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Working Paper

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Suggested Citation: Ofori, Isaac K. (2024) : Frontier Technology Readiness, Democracy, and Income Inequality in Africa, ZBW - Leibniz Information Centre for Economics, Kiel, Hamburg

This Version is available at:

<https://hdl.handle.net/10419/298788>

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Frontier Technology Readiness, Democracy, and Income Inequality in Africa

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Abstract

The proliferation of frontier technologies in the Global South has increased over the past decade. Despite this development, evidence-based policy recommendations regarding their socioeconomic impacts within the context of Africa are scarce. This study addresses this gap by employing macro data from 39 African countries to investigate the impact of frontier technology adoption (FTR) on income inequality. Additionally, the study explores whether democracy serves as a moderator of FTR, influencing a more equitable income distribution. Furthermore, this study assesses the inequality impacts of FTR across various policy thresholds of democracy. Results from the dynamic system GMM estimator reveal that: (i) FTR increases income inequality, (ii) democracy, particularly electoral and participatory democracy, mitigates income inequality, and (iii) FTR reduces income inequality only at a higher threshold of democracy (0.5 or better). This leads to the conclusion that, without inclusive democracy, FTR may impede Africa's social progress agenda by widening the income disparity gap.

Keywords: Africa; Frontier Technology Readiness; Democracy; Income Inequality.

JEL Codes: D63; O31; O33; O55; Q01

1. Introduction

Income inequality remains a major constraint to social progress, especially in the developing world (Chance et al., 2023, Chancel & Piketty, 2021; Alvaredo & Piketty, 2015; Ravallion, 2014). Studies have shown that the dark sides of income inequality extend beyond growth to include political instability, crimes, and premature mortality (Wilkinson & Pickett, 2015; Bourguignon, 1999). Fresh data from Chance et al. (2023) indicate that Africa stands out as a continent of extreme income inequality, with the top 10% of richest people holding 55% of total income compared to 10% for the bottom 50%. At its core, income inequality reflects systemic imbalances in economic opportunities, social mobility, and political power, intersecting with factors such as human capital development and fiscal/social redistribution (Batuo et al., 2022; Fay, 2012).

As African countries strive to foster equitable income distribution amid their tight fiscal space (International Monetary Fund, 2023), a new window of opportunity for governments to build resilient and more inclusive growth trajectories has opened up.¹ This window represents the current surge in frontier technologies, which is revolutionising economies, particularly sectors such as healthcare, finance, transportation, and manufacturing (UNCTAD, 2023a).² Indeed, lessons from previous technological waves suggest that early adopters and adapters diversify their economies for significant gains in global value chain participation, growth and employment. For instance, Alderucci et al. (2020) submit that frontier technology adoption (hereafter: *FTR*) significantly enhance information flow, reduce production costs, and promote efficiency. Besides, IoT facilitates faster and cheaper data exchange, 3D printing stimulates rapid prototyping and customised manufacturing, and generative AI are boosting human capabilities through technology (Autor, 2022; Blanas et al., 2019; WIPO, 2023).

However, consistent with structural transformation and skilled-biased technical change theories (Acemoglu 2003; 2002, Aghion et al., 2002), *FTR* can deepen income inequality by widening the skill premium (Ghani et al, 2016). This is because *FTR* can trigger labour market shifts, skill requirements and unemployment. This is plausible in African

¹ Frontier technological adoption is used interchangeably with frontier technology readiness/deployment.

² **Examples of frontier technologies** are the metaverse, the Internet of Things (IoT), blockchain, artificial intelligence (AI), big data, drones, robotics, quantum computing, 3D printing, bioprinting, organoids, and genetic engineering.

countries where the economic structure is predominantly informal, and the digital divide and financial exclusion for adopting and mastering frontier technologies remain high (International Telecommunication Union [ITU], 2020).

Amidst the discourse on the potential socioeconomic impacts of frontier technologies in the Global South, democratic governance emerges as a critical mechanism that can condition FTR to impact income inequality. The emphasis on democracy as a moderator stems from its capacity to shape institutional frameworks governing innovation, technology adoption and their socioeconomic impacts (Hooks et al., 2022; Acemoglu, 2021; Helms, 2016). The main argument guiding this empirical enquiry is that a more democratic society is socially progressive and tends to institute schemes that support the private sector in adopting, mastering and adapting frontier technologies (Carayannis & Campbell, 2014). For instance, in highly egalitarian democracies, governments facilitate fairer access to frontier technologies, protect property rights, and partner with and/or provide technical and financial support for innovation projects. Furthermore, most democratically elected governments prioritise public discourse, civic engagement, and accountability mechanisms that can influence the allocation of frontier technologies in ways that benefit all (Cervellati et al., 2018; Sclove, 1995).

However, perusing the innovation and inequality-centric literature, we identify three pressing gaps. First, to the best of our knowledge, no study has assessed the impact of FTR on income inequality in Africa. Second, previous studies have not investigated whether democracy (disaggregated into liberal, deliberative, electoral, participatory, and egalitarian) is a significant channel for moderating FTR to equalise income in Africa. Third, the income inequality impacts of FTR across different thresholds of democratic governance have not been unexplored in the shared growth literature. This study bridges these gaps using macro data from a sample of 39 African countries. Results based on the dynamic system GMM estimator reveal that: (i) FTR deepens income inequality in Africa, (ii) democracy, notably electoral and participatory democracy, mitigates income inequality, and (iii) FTR has medium- to long-term equitable income distribution effects only at higher thresholds of democracy.

This novel research contributes to the socioeconomic sustainability literature on several fronts. Foremost, this study sheds light on the nuanced relationship between frontier technologies, democracy, and income inequality in developing countries.

Particularly, it contributes to the evolving discourse surrounding the societal implications of technological innovation in democratic and low-income societies. A major lesson from this research is that frontier technology adoption deepens inequality in Africa. Evidence from this study also suggests that although frontier technologies wield remarkable fairer income distribution effects, such gains can only be realised at higher levels of democratization. This study emphasises the urgent need for African governments to establish robust frameworks, systems, and structures that facilitate the adoption, mastery, and adaptation of frontier technologies across all segments of the population.

2. Literature review

2.1 Theories and empirical literature on technology adoption and inequality

Although both neo-classical and endogenous growth theories identify technological progress/innovation as a major driver of long-term growth, the income distributional impacts remain highly debated. First, Schumpeterian growth (technological progress) theory implicitly pinpoints innovation as an engine of long-run growth and income distribution (see Schumpeter, 1934; 1939). This idea is deepened in the neoclassical (Solow, 1957) and new-growth theories (Romer, 1990), which suggest that technology-induced structural transformation and growth is resilient and sustainable. In this sense, current frontier technology revolution (e.g., AI, 3D printing, nanotechnology) can alleviate poverty and contribute to fairer income distribution through employment and entrepreneurship.

