectiveness of policies on poverty and the severity of poverty from the interactions between financial institutions and income inequality are contingent on existing levels of poverty and severity of poverty. Hence, the corresponding policy thresholds are tailored towards countries with low, intermediate and high initial levels of poverty and the severity of poverty. On the other hand, the effect of inequality on poverty is oriented within an interactive framework such that thresholds of financial institutions dynamics are provided at which the effect of income inequality on poverty is no longer positive but changes to negative.

The following main findings are established. (i) Income inequality increases poverty almost exclusively in the 10th quantile of the poverty distribution and overwhelmingly throughout the conditional distribution of the severity of poverty. (ii) With a slight exception in the 90th quantile of the conditional distribution of poverty, the corresponding net effects are consistently positive. (iii) In the light of the negative conditional impacts, financial institutions policy thresholds or minimum financial institutions levels needed to completely dampen the positive effect of income inequality on poverty dynamics are provided: (i) 0.504 of the financial institutions depth index for the effect of income inequality in the 10th quantile of poverty and respectively, 0.339, 0.385, 0.217 and 0.373 of financial institutions depth index for the effect of income inequality in the 25th, 50th, 75th and 90th quantiles of the severity of poverty and (ii) 0.255 of the financial institutions access index for the effect of income inequality in the 10th quantile of poverty and respectively, 0.149, 0.212, 0.283, 0.266 and 0.326 of financial institutions access index for the effect of income inequality in the 10th, 25th, 50th, 75th and 90th quantiles of the severity of poverty.

The policy implications can be discussed from three main perspectives. (i) Practically, from interactive regressions, when policy thresholds of the modulation or policy variables are

provided such that, they are situated within the statistical range and, thus, make economic sense and have policy meaning, the computed policy thresholds directly represent actionable policy tools that policy makers can act upon. This is essentially because policy makers need to target policy variables above the computed thresholds to have the desired incidence on the outcome of poverty and the severity of poverty. (ii) Since financial institutions' depth and access only mitigate poverty and severity of poverty by dampening the positive incidence of income inequality on poverty and severity of poverty, it follows that computed and recommended policy thresholds are both relevant for the achievement of SDG10 (i.e., inequality mitigation) and SDG1 (i.e., poverty reduction). (iii) The provided financial institutions' thresholds are not very close to the maximum points disclosed in the summary statistics, indicating that policy makers can achieve recommended policy thresholds with relatively modest policy efforts.

This study obviously leaves room for future research, especially as it pertains to considering other channels and policy proxies that can reduce poverty in order to provide opportunities for the achievement of SDG1 on the mitigation of extreme poverty. Furthermore, focusing on other SDGs is important for policy orientation, notably because financial inclusion strategy by means of financial institutions depth and access is relevant in achieving other SDGs.

6. Declaration

Compliance with Ethical Standards

Conflict of Interest: The author declares that he has no conflict of interest.

Ethical approval: This article does not contain any studies with human participants or animals performed by the author.

Data availability: the data for this research are available upon request.

Appendices

Appendix 1: Definitions and sources of variables

| Variables | Definitions | Sources |
|---|---|---------------------|
| Poverty Headcount | Poverty headcount ratio at national poverty lines (% of population) | WDI (World Bank) |
| Severity of poverty | “Poverty severity, which measures the degree of inequality among the poor by putting more weight on the position of the poorest”. Squared of poverty gap index | Generated |
| Income Inequality (Gini) | “The Gini coefficient is a measurement of the income distribution of a country's residents”. | WDI (World Bank) |
| Financial Institutions Depth Index | “ <i>The Financial Institutions Depth (FID) Index, which compiles data on bank credit to the private sector, pension fund assets, mutual fund assets, and insurance premiums (life and non-life) as percentages of GDP</i> ”. | Findex (World Bank) |
| Financial Institutions Access Index | “ <i>The Financial Institutions Access (FIA) Index, which compiles data on the number of bank branches and the number of automatic teller machines (ATMs) per 100,000 adults</i> ” | Findex (World Bank) |
| Financial Institutions Efficiency Index | “ <i>The Financial Institutions Efficiency (FIE) Index, which compiles data on the banking sector's net interest margin, the lending–deposits spread, the ratios of non-interest income to total income and overhead costs to total assets, and the returns on assets and equity</i> ”. | Findex (World Bank) |
| Inflation | Inflation, consumer prices (annual %) | WDI (World Bank) |
| Foreign Aid | Net Official Development Assistance received (% of GNI) | WDI (World Bank) |
| Government Expenditure | General government final consumption expenditure (% of GDP) | WDI (World Bank) |
| Economic growth | GDP growth (annual %) | WDI (World Bank) |
| Foreign Investment | Foreign direct investment, net inflows (% of GDP) | WDI (World Bank) |
| Remittances | Remittance inflows (%GDP) | WDI (World Bank) |
| Trade | Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product. | WDI (World Bank) |

GDP: Gross Domestic Product. GNI: Gross National Income. WDI: World Development Indicators. IMF: International Monetary Fund. GFDD: Global Financial Development Database.

