A G D I   Working Paper

WP/23/047

Mobile money innovations, income inequality and gender inclusion in sub-Saharan Africa

Forthcoming: Financial Innovation

Simplice A. Asongu*
(Corresponding author)
Association for the Promotion of Women in Research and Development in Africa
(ASPROWORDA), Cameroon.
E-mails: asongusimplice@yahoo.com,
asongus@afridev.org

Peter Agyemang-Mintah
College of Business, Zayed University, Abu Dhabi,
P.O. Box 144534, Abu Dhabi, United Arab Emirate, UAE
E-mail: z10875@zu.ac.ae

Joseph Nnanna
The Development Bank of Nigeria,
The Clan Place, Plot 1386A Tigris Crescent,
Maitama, Abuja, Nigeria
E-mail: jnnanna@devbankng.com

Yolande E. Ngoungou
Association for the Promotion of Women in Research and Development in Africa
(ASPROWORDA), Cameroon.
&
University of Yaoundé 2, Soa, Cameroon
E-mail: yolandengoungou@gmail.com

Research Department

Mobile money innovations, income inequality and gender inclusion in sub-Saharan Africa

Simplice A. Asongu, Peter Agyemang-Mintah, Joseph Nnanna & Yolande E. Ngoungou

Abstract

The study assesses the role of mobile money innovations on income inequality and gender inclusion in 42 Sub-Saharan African countries for the period 1980 to 2019 using interactive quantile regressions. The following findings are established. First, income inequality unconditionally reduces the involvement of women in business and politics. Second, mobile money innovations interact with income inequality to have a positive impact on women in business and politics. Third, net effects from the role of mobile money innovations in income inequality for gender inclusion are consistently negative. Fourth, given that the positive conditional or interactive effects and negative net effects are consistent across the conditional distribution of gender inclusion, thresholds at which mobile money innovations can completely dampen the negative effect of income inequality on gender inclusion are provided. Among others, policy makers should work towards improving conditions for mobile money innovations. They should also be aware that reducing both income inequality and enhancing mobile money innovations simultaneously leads to more inclusive outcomes in terms of gender inclusion.

Keywords: Financial inclusion; inequality; mobile phones; sub-Saharan Africa; women
JEL Classification: G20; O40; I10; I20; I32

1. Introduction

The motivation of the present research which is focused on the role of mobile money innovations on income inequality and women in business and politics in Sub-Saharan Africa (SSA) is premised on five main foundational factors, notably: first, the exclusion of women in political and economic activities and the importance of involving women economically and politically to boost economic prosperity. Second, the policy concern of income inequality and the specificity of SSA in terms of exclusive development (i.e., economic prosperity that is not equitably distributed across the population). Third, the role of mobile money innovations in inclusive development. Fourth, gaps in the existing literature[1]. The underlying motivational factors are substantiated in the following paragraphs in greater perspective, following the same chronology in which they have been highlighted.

First, the concern of gender inclusion prominently features among the sustainable development goals (SDGs) of the United Nations. SDG5 which is oriented towards gender equality and female empowerment is the focus of the present study given the targeted outcomes on engaging more women in politics and business. Both policy and scholarly literature are consistent on the view that SSA is one of the regions in the world with the highest levels of gender exclusion and the gender gap between women and men has led to a loss of about 160 trillion USD in terms of gross domestic product (GDP) (World Bank, 2018; Asongu *et al*., 2021a). This study is therefore an extension of the existing literature by assessing how mobile money innovations affect the incidence of inequality on gender economic and political empowerment. This is essentially because beyond the concern of gender exclusion discussed in this paragraph, there is also a policy syndrome of income inequality which is a substantial impediment in the achievement of some poverty- and inequality-related SDGs.