Nonetheless, a strand of the literature also holds the view that innovation-induced structural shift can benefit high-tech service sector owners and workers (see Acemoglu 2003; Aghion et al., 2002). This is ingrained in the skill-biased technical change (SBTC) theory, which contends that contemporary creative destruction complements (rather than substitutes) high skilled workers. Frontier/adaptable technologies can thus intensify income inequality by increasing the productivity and demand for high-skilled workers relative to their low-skilled counterparts (Autor et al., 2022). For instance, whereas frontier technology adoption can increase the relative demand and wages of machine learners, biotechnologists, nanotechnologists, and data scientists (Acemoglu & Autor, 2011; Domini et al., 2020), such shifts can trigger unemployment or reduce the wages of low-skilled who might not be able to transition to new jobs (Blanas et al., 2019). A plethora of recent

studies find technology adoption to deepen income inequality in both developing and advanced economies (see e.g., Aghion et al., 2019; Santo et al., 2017; Guellec & Paunov, 2017; Rattsø & Stokke, 2013; Law et al., 2020; Ding et al., 2011).

On the contrary, the Schumpeterian model of top income inequality developed by Jones and Kim (2018) also demonstrates that innovation can restrain entrepreneurial income thereby reducing income inequality. Jones and Kim (2018) argue that knowledge creation attracts high wages for entrepreneurs through commercialisation, thus contributing to income inequality. However, as these ideas become obsolete in the long-run, wage inequality falls as new entrants constrain the entrepreneurial incomes of incumbent firms. Similarly, Brynjolfsson (2023) submits that frontier technologies, for example, generative AI enable the least experienced/knowledgeable workers to become better at their jobs.³ This way, frontier technologies can mitigate the skill gap and equalise income. Studies reporting a favourable effect of technology adoption on income equality have been documented in the literature (see e.g., Wu et al., 2024; Ongo et al., 2024; Antonelli & Gehring, 2017; Gilfoyle, 2023; Brynjolfsson, 2023).

2.2 Theories and empirics on the link between democracy, technology adoption, and inequality

The theoretical link between democracy and inequality is deeply rooted in three related theories: the political economy of growth theory, institutional theory, and the economic liberalism/federalism theories of economic systems. First, proponents of the political economy theory of growth (see e.g., Acemoglu and Robinson, 2012; Roubini, 1990; Alesina & Alberto, 1993) argue that the political structures of a country determine the trajectory of growth and income distribution. Particularly, Acemoglu and Robinson (2012) stress that inclusive democratic institutions promote income equality and social welfare through effective redistribution (tax and transfers) and productive policies. However, the income gap between the elites and the poor swells when inequality despotic political leaders manipulate economic structures to extract resources from the latter to enrich the former.

Similarly, the institutional theorists (see e.g., Alesina & Rodrik, 1994; North, 1990; Rodrik, 1999) highlight the role of formal and informal norms, rules and structures for

³ Examples of generative AI include Copilot and ChaGPT.

equitable income path and distribution. For instance, Alesina and Rodrik (1994) and Rodrik (1999) opine that mature democracies allocate resources efficiently to increase economic efficiency and inclusive growth. For instance, egalitarian, participatory, and deliberative democracies incorporate the views, concerns, and welfare of citizens, especially vulnerable groups, in decision-making for equitable growth. In such societies, citizens' demand for political authorities to support them in frontier technology adoption, mastering and adaptation will more likely be met. In this context, democracy, can, thus, facilitate frontier technology deployment across all sectors of the economy for equitable growth.

The economic liberalism view of economic systems also holds the view that liberal democracies create free markets and better regulatory regimes that enable economic agents to be more innovative and productive (see Gwartney & Lawson, 2003; Norton, 1998). For instance, liberal democracies safeguard property rights, reduce transaction costs, and provide a fair business environment for economic agents to invest and gain from the economy (Heo & Tan, 2001). Contrariwise, repressive democracies deepen income inequality by crowding out the poor and vulnerable in society from labour markets, for example, through obnoxious taxes and burdensome regulations (Acemoglu & Robinson, 2012). Extractive democracies can therefore polarise frontier technology adoption, providing grounds for the affluent or a few politically connected individuals to gain from innovation diffusion.

Also, economic federalism, which denotes power sharing and decentralisation of sub-national entities, is thought of as integral to resource allocation and income distribution (see, Deacon, 2009). For instance, Acemoglu et al. (2005) reckon that, in electoral democracies, the quest for political elites to be re-elected breeds political competition, which then leads to productive policy formulation and accountability. However, state capture by political elites will not favour proactive policy implementation (e.g., policies on open innovation, digital infrastructure, and technological hub development) since electoral systems can be manipulated to renew their mandate. In this regard, democracy will fail to condition frontier technology adoption to promote income equality. Several empirical studies show that democracy promotes innovation, technology adoption and/or income equality (see e.g., Rabiul, 2018; Ho et al. 2018; Knutsen, 2011;

Halperin et al. 2005; Rivera-Batiz, 2002; Aghion & Howitt, 2009), although Ouechtati (2023), Wong (2022), and Ross (2006) present contrary findings.

The above suggests that the effect of frontier technology adoption is nuanced, implying that factors such as the socioeconomic and political regimes of countries could be critical in conditioning such innovation waves to equalise income. Nonetheless, a careful review of the extant scholarship shows that studies have not examined the impact of frontier technology adoption on income inequality in Africa. Additionally, studies have not explored whether democracy (disaggregated into electoral, liberal, deliberative, egalitarian, and participatory) moderates frontier technology adoption to equalise income in Africa. Besides, the question of whether frontier technology adoption has an income inequality-reducing effect at higher thresholds of democracy remains unaddressed in the literature. This study addresses these voids in the literature drawing on the research methods and data described in the next section.

3. Methods and data

3.1 Model specification and estimation strategy

To empirically investigate the dynamic relationship between FTR, democracy and income inequality, we follow the functional approach of Lee and Rodríguez-Pose (2013) by specifying Equation 1 as follows:

$$Ineq_{it} = \alpha_0 + \alpha_1 Ineq_{it-1} + \beta_1 Polstab_{it} + \beta_2 Remit_{it} + \beta_3 Ecogrow_{it} + \beta_4 Fdi_{it} + \beta_5 Foraid_{it} + \beta_6 Ftr_{it} + \beta_7 Democ_{it} + \eta_i + \varphi_t + \varepsilon_{it} \quad (1),$$

Further, to assess whether democracy is a significant transmission channel through which frontier technology adoption impacts income inequality, Equation 1 is modified as:

$$Ineq_{it} = \alpha_0 + \alpha_1 Ineq_{it-1} + \beta_1 Polstab_{it} + \beta_2 Remit_{it} + \beta_3 Ecogrow_{it} + \beta_4 Fdi_{it} + \beta_5 Foraid_{it} + \beta_6 Ftr_{it} + \beta_7 Democ_{it} + \beta_8 (Ftr_{it} \times Democ_{it}) + \eta_i + \varphi_t + \varepsilon_{it} \quad (2),$$

where $Ineq_{it}$ is the level of income inequality in country i at time t . Accordingly $Ineq_{it-1}$ is the first lag of income inequality, establishing the dynamic relationship between democracy, frontier technology adoption and income inequality. Also, $Polstab$ is political stability, $Remit$ represents remittances; $Ecogrow$ is denotes economic growth; Fdi is

foreign direct investment; and *Ftr* is frontier technology readiness. Also, *Democ* is a vector of democracy variables (liberal, electoral, deliberative, participatory, and egalitarian democracy), which are introduced stepwisely in the models. Additionally, *Ftr* × *Democ* is frontier technology adoption and democracy interaction term, ε_{it} is the error term and η_i represents the country-specific effects.