Appendix 2: Summary Statistics

| Mean | S.D | Min | Max | Obs |
|------|-----|-----|-----|-----|
|------|-----|-----|-----|-----|

| | | | | | |
|-----------------------------------|--------|---------|---------|----------|------|
| Poverty Headcount | 48.215 | 14.055 | 7.900 | 73.200 | 1680 |
| Severity of Poverty | 16.529 | 22.480 | 0.000 | 169.299 | 1681 |
| Inequality (Gini) | 53.250 | 19.829 | 0.000 | 86.832 | 1680 |
| Financial Institutions Depth | 0.097 | 0.147 | 0.000 | 0.880 | 1680 |
| Financial Institutions Access | 0.077 | 0.128 | 0.000 | 0.880 | 1680 |
| Financial Institutions Efficiency | 0.494 | 0.199 | 0.000 | 0.990 | 1680 |
| Inflation | 32.026 | 593.191 | -13.056 | 23773.13 | 1680 |
| Foreign Aid | 11.345 | 11.527 | -0.250 | 94.946 | 1680 |
| Government Expenditure | 5.353 | 25.868 | -17.463 | 565.538 | 1680 |
| GDP growth | 3.635 | 5.173 | -50.248 | 35.224 | 1680 |
| Foreign Direct Investment | 2.938 | 6.456 | -28.624 | 103.337 | 1680 |
| Remittances | 4.385 | 17.842 | 0.000 | 235.924 | 1680 |
| Trade Openness | 67.240 | 35.588 | 6.320 | 311.354 | 1680 |

SD: Standard Deviation. Min: Minimum. Max: Maximum.

Appendix 3: Correlation matrix (uniform sample size: 1680)

| | PovHC | SoPov | FID | FIA | FIE | Infl | NODA | Gov. | GDPg | FDI | Gini | Remit | Trade |
|-------|--------|--------|--------|--------|--------|--------|--------|-------|-------|--------|--------|-------|-------|
| PovHC | 1.000 | | | | | | | | | | | | |
| SoPov | 0.071 | 1.000 | | | | | | | | | | | |
| FID | -0.069 | -0.207 | 1.000 | | | | | | | | | | |
| FIA | -0.264 | -0.283 | 0.412 | 1.000 | | | | | | | | | |
| FIE | -0.338 | -0.146 | 0.312 | 0.305 | 1.000 | | | | | | | | |
| Infl | 0.055 | 0.066 | -0.025 | -0.022 | 0.001 | 1.000 | | | | | | | |
| NODA | 0.375 | 0.084 | -0.251 | -0.164 | -0.246 | -0.013 | 1.000 | | | | | | |
| Gov. | -0.044 | -0.023 | 0.036 | 0.018 | 0.073 | -0.095 | 0.092 | 1.000 | | | | | |
| GDPg | -0.111 | -0.036 | 0.001 | 0.029 | 0.069 | -0.062 | -0.017 | 0.146 | 1.000 | | | | |
| FDI | 0.004 | -0.050 | 0.058 | 0.196 | -0.010 | -0.017 | 0.069 | 0.031 | 0.081 | 1.000 | | | |
| Gini | 0.120 | 0.139 | 0.001 | -0.156 | -0.034 | 0.012 | 0.097 | 0.017 | 0.005 | -0.094 | 1.000 | | |
| Remit | 0.082 | -0.046 | 0.111 | -0.013 | -0.052 | -0.009 | 0.034 | 0.088 | 0.031 | 0.014 | 0.044 | 1.000 | |
| Trade | -0.146 | -0.054 | 0.255 | 0.380 | 0.005 | -0.028 | -0.056 | 0.083 | 0.059 | 0.308 | -0.040 | 0.305 | 1.000 |

PovHC: Poverty Headcount. SoPov: Severity of Poverty. FID: Financial Institutions Depth. FIA: Financial Institutions Access. FIE: Financial Institutions Efficiency. Infl: Inflation. NODA: Foreign Aid. Gov: Government Expenditure. GDPg: Gross Domestic Product growth. FDI: Foreign Direct Investment. Gini: the Gini Coefficient. Remit: remittances.

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