Second, the concern of income inequality is fundamental in the achievement of SDGs because, among others, Bicaba *et al*. (2017) have recently established that unless the focus of income inequality is promptly tackled in SSA, most countries in the sub-region are unlikely to achieve most SDGs by 2030. The specificity of SSA within the remit of exclusive development is that compared to other regions of the world, the sub-region is characterized by one of the highest rates of income inequality (Asongu & Nwachukwu, 2016; Tchamyou, 2020). Recent evidence

---

[1] Throughout the study "gender inclusion" is used interchangeably with women in politics and business. As clarified in Appendix 1 and Section 3.1, mobile money innovations within the context of the study are when mobile phones are used to facilitate transactions such as the payment of bills and sending of money.

revealed that it is fundamentally because of income inequality that poverty levels are still high in SSA, not least, because the favorable effects of economic growth are not evenly distributed across the population year after year (Tchamyou, 2019). In essence, in 2019, SSA outpaced Asia and became the region with the greatest number of people living in extreme poverty (Nwani & Osuji, 2020). Consistent with contemporary financial inclusion literature, a means by which income inequality can be mitigated is through mobile money innovations (Awel & Yitbarek, 2022; Kim, 2022; Ngono, 2021).

Third, the role of mobile money innovations is fundamental in the achievement of inclusive development, especially in the light of the fact that these are associated with at least eight of the seventeen SDGs (UNCDF, 2022). In essence, according to the narrative on the seventeen SDGs, financial inclusion is linked to, among others: the first goal or SDG1 that relates to poverty eradication. The second goal or SDG2 that is concern with ending hunger, boosting sustainable agriculture and ensuring food security. SDG3 which focuses on health and wellbeing, SDG5 linked to gender equality and the empowerment of women, SDG8 linked to the economic growth promotion and SDG9 concerned with boosting the industry, infrastructure and innovation of nations. Moreover, financial inclusion is also relevant to SDG10 linked to inequality mitigation and SDG17 related to consolidating the channels of implementation through partnerships, especially considering the role of financial inclusion through consolidated mobilization of investment and consumption resources (Tchamyou *et al*., 2019a, 2019b; Asongu & le Roux, 2019; Abdulqadir & Asongu, 2022; UNCDF, 2022). Given the highlighted importance of financial inclusion in achieving a multitude of SDGs, this study is premised on understanding how mobile money innovations can be leveraged upon by policy makers to promote gender inclusion within the remits of women's involvement in business and politics, owing to an apparent gap in the existing literature.

Fourth, the existing contemporary literature can be discussed in two main strands, notably: studies on mobile money innovations on the one hand and research on gender inclusion on the other hand. In the first strand, the attendant literature on mobile money innovations has been concerned with among others: the adoption of mobile money in response to shocks of idiosyncratic nature (Koomson *et al*., 2021) and drivers of the diffusion of FinTech services by small and medium enterprises (SMEs) (Coffie *et al*., 2021). The relevance of mobile money in utility bill payments (Awel & Yitbarek, 2022) and the importance of financial inclusion in inclusive development in rural households (Serbeh *et al*., 2022) have also been considered in

this strand. Moreover, other studies worth noting have focused on digital currency pricing (Schilling & Uhlig, 2019; Biais *et al*., 2020; Choi & Rocheteau, 2021); robust framework for the functioning of digital platforms (Eyal & Sirer, 2014; Chiu & Koeppl, 2019; Biais *et al*., 2019; Pagnotta, 2021; Saleh, 2021) and digital currency mining and the establishment of related fees (Huberman *et al*., 2021; Easley *et al*., 2019).

The second strand on the linkage between mobile money innovations and gender inclusion has focused on among others, the incidences of bank mechanisms, microfinance and mobile money in funding women's entrepreneurship in SSA (Ngono, 2021). This strand is also concerned with how the financial inclusion of women is influenced by mobile money (Kim, 2022). Linkages among information and communication technology (ICT) usage, mobile money and financial access of women (Osabuohien & Karakara, 2018; Asongu & Odhiambo, 2018a) as well as gender disparities in financial inclusion (Mndolwa & Alhassan, 2020) have also been considered in the existing literature.