Drawing from Equation 2, the total/marginal effects from the FTR-democracy interaction are computed as:

$$\frac{\partial(Ineq_{it})}{\partial(Ftr_{it})} = \beta_6 + \beta_8(\overline{Democ_{it}}) \quad (3)$$

It is worth noting that these total effects are evaluated the mean of the democracy variables.

3.2 Estimation strategy

This study employs Roodman's (2009) two-step system generalised method of moments (GMM) for the estimation. This choice of this estimator is informed by several reasons. First, unlike the Baum et al. (2003) instrumental variable regression estimator, Arellano and Bond's (1995) approach is dynamic, therefore making it possible to account for the persistence of income inequality in Africa. According to Obeng et al. (2022), failure to do so in shared growth estimation can introduce specification bias in the estimation. Further, the system GMM technique addresses the issues of endogeneity inherent in panel data. Endogeneity is present in the data because the lag of income inequality correlates with the stochastic error term. This study Also, vis-à-vis the first difference GMM estimator, the two-step system GMM mitigates specification bias. Besides, the Roodman (2009) system GMM estimator is asymptotically consistent and yields robust estimates in small time-span and large cross-sections. The estimator, is, therefore, appropriate in this study because the study period (11) is lower than the number of sampled countries (39). Besides, the Roodman two-step system GMM estimator addresses instrument proliferation and potential estimation concerns relating to autocorrelation and unobserved heterogeneity by eliminating time-invariant omitted variables.

Following Arellano and Bond (1995), the study uses internal instruments to handle the endogeneity problem. The study assesses the reliability of the estimates based on (i) Hansen's (1998) test of overidentification restriction, (ii) the test for the presence of first-order autocorrelation in the residuals [AR(1)], and (iii) the absence of second-order serial correlation in the residuals [AR(2)].

3.3 Research data

This section presents the definition and data sources for the variables employed for the analysis. The study focusses on 39 African countries from 2010-2020. These countries have been listed in Table A.1

3.3.1 Definition of variables

The main income inequality variable is the Palma ratio. The variable measures the ratio of the income of the top 10% richest people to that of the bottom 40%. This is important because it captures the tails of income distribution within a given population. To allow for robustness checks, this study employs the Gini index as an alternative measure of income inequality. Data for both variables are drawn from the World Income Inequality Database (UNU-WIDER, 2023).

3.3.2 Main predictor

Frontier technology readiness (FTR) is the primary predictor variable in the study. FTR denotes a country's technological preparedness/capacity in physical investment, human capital, and technical know-how for adopting, mastering, and adapting technologies (UNCTAD, 2023a). The study sources the FTR dataset from the UNCTAD's Technology and Innovation Data Centre (UNCTAD, 2023b).

3.3.3 Moderating variable

To permit targeted policy recommendations, this study considers the contingency effects of five high-level democracy dynamics, namely electoral, participatory, deliberative, liberal, and egalitarian in the FTR-inequality nexus. We consider these democratic dimensions because they collectively signify inclusive governance, a channel through which FTR can benefit all segments of the population. Egalitarian democracy is important

because it ensures equal protection of individual rights, equitable resource distribution, and unbiased access to power across social groups (Coppedge et al., 2019). Also, liberal democracy matters because it prioritises safeguarding individual and minority rights against state and majority tyranny. It assesses democracy quality through constitutional protections, an independent judiciary, and effective checks and balances that constrain executive power (Coppedge et al., 2018). Participatory democracy captures active citizen engagement in all political processes. It favours direct citizen rule whenever possible, emphasizing involvement in civil society organisations, and subnational elected bodies (Coppedge et al., 2016). Electoral democracy prioritises responsiveness to citizens by promoting fair electoral competition. It ensures extensive suffrage, clean elections, freedom of expression, and independent media. Deliberative Democracy focuses on decision-making processes driven by public reasoning for the common good (Coppedge et al., 2011). The democracy indicators are taken from the Variety of Democracy (V-DEM) database (see Coppedge et al., 2018).

3.3.4 Control variables

The study controls for five variables in the conditioning information set. These variables are foreign direct investment, remittances, foreign aid, political stability, and economic growth. The study measures foreign direct investment as the net inflow of direct investment as a share of national income. Whereas some studies contend that foreign direct investment promotes growth and fairer income distribution (Xu et al., 2021; Kaulihowa & Adjasi, 2018), there is also evidence that it widens the income disparity gap in developing countries (Nguyen, 2021). The shared growth literature also indicates remittance inflow enables recipient individuals/households to invest in health, education and businesses, which are critical to income equality (Akobeng, 2016). Regardless, recent evidence by Song et al. (2021) also demonstrates that remittance inflow deepens income inequality in developing countries. Foreign aid, which is appreciated as the net official development assistance, is also relevant in income distribution analysis because anecdotal evidence shows that donor funds from institutions such as the United Nations Development Programme support African countries to mitigate income inequality. For instance, Younsi et al. (2019) argue that foreign aid enables African countries to broaden access to critical services and socioeconomic opportunities to reduce income inequality.

The essence of political stability also rests in the argument that stable governance is integral to economic freedom, social cohesion and the implementation of inclusive policies necessary for economic agents to participate meaningfully in labour markets (Elkjær & Klitgaard, 2021). Data for all these control variables are mined from the World Bank’s World Development Indicators (World Bank, 2023). Table 1 documents the symbols, descriptions, and data sources for all variables whilst Table A.2 reports the pairwise correlations between the variables.

Table 1: Description of variables and data sources

Variables	Symbols	Descriptions	Sources
<i>Dependent variables</i>			
Palma ratio	<i>Palma</i>	Indicates the ratio of national income shares of the top 10% of households to those of the bottom 40%	UNU-WIDER (2023)
Gini index	<i>Gini</i>	It measures the extent to which the distribution of income among individuals or households within an economy deviates from perfect equality.	UNU-WIDER (2023)
<i>Main predictor variables</i>			
Frontier technology readiness	<i>Ftr</i>	Frontier technology readiness index	UNCTAD (2023)
<i>Moderating variables</i>			
Egalitarian democracy	<i>Egade</i>	Egalitarian democracy index	Coppedge et al. (2018)
Liberal democracy	<i>Libde</i>	Liberal democracy index	Coppedge et al. (2018)
Participatory democracy	<i>Parde</i>	Participatory democracy index	Coppedge et al. (2018)
Deliberative democracy	<i>Delde</i>	Deliberative democracy index	Coppedge et al. (2018)
Electoral democracy	<i>Elecde</i>	Electoral democracy index	Coppedge et al. (2018)
<i>Control variables</i>			
Economic growth	<i>Ecogrow</i>	Gross domestic product per capita (2017 purchasing power parity)	World Bank (2023)
Political stability	<i>Polstab</i>	Measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism.	World Bank (2023)
Remittances	<i>RemitT</i>	Personal remittances received as a percentage of gross domestic product	World Bank (2023)
Foreign direct investment	<i>Fdi</i>	Net of inflow of foreign of official foreign direct investment as a share of gross domestic product	World Bank (2023)
Foreign aid	<i>Foraid</i>	The inflow of official development assistance (percentage of GNI)	World Bank (2023)

Source: Authors' construct, 2023

4. Presentation and discussion of results

Table 2 presents the descriptive statistics of the variables. Table 2 shows an average Palma ratio of 4.699, meaning that the income of the richest 10% people in Africa is at least 4 times higher than that of the poorest 40%. This is buttressed by the high average income inequality value of 54.142%.

Table 2: Descriptive statistics, 2010-2020

Variable	Obs	Mean	Std. Dev.	Minimum	Maximum
Palma ratio	397	4.699	2.119	1.255	15.137
Gini index	397	54.142	7.986	31.877	72.877
Political stability	429	-0.598	0.797	-2.665	1.111
Remittances	429	3.346	4.412	0.000	27.302
Economic growth	429	5667.599	5456.20	711.355	32214.906
Foreign direct investment	429	3.028	5.758	-18.918	39.811
Foreign aid	429	5.454	5.251	0.010	31.050
Frontier technology readiness	429	0.214	0.137	0.000	0.600
Egalitarian democracy	429	0.289	0.151	0.068	0.642
Deliberative democracy	429	0.178	0.151	0.040	0.721
Liberal democracy	429	0.297	0.181	0.043	0.680
Participatory democracy	429	0.260	0.119	0.044	0.516
Electoral democracy	429	0.431	0.182	0.072	0.773

Note: Obs. is observations and Std. Dev. is the standard deviation.

Egalitarian and electoral democracy also average 0.289 and 0.431, suggesting that democracy in countries is generally young. Frontier technology readiness also averages 0.214, meaning that the adoption/deployment of frontier technologies by African countries is low. A scrutiny of the data by way of graphical analysis also indicates that South Africa, Tunisia, Morocco, and Egypt are the top five countries in Africa with high capacity for frontier technology adoption. Similarly, the data reveals that frontier technologies adoption in Burundi, Sudan, Gambia, Democratic Republic of Congo, and Guinea Bissau is low.

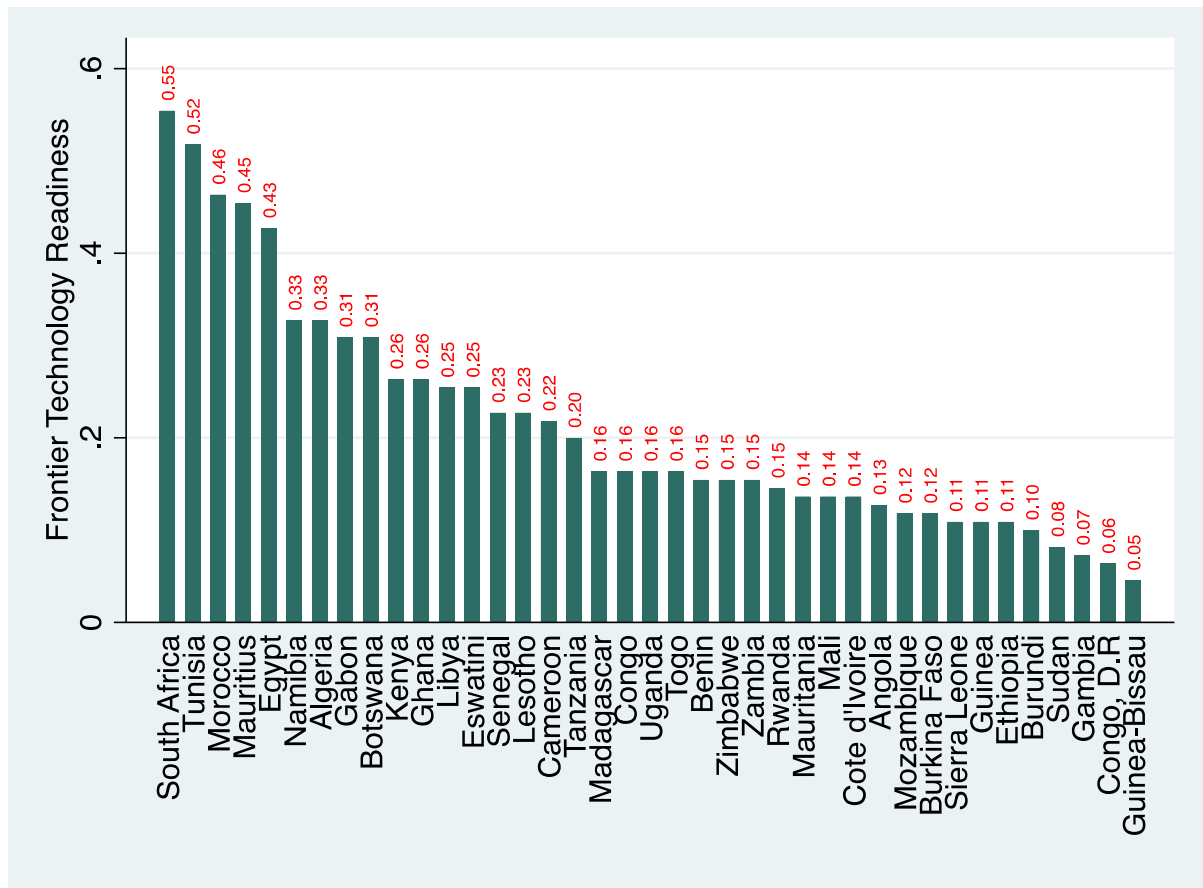


Figure 1: Frontier Technology Readiness in African Countries, 2010-2020.

4.2 Effects of FTR and democracy on income inequality

Table 3 reports findings for the direct effects of frontier technology adoption and democracy on income inequality. Concerning Question 1, the evidence in Column 1 shows that FTR increases income inequality, irrespective of model specification. Precisely, we find that a unit increase in FTR increases income inequality by 0.046 points. This evidence is statistically significant at the 1% significance level.

Concerning Question 2, we find that only participatory democracy (Column 4) and electoral democracy (Column 6) are statistically significant in reducing income inequality in Africa. The results reveal that a unit increase in participatory democracy and electoral democracy reduce income inequality by 0.157 and 0.124 points, respectively. However, relative to electoral democracy, the effect of participatory democracy is remarkable.