The closest study in the existing literature to be present in this study is Ngono (2021) which has assessed the incidence of microfinance, mobile money and bank channels in financing women's entrepreneurship in SSA. To put this in perspective, Ngono (2021) has focused on 48 countries in region for the period 2004-2018 using the generalized method of moments (GMM) estimation approach. The findings show that banking services do not lead to a significant impact on the self-employment of women while mobile money and microfinance services (i.e. considered as alternatives) are significant. The present study is akin to Ngono (2021) on two fronts: (i) the relevance of mobile money in facilitating women's economic empowerment and (ii) the focus on SSA. However, the present study departs from Ngono (2021) on four main fronts, namely: (i) data and periodicity (42 countries for the period 1980 to 2019 versus 48 countries for the period 2004-2018); (ii) methodology (Quantile regressions versus GMM estimations); (iii) outcomes of gender enhancement (political and economic empowerment versus economic empowerment) and (iv) policy relevance (accounting for policy thresholds and initial outcome variables versus blanket linkages based on mean values of the outcome variable). This last distinctive feature is worth elaborating further.

Considering the fourth distinctive feature above, two points are noteworthy. First, this study argues that providing the linkage between independent variables and outcomes of gender economic inclusion as done by Ngono (2021) has less policy and managerial implications.

Moreover, managerial implications of this study are associated with women in business while policy implications relate to women in politics. The present study goes beyond establishing whether mobile money has a positive or negative effect on gender economic inclusion to providing critical levels of mobile money innovation that policy makers can act upon to promote gender economic and political inclusions. Moreover, these policy thresholds are contingent on income inequality. In essence, this study establishes critical mobile money innovations thresholds that are needed to mitigate the negative incidence of income inequality on the involvement of women in business and politics. Second, policy implications from Ngono (2021) are blanket because they are based on the mean values of the outcome variable, considering the estimation technique. This study argues that such blanket policy implications can be ineffective unless they are contingent on initial levels of the outcome variables and hence, corresponding implications should be tailored towards existing levels of the outcome variables. In the present study, initial levels of women in business and politics are considered in the estimation exercise such that the established linkages are contingent on initial levels of women in business and politics. These substantiated distinctive features are framed in a Quantile regression estimation framework.

The study is also positioned as a contribution of the existing literature on new technology, work and employment, not least, because new technologies such as mobile money innovations are employed to assess how income inequality affects the work of women within business and political spheres. In essence, as argued by Freeman (2005), compared to traditional forms of technology, modern technologies provide more avenues for the economically-excluded in society (e.g. such as women) to engage with working environments. This is essentially because modern technologies such as mobile money innovations are viewed as constituting a factor that favors opportunities for the engagement of women at work (see Whittall *et al.*, 2009) as clarified in the theoretical underpinnings section of this study.

Given the forgoing, by assessing the role of mobile money innovations in the impact of income inequality on women in politics and business, this study contributes to the contemporary stream of literature on the importance of new information technologies in promoting work, labour unions and employment (Geelan, 2021; Staples & Whittall, 2021; Flanagan & Walker, 2021; Hennebert *et al.*, 2021). The rest of the study is structured as follows. The theoretical underpinnings and corresponding literature are engaged in Section 2 while the data and

methodology are covered in Section 3. Section 4 provides the empirical findings whereas the study concludes in Section 5 with policy implications and future research directions.