Table 3: Unconditional Effects of FTR and Democracy of Income Inequality (Outcome Variables: Palma Ratio)

Variables	1	2	3	4	5	6
Palma ratio (-1)	0.9694*** (0.0138)	0.9690*** (0.0119)	0.9665*** (0.0124)	0.9558*** (0.0116)	0.9717*** (0.0173)	0.9682*** (0.0188)
Political stability	0.0036 (0.0029)	0.0050* (0.0028)	0.0054* (0.0028)	0.0094*** (0.0033)	0.0033 (0.0029)	0.0090*** (0.0031)
Remittances	-0.0046*** (0.0013)	-0.0044*** (0.0012)	-0.0045*** (0.0013)	-0.0047*** (0.0010)	-0.0047*** (0.0013)	-0.0049*** (0.0011)
Economic growth	-0.0199*** (0.0073)	-0.0195** (0.0079)	-0.0192** (0.0082)	-0.0198** (0.0097)	-0.0196** (0.0077)	-0.0166** (0.0071)
Foreign direct investment	0.0011** (0.0005)	0.0012** (0.0005)	0.0012** (0.0005)	0.0011* (0.0006)	0.0010** (0.0005)	0.0010* (0.0005)
Foreign aid	-0.0001 (0.0005)	0.0001 (0.0005)	0.0002 (0.0005)	0.0004 (0.0005)	-0.0002 (0.0005)	0.0007* (0.0004)
FTR	0.0464*** (0.0117)	0.0575*** (0.0118)	0.0556*** (0.0118)	0.0637*** (0.0134)	0.0433*** (0.0122)	0.0566*** (0.0138)
Egalitarian democracy		-0.0510 (0.0355)				
Liberal democracy			-0.0377 (0.0304)			
Participatory democracy				-0.1570** (0.0709)		
Deliberative democracy					0.0104 (0.0223)	
Electoral democracy						-0.1248*** (0.0456)
Constant	0.2076*** (0.0705)	0.2161*** (0.0771)	0.2142** (0.0811)	0.2636*** (0.0936)	0.1992** (0.0800)	0.2312*** (0.0811)
Observations	358	358	358	358	358	358
Countries/Instruments	39/28	39/28	39/28	39/28	39/28	39/28
Wald Statistic	79261***	59998***	62438***	44463***	69296***	44830***
Hansen P-Value	0.375	0.264	0.256	0.237	0.325	0.221
AR(1) [AR(2)]	0.324 [0.197]	0.426 [0.165]	0.310 [0.181]	0.509 [0.115]	0.322 [0.213]	0.514 [0.131]

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

That said, we now assess the effects of the control variables on income inequality. The study finds that remittances and economic growth reduce income inequality, regardless of the type of model specification. For instance, the results in Column 1 shows that a 1% increase in remittances and economic growth reduces income inequality by 0.004 and 0.019 points, respectively. The income inequality-reducing effect of remittances can be attributed anecdotal evidence that such external financial flows enable recipient households to alleviate poverty and/or access socioeconomic opportunities, which are critical to income inequality reduction. For instance, some researchers submit that remittances enable recipient households to fund investments in small business, education and skill set development (see e., Pan & Sun, 2024; Akobeng, 2016). The negative effect of economic growth on income inequality is also consistent with recent evidence in the growth literature, which suggests that economic expansion is critical to global value chain participation, job creation and poverty alleviation (Fox & Oviedo, 2013; Bigsten, 2018). Further, the study reveals that foreign direct investment heightens income inequality in Africa, corroborating recent evidence that FDI can trigger income inequality by perpetuating skill-biased employment (Kaulihowa & Adjasi, 2018). This is plausible especially in the context of Africa where the level of human capital is generally low and the economic structure is predominantly informal (Sarkodie & Adams, 2020). Additionally, we find that foreign aid is not statistically significant in promoting equitable income distribution in Africa. This result concurs evidence by Asongu (2014) that aid flows to African are ineffective in promoting economic growth and inclusive human development. Finally, the study finds strong evidence to show that income inequality persists in Africa, as indicating by the positive coefficients of the lag of the Palma ratio.

4.4 Conditional (non-linear) effects of FTR on Income Inequality

Thus far, this study has established that FTR deepens income inequality in Africa. Additionally, this study has shown that only electoral democracy and participatory democracy are directly effective in mitigating income inequality in Africa. However, it remains unclear whether democracy moderates frontier technology adoption to equalise income in Africa. Accordingly, this section explores the contingency effects of the various democracy variables (electoral, deliberative, participatory, liberal, and egalitarian) in the relationship between FTR and income inequality.

Table 4: Conditional Effects of FTR on Income Inequality (Outcome Variable: Palma Ratio)

Variables	1	2	3	4	5
Palma ratio (-1)	0.9155*** (0.0178)	0.9133*** (0.0169)	0.9148*** (0.0199)	0.9078*** (0.0178)	0.9033*** (0.0197)
Political stability	0.0121*** (0.0041)	0.0125*** (0.0043)	0.0144*** (0.0050)	0.0147*** (0.0051)	0.0141*** (0.0046)
Remittances	-0.0033*** (0.0010)	-0.0037*** (0.0010)	-0.0029*** (0.0009)	-0.0036*** (0.0010)	-0.0032*** (0.0011)
Economic growth	-0.0173* (0.0098)	-0.0165* (0.0097)	-0.0218** (0.0098)	-0.0192* (0.0095)	-0.0148 (0.0109)
Foreign direct investment	-0.0003 (0.0003)	-0.0002 (0.0003)	-0.0005 (0.0003)	-0.0005 (0.0003)	-0.0004 (0.0003)
Foreign aid	-0.0011 (0.0008)	-0.0012 (0.0008)	-0.0010 (0.0008)	-0.0011 (0.0007)	-0.0006 (0.0008)
Frontier technology readiness (FTR)	0.4223*** (0.0980)	0.3738*** (0.0913)	0.6024*** (0.1137)	0.5226*** (0.0864)	0.5950*** (0.1335)
Egalitarian democracy	0.2685*** (0.0731)				
Liberal democracy		0.2227*** (0.0547)			
Participatory democracy			0.3972*** (0.0751)		
Deliberative democracy				0.2643*** (0.0476)	
Electoral democracy					0.2395*** (0.0549)
FTR x Egalitarian democracy	-1.5384*** (0.4005)				
FTR x Liberal democracy		-1.2980*** (0.3388)			
FTR x Participatory democracy			-2.3876*** (0.4687)		
FTR x Deliberative democracy				-1.7066*** (0.3207)	
FTR x Electoral democracy					-1.4481*** (0.3465)
Constant	0.2162** (0.0957)	0.2238** (0.0900)	0.2303** (0.0943)	0.2452*** (0.0895)	0.1878* (0.1017)
Total effects	-0.0084 (0.0340)	-0.0026 (0.0349)	0.0054 (0.0312)	-0.0235 (0.0411)	-0.0276 (0.0441)
Observations	358	358	358	358	358
Countries/Instruments	39/29	39/29	39/29	39/29	39/29
Wald Statistic	12628***	13315***	25804***	12878***	15866***
Hansen P-Value	0.363	0.414	0.307	0.427	0.559
AR(1) [AR(2)]	0.017 [0.459]	0.008 [0.695]	0.025 [0.316]	0.008 [0.461]	0.021 [0.634]

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 4 reports the findings from the analysis. To begin with, we find that the coefficient of FTR and all the democracy variables are *negative* and statistically significant. This means that FTR and democracy are complementary forces for promoting equitable income distribution in Africa.