2. Theoretical underpinnings and testable hypotheses

This section discusses the theoretical underpinnings and corresponding testable hypotheses. It is discussed in three main strands, notably a: discourse of the theoretical underpinnings; next, contextualization of the theoretical underpinnings within the remit of the present study and finally, statement of the testable hypotheses given the theoretical underpinnings and corresponding contextual clarification. First, the theoretical underpinnings for the linkage between financial inclusion and inclusive development builds from Tchamyou *et al*. (2019a) who have used such theoretical underpinnings in assessing linkages among information and communication technology (ICT), financial institutions and income inequality. According to the narrative from Tchamyou *et al*. (2019a), both information technology and financial institutions are fundamental in the mitigation of income inequality. This theoretical premise is consistent with the financial development and inclusive development literature supporting the perspective that when the population is provided with financial inclusion opportunities, concerns related to poverty and inequality are likely to be addressed, especially if most of the those benefiting from the attendant financial access are from the poorer fraction of the population (Greenwood & Jovanovic, 1990; Galor & Zeira, 1993; Galor & Moav, 2004; Aghion & Bolton, 2005; Beck *et al*., 2007; Tchamyou & Asongu, 2017a; Asongu & Odhiambo, 2018b).

As documented in Tchamyou *et al*. (2019a), the linkage between financial development and inclusive development is theoretically based on the extensive and intensive margin theories. These two existing theories are substantiated to elaborate detail in what follows. (i) Consistent with the intensive margin theory, inclusive development can be apparent when financial services are extended to existing customers who are already benefiting from the existing financial services. To be sure, mobile money innovations which are employed in this study as the modulating variables can be employed by existing financial institutions to improve access to financial services by already existing customers. Such is already apparent in most financial institutions of the world that are leveraging on existing mobile phone platforms in order to improve services to their clients especially within the remit of the mobile phone used to send money and the mobile phone used to pay bills online (Lashitew et al., 2019). The theoretical strand is broadly in the accordance with Chipote *et al*. (2014).

(ii) The extensive margin theory maintains that financial access can also be provided to the population that was not previously benefiting from financial services. Such is the case when the financial institutions leverage on existing technologies to extend their services to a previously unbanked fraction of the population. Such extension of financial services by means of mobile money innovations (i.e., used as moderating variables in this study) engenders inclusive development outcomes such as the reduction of income inequality and gender empowerment which are respectively, employed in this study as the main mechanism and inclusive development outcome. This insight on the extensive margin theory is consistent with a strand of literature on the linkage between financial inclusion and inclusive development outcomes (Odhiambo, 2014; Orji, Aguegboh & Anthony-Orji, 2015; Chiwira *et al*., 2016) and such a theoretical foundation is even more apparent in reducing income inequality and poverty when a substantial part of the population is not benefiting from formal financial services (Evans & Jovanovic, 1989; Holtz-Eakin *et al*., 1994; Black & Lynch, 1996; Bae *et al*., 2012; Batabyal & Chowdhury, 2015).

Second, concerning the contextualization of the theoretical underpinnings, it is relevant to clarify that the theoretical underpinnings are premised on the importance of financial inclusion in inclusive development. Mobile money innovations used as the moderating or policy variables in this study constitute the context of financial inclusion while income inequality and gender empowerment (i.e. in business and politics) entail the inclusive development context. Of this latter inclusive development context, the main channel or income inequality is a policy syndrome or negative economic signal while gender empowerment in business and politics are the macroeconomic outcomes. Hence, the intuition for the study is simply to follow: financial inclusion moderates the incidence of income inequality on gender inclusion granting that income inequality reduces gender empowerment in business and politics. Accordingly, income inequality has been documented to be negatively correlated with gender inclusion in SSA (Asongu & Odhiambo, 2019).

Third, building on the above, it follows that the extensive and intensive margin theories support the position that income inequality reduces inclusive development and financial inclusion improves inclusive development. Contextualizing these two premises engenders the following two testable hypotheses.

Hypothesis 1: income inequality reduces the presence of women in business and politics

Hypothesis 2: mobile money innovations modulate the negative influence of income inequality on the presence of women in business and politics.

3. Data and methodology

3.1 Data

Constraints in data availability at the time of the study motivate this study to focus on 42 countries in SSA for the period 1980-2019[2]. Following the information disclosed in Appendix 1, the data comes from three principal sources, notably: the World Bank's World Development Indicators (WDI), the Global Findex database and the Global Financial Development Database. Two main outcome variables on gender empowerment are employed, namely: (i) women in politics proxied with the proportion of seats held by women in national parliament (%) and (ii) women in business proxied by women in businesses and law index score (scale 1 to 100). The choice of these variables is consistent with contemporary gender inclusive development literature (Min *et al*., 2021; Bezinna *et al*., 2022; Achuo *et al*., 2022). In line with contemporary income inequality literature (Tchamyou, 2020, 2021), the Gini index is the proxy for income inequality.

Two mobile money innovation variables are used in the study as the modulating or policy variables, in accordance with existing mobile money innovations literature (Lashitew *et al*., 2019; Asongu *et al*., 2020, 2021b). First, the mobile phone to send money, proxied by the percentage of respondents who report using a mobile phone to send money in the past 12 months (% age 15+). Second, the mobile phone used to pay bills online, proxied by the percentage of respondents who report using a mobile phone to pay bills online in the past 12 months (% age 15+). Missing observations are addressed using the nearest neighbour data engineering technique. This approach was used to address missing observations in the mobile money variables consistent with Ofori *et al*. (2022).

To account for omitted variable bias, the following variables are controlled for and hence, involved in the conditioning information set, namely: financial institutions depth, financial

---

[2]The 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*".

institutions access, financial institutions efficiency, inflation, development assistance, government expenditure, gross domestic product (GDP) growth, foreign direct investment (FDI), remittances and trade. The choice of the variables in the conditioning information set is consistent with contemporary inclusive development and gender empowerment literature (Tchamyou *et al*., 2019a; Ofori *et al*., 2021; Asongu & Nting, 2022; Asongu *et al*., 2021c).

It is relevant to clarify that whereas the underlying factors in the conditioning information set have been documented to influence gender inclusion in the corresponding literature, the anticipated signs cannot be established with certainty. This is essentially because of the empirical framework used in this study which is non-linear in nature. Accordingly, an interactive quantile regression technique is adopted in this study. An interactive regression is non-linear and hence, multicollinearity concerns are always apparent. It is for this underlying reason that in order to avoid the pitfalls of interactive regressions documented in Brambor *et al*. (2006), this study controls for the potential concerns of multicollinearity by computing the net effects and thresholds in order to assess the role of mobile money innovations in the incidence of income inequality on gender economic inclusion. Accordingly, consistent with the existing contemporary interactive regressions' literature (Nchofoung *et al*., 2021; Nchofoung & Asongu, 2022a), such a net effect of income inequality is the sum of the unconditional incidence of income inequality and the conditional or interactive effect of income inequality.

Building on the above, the expected signs from variables in the conditioning information set cannot be established with certainty because on the one hand, there is a concern of multicollinearity which affects the expected signs (see Asongu *et al*., 2020, 2021) is overlooked in interactive regressions (Brambor *et al*., 2006) and on the other, the estimated coefficients are not interpreted as in linear additive models given that net effects and thresholds are computed. The definitions and sources of the variables are provided in Appendix 1 while the summary statistics (employed for the highlighted computation of thresholds and net effects) is provided in Appendix 2. The correlation matrix is disclosed in Appendix 3 to complete the picture of the summary statistics.

3.2 Methodology

Considering the motivational factors disclosed in the introduction, this study aims to assess the linkages throughout the conditional distribution of the outcome variables. Hence, consistent with the same motivational factors, the quantile regressions technique is chosen as an estimation

approach because it enables the study to achieve the attendant objective. It is worthwhile to note that the choice of the estimation approach is fundamentally motivated by departing from Ngono (2021) (i.e., a study closest to the present study in the literature) in order to provide more room for policy implications. Consistent with the attendant literature, the selected estimation approach is tailored such that the corresponding findings articulates linkages with low, intermediate and high initial levels of the outcome variables (Billger & Goel, 2009; Asongu, 2017; Tchamyou & Asongu, 2017b; Boateng *et al*. 2018). One main caveat of the quantile regressions technique is that it can only be employed to obtain global impacts and therefore, country-specific studies are still recommended for policy implications.