Having said that, we proceed to compute the corresponding total effects, taking into consideration Equation 3. First, for the FTR-egalitarian democracy interaction in Column 1, we report a total effect of -0.008 points, which is computed by considering the direct effect of FTR on income inequality (0.4223), the average egalitarian democracy index of 0.28 and the coefficient of the FTR-egalitarian democracy (-1.5384). Following similar calculations, we find marginal effects of -0.0026 points and -0.0276 points for the FTR-liberal democracy and FTR-electoral democracy, respectively. Although the sign of these total effects suggests that democracy moderates FTR to equalise income in Africa, these effects are not statistically significant. In other words, the current depth of electoral, participatory, liberal, egalitarian, and deliberative democracies in Africa are ineffective in conditioning FTR to promote equitable income distribution.

4.5: Robustness check

In this section, we subject our findings in Section 3 to robustness checks to reinforce the reliability of the results for policymaking. Specifically, the study assesses whether the both the (un)conditional effects of FTR on income inequality remain that same when the Gini index is used as an alternative outcome variable.

Regarding Question 1, Column 1 of Table 5 shows evidence of a strong and statistically positive effect on income inequality. The magnitude of the effect shows that a unit increase in FTR intensifies income inequality by 0.008 points. This positive effect is consistent with the evidence in Table 3, where we showed that FTR increases income inequality by 0.046 points. Also, concerning the effects of the democracy dynamics on income inequality, we find evidence consistent with the results in Table 3 that participatory democracy and electoral democracy are remarkable in reducing income inequality. Precisely, the evidence in Columns 4 and 6 of Table 5 reveals that participatory democracy and electoral democracy promote income equality by 0.027 and 0.019 points, respectively.

Table 5: Unconditional Effects of FTR and Democracy on Income Inequality (Outcome Variable: Gini Index)

Variables	1	2	3	4	5	6
Gini index (-1)	0.9407*** (0.0155)	0.9466*** (0.0159)	0.9420*** (0.0171)	0.9328*** (0.0143)	0.9354*** (0.0194)	0.9452*** (0.0188)
Political stability	0.0003 (0.0005)	0.0004 (0.0005)	0.0006 (0.0004)	0.0010** (0.0005)	0.0002 (0.0005)	0.0007* (0.0004)
Remittances	-0.0006*** (0.0002)	-0.0005*** (0.0002)	-0.0005*** (0.0002)	-0.0005*** (0.0001)	-0.0006*** (0.0002)	-0.0007*** (0.0001)
Economic growth	-0.0043*** (0.0013)	-0.0041*** (0.0014)	-0.0043*** (0.0015)	-0.0042** (0.0017)	-0.0043*** (0.0013)	-0.0036** (0.0014)
Foreign direct investment	0.0001** (0.0001)	0.0002** (0.0001)	0.0002** (0.0001)	0.0002** (0.0001)	0.0001* (0.0001)	0.0002*** (0.0001)
Foreign aid	0.0000 (0.0001)	0.0000 (0.0001)	0.0000 (0.0001)	0.0001 (0.0001)	-0.0000 (0.0001)	0.0001 (0.0001)
FTR	0.0080*** (0.0016)	0.0103*** (0.0016)	0.0108*** (0.0017)	0.0125*** (0.0020)	0.0079*** (0.0016)	0.0126*** (0.0019)
Egalitarian democracy		-0.0079 (0.0052)				
Liberal democracy			-0.0095** (0.0047)			
Participatory democracy				-0.0271*** (0.0095)		
Deliberative democracy					-0.0007 (0.0036)	
Electoral democracy						-0.0193*** (0.0063)
Constant	0.0667*** (0.0172)	0.0636*** (0.0185)	0.0680*** (0.0196)	0.0761*** (0.0184)	0.0698*** (0.0187)	0.0653*** (0.0175)
Observations	358	358	358	358	358	358
Countries/Instruments	39/28	39/28	39/28	39/28	39/28	39/28
Wald Statistic	160755***	134683***	116188***	99900***	137746***	153287***
Hansen P-Value	0.409	0.298	0.273	0.296	0.358	0.171
AR(1) [AR(2)]	0.165 [0.233]	0.216 [0.202]	0.152 [0.202]	0.267 [0.132]	0.188 [0.237]	0.234 [0.141]

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6: Conditional effects of FTR on Income Inequality (Outcome Variable: Gini Index)

Variables	1	2	3	4	5
Gini index (-1)	0.9163*** (0.0162)	0.9146*** (0.0140)	0.9096*** (0.0164)	0.9048*** (0.0152)	0.9022*** (0.0172)
Political stability	0.0016** (0.0006)	0.0017** (0.0007)	0.0020** (0.0007)	0.0020*** (0.0007)	0.0019** (0.0007)
Remittances	-0.0004** (0.0002)	-0.0005*** (0.0001)	-0.0004*** (0.0001)	-0.0005*** (0.0002)	-0.0004** (0.0002)
Economic growth	-0.0030* (0.0016)	-0.0029* (0.0016)	-0.0033** (0.0015)	-0.0031** (0.0015)	-0.0027* (0.0016)
Foreign direct investment	-0.0000 (0.0000)	-0.0000 (0.0000)	-0.0001* (0.0000)	-0.0001* (0.0000)	-0.0001 (0.0000)
Foreign aid	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)	-0.0001 (0.0001)
FTR	0.0624*** (0.0135)	0.0546*** (0.0130)	0.0834*** (0.0156)	0.0712*** (0.0113)	0.0846*** (0.0188)
Egalitarian democracy	0.0366*** (0.0098)				
Liberal democracy		0.0294*** (0.0077)			
Participatory democracy			0.0517*** (0.0109)		
Deliberative democracy				0.0338*** (0.0062)	
Electoral democracy					0.0316*** (0.0077)
FTR x Egalitarian democracy	-0.2170*** (0.0559)				
FTR x Liberal democracy		-0.1804*** (0.0491)			
FTR x Participatory democracy			-0.3217*** (0.0663)		
FTR x Deliberative democracy				-0.2198*** (0.0425)	
FTR x Electoral democracy					-0.1982*** (0.0488)
Constant	0.0628*** (0.0181)	0.0643*** (0.0168)	0.0663*** (0.0165)	0.0706*** (0.0161)	0.0647*** (0.0180)
Total effects	0.0016 (0.0055)	0.0023 (0.0056)	0.0029 (0.0050)	0.0009 (0.0061)	-0.0006 (0.0066)
Observations	358	358	358	358	358
Countries/ Instruments	39/29	39/29	39/29	39/29	39/29
Wald Statistic	68447***	85874***	195849***	86542***	105836***
Hansen P-Value	0.423	0.461	0.376	0.479	0.640
AR(1)	0.025 [0.015	0.039	0.021	0.037
AR(2)	0.398	0.502	0.298	0.393	0.481

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Also, similar to our findings in Table 3, we find that coefficients of the interaction terms for FTR and all the democracy variables are negative and statistically significant at 1%, implying that investments for boosting FTR and democracy are shared growth-enhancing.