Another point worth clarifying is the perspective that, compared to OLS that are founded on the assumption that the corresponding error terms are normally distributed, with the quantile regression approach, the attendant assumption does not hold. Moreover, parameters are modelled at various points in the conditional distribution of the gender inclusion outcome variables. The discourse on the quantile regression approach is consistent with both contemporary and non-contemporary literature on the subject (Koenker & Bassett, 1978; Keonker & Hallock, 2001; Asongu, 2017). Considering the above, in the estimation exercise, the θth quantile estimator of women in business and women in politics is derived by solving for the optimization problem in Equation (1), that is provided without subscripts for the purpose of simplicity in presentation.

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

where $\theta \in (0,1)$. Compared to OLS that are for the most part based on the minimization of the total of squared residuals, the quantile regression framework consists of summing the absolute deviations of all the corresponding quantiles. For example, in the corresponding approach, many quantile such as the 50th quantile or the median and the 75th quantile (i.e. corresponding to θ =0.10 or 0.75, respectively) are reduced by approximately weighing the residuals. The attendant conditional quantile of women in business or women in politics or y_i given x_i is:

$$Q_y(\theta / x_i) = x_i'\beta_\theta \tag{2}$$

where for the comparative θ^{th} quantile that is estimated, parameters that are characterised by unique slopes are modelled. The corresponding formulation is parallel to $E(y / x) = x_i'\beta$ in the OLS slope within which remit, parameters are examined exclusively at the average of the

conditional distribution of women in politics or women in business. For the model in Eq. (2), the dependent variable y_i is the women in business and politics indicator while x_i contains a constant term, *inequality, the mobile phone used to send money, the mobile used to pay bills online, financial institutions depth, financial institutions access, financial institutions efficiency, inflation, development assistance, government expenditure, gross domestic product (GDP) growth, foreign direct investment (FDI), remittances and trade.*

4. Empirical results

4.1 Presentation of results

The empirical results are presented in this section in two main tables. While Table 1 shows findings on the linkages among the mobile phone used to send money, income inequality, women in politics and women in business, Table 2 discloses corresponding results related to linkages among the mobile used to pay bills online, income inequality, women in politics and women in business. What is also worth noting from the findings is that the choice of the quantile regression approach is validated, not least because when OLS estimates are compared with the corresponding quantile regressions estimates (i.e., throughout the conditional distribution of the outcome variables), it is apparent that the estimates are distinct in terms of significance, sign and magnitude of significance.

Given the motivation of the present study and by extension, the testable hypotheses, the research is consistent with contemporary interactive regressions literature in computing net effects (Nchofoung *et al*., 2022; Nchofoung & Asongu, 2022b). Accordingly, to examine the incidence of mobile money innovation on income inequality and gender inclusive outcome variables, the overall or net effects are computed. Such net effects embody the unconditional effects of income inequality as well as the conditional or interactive effects of income inequality. Moreover, in accordance with Brambor *et al*. (2006) on the pitfalls of interactive regressions, thresholds are also computed as we shall further substantiate in Section 4.2. These thresholds entail both the conditional and the unconditional effects of the main independent variable of interest or principal channel by which mobile money innovations influence the gender inclusive outcome variables of women in business and politics.

It is relevant to further substantiate the computation of net effects with an illustrative example. In the first column of Table 1 in the regressions focusing on OLS, the net effect from the role of the mobile used to send money in the incidence of the income inequality on women in politics

is -0.058 = ([0.0008 × 10.280] + [-0.067]). In the corresponding computation, -0.067 is the unconditional effect of income inequality on women in politics while 10.280 is the mean or average value of the mobile used to send money. 0.0008 is the interactive or conditional effect of income inequality.

Given the above information criteria, the following findings can be established from Tables 1-2. First, with the exception of the top quantile of Table 1, *Hypothesis* 1 is overwhelmingly valid because income inequality has a negative unconditional effect on the outcome variables. Second, the validity of *Hypothesis* 2 is apparent in the: (i) bottom quantiles of the right-hand side of Table 1 (i.e., focusing on women in business and the mobile used to send money); (ii) the 10th and top quantiles of Table 2 (focusing on women in politics and the mobile used to pay bills online).

"Insert Table 1"

Third, following Brambor *et al*. (2006), while the information provided above on the validity of Hypotheses 1 and 2 is informative, in order to robustly assess the attendant hypotheses, it is worthwhile to compute net impacts in order to avoid a pitfall of interactive regressions documented by the authors. It is also worthwhile to note that as clarified in the footnotes of the corresponding tables, net effects are computed exclusively in cases where both the conditional and unconditional effects of income equality on the outcome variables are statistically significant. Fourth, on the premise of the computed net effects, with the exception of the 75th quantile in the right-hand side of Table 2 (for which a negative synergy is apparent), the computed net effects are overwhelmingly negative. From the disclosed findings, net negative effects are apparent in the: (i) bottom quantile of the left-hand side of Table 1 in the regressions pertaining to the mobile used to send money and women in business and (ii) the 10th quantile and top quantiles of the left-hand side of Table 2 in regressions focusing the mobile used to pay bills online and women in politics.

"Insert Table 2"

Comparing the first-three findings within the remits of unconditional effects, conditional or interactive effects and net effects, it is apparent that mobile money innovations are necessary but not a sufficient condition for the complete mitigation of the negative incidence of income

inequality on the outcome variables. Put differently: (i) income inequality reduces the number of women in business and the number of women in politics; (ii) the mobile money innovation modulates the negative incidence of income inequality on the gender inclusive outcomes. However, the positive conditional effects substantially contrast with the negative net effects in the perspective that the modulating mobile money innovation variables must reach some critical levels of penetration before the corresponding mobile money innovations can completely nullify the negative incidence of income inequality on the targeted gender inclusive outcome: this is the focus of the next section on policy thresholds. Fifth, most of the control variables are significant. However, as we have clarified earlier, owing to the concern of multicollinearity that is apparent in interactive regressions, the expected signs of the variables in the conditioning information set cannot be established with certainty.

4.2 Policy thresholds

This section is an extension of the analysis with an assessment of policy thresholds. Accordingly, as we have discussed earlier, the purpose of the section is to establish critical masses of the modulating variables that policy makers can directly act upon to influence the targeted gender inclusive outcomes in the desired direction. Moreover, for policy makers to act upon the suggested policy thresholds, these attendant thresholds must have economic meaning and make statistical sense. In other words, the computed thresholds can be policy-relevant, only and only if, they are situated within the remit of the range of the summary statistics provided in Appendix 2. Accordingly, the computed thresholds should be situated between the minimum and the maximum values as disclosed in the summary statistics, if policy makers are to make any tangible claims of leveraging on the suggested thresholds for policy decision-making. These underpinnings for the relevance of the policy thresholds are consistent with contemporary interactive regressions literature (Nchofoung *et al*., 2022; Nchofoung & Asongu, 2022a).

Still building on the example provided in Table 1, in the second column of the attendant tables, the mobile phone used to send money thresholds at which the negative incidence of income inequality on women in politics is completely mitigated is equal to 83.750 (0.067/0.008) (% age 15+). Unfortunately, the computed threshold is not policy-relevant because it is not situated within the statistical range (0.000 to 50.122) of the mobile phone used to send money as apparent in Appendix 2. It follows that the maximum penetration level from which policy makers can take feasible measures to increase the level of the mobile used to send money is 50.122 (% age 15+). By extension, all the computed policy thresholds corresponding to Table

1 does not make economic sense and hence, is not policy-relevant. This is not the case of policy thresholds provided in Table 2. Accordingly, the provided thresholds pertaining to the mobile phone used to pay bills online make economic sense and are policy-relevant because they are all within the statistical range provided in the summary statistics. In other words, they are situated between 0.000 (i.e. minimum) and 37.104 (i.e. maximum), not least because the highest threshold provided in the table is 33.500 mobile phone used to pay bills online (% age 15+).