4.6 Threshold analysis

So far, the two major contributions from this study are that (i) FTR heightens income inequality in Africa, and (ii) all the democracy variables – liberal, egalitarian, deliberative, participatory, and electoral – are ineffective for conditioning FTR to promote fairer income distribution. This study argues that the ineffectiveness of these democracy variables in moderating FTR to equalise income can be attributed to the fact that the performance of the sampled countries across these democratic dynamics are below average (i.e., 0.5), as apparent in Table 2.

Accordingly, in this section, we deepen the analysis by exploring whether FTR can effectively reduce income inequality at advanced/higher levels of democracy. Specifically, the study investigates whether, once the sampled countries have achieved the average threshold of democracy (i.e., 0.5), FTR becomes an effective mechanism for mitigating income inequality. Therefore, we performed a threshold analysis based on Equation 3, where we compute the total effects of FTR on income inequality (i.e., Palma ratio) at threshold levels of 0.5, 0.6, 0.7, 0.8, 0.9, and 1.0 for each democracy variable. The attendant results, which we report in Table 7, are unique and revealing. We find that a higher level of democracy is required to nullify the income inequality-enhancing effect of FTR. This is because the effect of FTR on income inequality is everywhere negative and statistically significant once a minimum threshold of 0.5 has been achieved. For instance, given a minimum threshold of 0.5 for egalitarian, liberal, participatory, deliberative, and electoral democracy, FTR reduces income inequality by 0.346, 0.275, 0.591, 0.330, and 0.128 points, respectively.

Table 7: FTR total effects on income inequality at various democracy thresholds

Democracy thresholds	Ftr x Egal Total effect	Ftr x Libr Total Effect	Ftr x Part Total Effect	Ftr x Delb Total Effect	Ftr x Elet Total Effect
0.50	-0.3469*** (0.1102)	-0.2752*** (0.0901)	-0.5914*** (0.1284)	-0.3307*** (0.0877)	-0.1289*** (0.0597)
0.60	-0.5007*** (0.1493)	-0.4050*** (0.1223)	-0.8302*** (0.1743)	-0.5013*** (0.1180)	-0.2738*** (0.0890)
0.70	-0.6545*** (0.1887)	-0.5348*** (0.1552)	-1.0689*** (0.2206)	-0.6720*** (0.1490)	-0.4186*** (0.1211)
0.80	-0.8084*** (0.2284)	-0.6646*** (0.1885)	-1.3077*** (0.2671)	-0.8427*** (0.1803)	-0.5634*** (0.1543)
0.90	-0.9622*** (0.2682)	-0.7944*** (0.2219)	-1.5464*** (0.3137)	-1.0133*** (0.2119)	-0.7082*** (0.1881)
1.00	-1.1161*** (0.3080)	-0.9242*** (0.2555)	-1.7852*** (0.3604)	-1.1840*** (0.2436)	-0.8530*** (0.2221)

Note: Standard errors in parenthesis; *** p<0.01, ** p<0.05, * p<0.1

Similarly, at the threshold level of 0.9 for egalitarian, liberal, participatory, deliberative, and electoral democracy, FTR promotes fairer income distribution by 0.962, 0.794, 1.546, 1.184, and 0.708 points, respectively. Conspicuously, the study find that participatory democracy is the most effective institutional regime for moderating FTR to foster equitable income distribution. The findings in Table 7 are robust per the results in Table 8, which indicate that FTR a negative total effect on income inequality where the Gini index is used as the outcome variable.

Table 8: FTR total effects on income inequality at various democracy thresholds

Democracy thresholds	Ftr x Egal Total effect	Ftr x Libr Total Effect	Ftr x Part Total Effect	Ftr x Delb Total Effect	Ftr x Elet Total Effect
0.50	-0.0461*** (0.0159)	-0.0355** (0.0135)	-0.0774*** (0.0188)	-0.0386*** (0.0122)	-0.0144 (0.0088)
0.60	-0.0678*** (0.0214)	-0.0535*** (0.0182)	-0.1096*** (0.0253)	-0.0606*** (0.0162)	-0.0342** (0.0128)
0.70	-0.0895*** (0.0268)	-0.0716*** (0.0229)	-0.1418*** (0.0318)	-0.0826*** (0.0203)	-0.0541*** (0.0173)
0.80	-0.1112*** (0.0324)	-0.0896*** (0.0277)	-0.1739*** (0.0384)	-0.1045*** (0.0244)	-0.0739*** (0.0219)
0.90	-0.1329*** (0.0379)	-0.1077*** (0.0325)	-0.2061*** (0.0450)	-0.1265*** (0.0286)	-0.0937*** (0.0266)
1.00	-1.1546*** (0.0434)	-0.1257*** (0.0374)	-0.2383*** (0.0516)	-0.1485*** (0.0328)	-0.1135*** (0.0314)

Note: Standard errors in parenthesis; *** p<0.01, ** p<0.05, * p<0.1

4.7 Discussion of results

This study extends the shared growth literature on three fronts. First, the finds that frontier technology readiness/adoption deepens income inequality in Africa. This evidence highlights the downsides of frontier technologies, particularly, on social progress if they outpace a society's ability to master and adapt. This evidence also aligns with the skill-biased technological change theory, which suggests that frontier technologies can initially intensify income inequality by widening the skill set gaps (Autor, 2022; Acemoglu & Autor, 2011; Domini et al., 2020). This is fuelled by the huge disparities in access to technologies, internet, and technological hubs across Africa's rural-urban divide (ITU, 2020). Besides, in Africa where informality is predominant and access to finance and energy is a major impediment to entrepreneurship, only a few economic agents, for example, established indigenous firms and multinational corporations, can deploy, master, and adapt frontier technologies (e.g., drones, robots, copilot, blockchain, machine learning and 3D printing) in their business operations (UNCTAD, 2023a). In this sense, frontier technologies can widen the income disparity gap between individual with specialised/managerial skills relative to their unskilled counterparts. The result corroborates the argument by Jovanovic (2009) that frontier technologies are costly to acquire, master and integrate in production values chains. This can significantly increase the competitiveness and profits of such established firms/companies, proving grounds to increase the wages and salaries of workers with specific skills.

Second, this study shows that participatory and electoral democracy are critical for equalising income in Africa. The evidence suggests that institutional proactiveness is essential to leverage frontier technologies to promote equitable income distribution. This evidence is ingrained in governance theory that accountable and inclusive governance is critical to shared growth (see Acemoglu & Robinson, 2012). The income inequality-reducing effect of participatory democracy can be attributed to the fact that such practices abhor state capture and take into consideration the voices, interests, and perspectives of the masses in decision-making. In Africa, where the population is youthful, this can ensure that the tax codes are business-friendly and national policies favour innovation and research and development, which are critical to firm performance and job creation (see Aghion et al., 2007). Also, the negative effect of electoral democracy on income inequality is deeply rooted in the argument that societies that choose their leaders

through regular, free, and fair elections realise shared prosperity. This is because through electoral democracy, voters can punish incumbent governments who do not implement policies to mitigate income inequality. Electoral democracy can thus promote accountable governance and cause politicians to be responsive to their citizens' needs, for example, by implementing and/or broadening social welfare programs.

Third, the transmission and threshold analyses also reveal that all the dimensions of democracy – liberal, egalitarian, electoral, deliberative, and particularity – are critical in moderating FTR to promote income equality. However, these democracy dynamics are effective in conditioning FTR to promote fairer income distribution only after a threshold of 0.5 (out of 1) has been achieved. This can be explained from several angles. To begin with, a high level of participatory and deliberative democracy is imperative for broad-based consultations and the effective integration of frontier technologies in education curriculum and business models. This is crucial because it addresses the ethical concerns and the dark sides of employing frontier technologies in business operations. In this sense, democracy can promote open innovation and firm performance, which have been shown to enhance female economic inclusion and fairer income distribution (Reuveny & Li, 2003). Liberal is also worthwhile for adjusting legal and regulatory frameworks to address emerging challenges and opportunities associated with frontier technologies. A more liberal democracy thus safeguards property rights and promotes fairer access to frontier technologies, preventing potential abuses that could contribute to inequality. Similarly, egalitarian democracy is critical for prioritising equality and social justice (Coppedge et al., 2018). Notably, in democratically egalitarian societies, policymakers initiate and/or support open innovation, research and development, and comprehensive digital infrastructure development. Such proactive investments can close the digital gap, boost entrepreneurship and durable job creation, and fairer income distribution.

5. Concluding remarks and policy recommendations

This study employs macro data for a sample of 39 African countries to bridge three important gaps in the shared growth literature. Foremost, this study investigates the effects of frontier technology readiness and democracy (disaggregated into liberal, deliberative, participatory, electoral, and egalitarian) on income inequality. Further, this study explores whether democracy is a significant transmission channel through which

frontier technology readiness reduces income inequality in Africa. Third, this study examines whether beyond a certain threshold of democracy, frontier technology readiness is critical in equalising income.

The study responds to these all-important questions by applying the dynamic generalised method of moments estimator to capture the persistence of inequality in Africa and address endogeneity and heteroscedasticity issues. Robust evidence from this study reveals that: (i) frontier technology adoption increases income inequality in Africa; (ii) democracy, particularly electoral and participatory democracy, is critical for equalising income; and (iii) democracy is only effective in nullifying the income inequality-enhancing effect of frontier technologies after a threshold of 0.5 has been achieved.

The study has several policy implications for Africa's 2063 shared growth agenda. Foremost, this study highlights the shared growth-deteriorating effects of frontier technologies. This evidence suggests the urgent need for African governments to prioritise capacity building of their firms, households, and institutions in adopting, mastering, and adapting frontier technologies. This is critical to ensure that the current wave of frontier technology adoption benefits all, especially by enabling those affected by the technological transition to find new durable jobs.

This study also emphasises that although democracy is critical in nullifying the adverse effect of frontier technologies on income distribution, a minimum threshold of 0.5 of sound democratic performance is required. This result also calls for the need for African governments to commit to and endeavour to improve the principles of inclusive democracy. This requires that policymakers implement comprehensive science, technology, and innovation programmes in their educational systems to equip their future workforce with the skills/competences required in the fast-evolving global economy. Further, we suggest that African governments and their development partners promote and/or support firms in frontier technology adoption and innovation. Policymakers should also endeavour to enhance information flow and deepen public education, consultation, and feedback loops.

Notwithstanding the contribution to this research to the shared growth scholarship, some avenues for future research remain. To begin with, other researchers can explore the inclusive human development and environmental sustainability. This

worth investigating considering the low carbon footprint and the growing deployment of frontier technologies in the education and health sectors.

Declaration: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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Appendices

Table A.1: List of countries

Algeria	Egypt	Libya	Sierra Leone
Angola	Eswatini	Madagascar	South Africa
Benin	Ethiopia	Mali	Sudan
Botswana	Gabon	Mauritania	Tanzania
Burkina Faso	Gambia	Mauritius	Togo
Burundi	Ghana	Morocco	Tunisia
Cameroon	Guinea	Mozambique	Uganda
Congo	Guinea-Bissau	Namibia	Zambia
Congo, D. R.	Kenya	Rwanda	Zimbabwe
Cote d'Ivoire	Lesotho	Senegal	

Table A.2: Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Palma ratio	1												
(2) Gini index	0.915 ^{***}	1											
(3) Political stability	0.360 ^{***}	0.329 ^{***}	1										
(4) Remittances	-0.0339	-0.0146	0.0599	1									
(5) Economic growth	-0.165 ^{***}	-0.381 ^{***}	0.189 ^{***}	-0.270 ^{***}	1								
(6) Foreign direct investment	0.0566	0.0923	0.184 ^{***}	-0.0636	-0.107 [*]	1							
(7) Foreign aid	-0.0459	0.138 ^{**}	-0.132 ^{**}	0.149 ^{**}	-0.592 ^{***}	0.183 ^{***}	1						
(8) Frontier technology readiness	-0.0649	-0.308 ^{***}	0.259 ^{***}	-0.0192	0.646 ^{***}	-0.0795	-0.534 ^{***}	1					
(9) Egalitarian democracy	0.132 ^{**}	0.0984	0.544 ^{***}	0.171 ^{***}	0.256 ^{***}	0.0581	-0.115 [*]	0.407 ^{***}	1				
(10) Deliberative democracy	0.154 ^{**}	0.116 [*]	0.498 ^{***}	0.0746	0.270 ^{***}	0.0709	-0.160 ^{**}	0.435 ^{***}	0.947 ^{***}	1			
(11) Liberal democracy	0.236 ^{***}	0.189 ^{***}	0.572 ^{***}	0.125 [*]	0.258 ^{***}	0.0593	-0.174 ^{***}	0.444 ^{***}	0.955 ^{***}	0.959 ^{***}	1		
(12) Participatory democracy	0.250 ^{***}	0.244 ^{***}	0.528 ^{***}	0.0455	0.188 ^{***}	0.0733	-0.0380	0.342 ^{***}	0.895 ^{***}	0.919 ^{***}	0.922 ^{***}	1	
(13) Electoral democracy	0.209 ^{***}	0.196 ^{***}	0.508 ^{***}	0.106 [*]	0.186 ^{***}	0.0471	-0.112 [*]	0.322 ^{***}	0.942 ^{***}	0.947 ^{***}	0.958 ^{***}	0.926 ^{***}	1

* p < 0.05, ** p < 0.01, *** p < 0.001