The establishment of mobile money innovation thresholds that mitigate the negative impact of income inequality on gender inclusion is consistent with the strand of literature on the positive role of mobile money on gender inclusion, among others, Khera *et al*. (2022) who have shown that digital financial services facilitate financial access, lower cost of financial transactions, and enhance inclusive finance. Loko and Yang (2022) and Yeyouomo *et al*. (2023) who have also established that financial technologies improve inclusive development within the remit of reducing gender income inequalities, improving gender financial inclusion and boosting the employment of women. This is also broadly in line with Sioson and Kim (2019) who have shown that improvements in financial technology are fundamental in mitigating the financial service gender gap. Moreover, the contingency of the mobile money innovation thresholds on initial levels of gender inclusion is also in accordance with a strand of literature on the importance of complementing mobile innovation technologies with complementary measures when the overall incidence on gender inclusion is not apparent. This perspective of complementary policies is in line with Tok and Heng (2022), especially as it pertains to variations in social norms and behavior of the population.

In summary, the results that innovations in mobile money promote gender inclusion are consistent with both empirical and theoretical literature. On the theoretical front, the findings are in line with both the intensive and extensive margin theories discussed in Section 2 (Tchamyou et al., 2019a), notably that innovations in mobile money can improve gender inclusion opportunities for both existing customers (i.e., the intensive margin theory) and new customers (i.e. the extensive margin theory) of mobile money, for the doing of business by females as well as engagement in governance activities by women. From an empirical standpoint, as earlier clarified, the findings are in line with empirical studies supporting the importance of financial technologies and mobile money innovations in inclusive development outcomes, especially in households that are led by the female gender (Suri & Jack, 2016; Sioson & Kim, 2019; Moufakkir & Mohammed, 2020; Loko & Yang, 2022; Yeyouomo *et al*., 2023).

5. Concluding implications and future research directions

The criticality of gender inclusion had been fundamental in sustainable development even before the advent of SDGs underpinning the post-2015 sustainable development agenda (United Nations, 2013). The present study has contributed to the scholarly and policy debate by assessing the role of mobile money innovations on income inequality and women in business and politics in 42 Sub-Saharan African countries for the period 1980 to 2019. Mobile money innovations are proxied by the mobile phone used to send money and the mobile phone used to pay bills online. Income inequality is proxied by the Gini index. The empirical evidence is based on interactive quantile regressions. The following findings are established.

First, income inequality unconditionally reduces the involvement of women in business and politics. Second, mobile money innovations interact with income inequality to have a positive incidence on women in business and politics. Third, net effects from the role of mobile money innovations in income inequality for gender inclusion are consistently negative. Fourth, given that the positive conditional or interactive effects and negative net effects are consistent across the conditional distribution of gender inclusion, thresholds at which mobile money innovations can completely dampen the negative effect of income inequality on gender inclusion are provided. The results are contingent on existing levels of gender inclusion, proxies for gender inclusion as well as the type of mobile money innovation. Policy implications are discussed in what follows.

On the first policy implication, it is relevant to state that the findings are consistent with the existing income inequality literature (e.g. Bicaba *et al*., 2017) on the position that unless income inequality is addressed, most sustainable development targets in the region will not be achieved. Within the remit of this study, we have shown that gender inclusion is one of such outcomes that cannot be achieved in the sub-region unless the concern of income inequality is addressed. Consequently, policy makers in sampled countries should take the necessary measures to mitigate income inequality in order to provide a conducive environment for other sustainable development outcomes.

Second, as apparent in the positive interactive estimates as well as relevant policy-thresholds, mobile money innovations appear not only to directly mitigate income inequality but also have an indirect positive effect on gender inclusion. By implication, policy makers should work

towards improving conditions for mobile money innovations, not least, because doing so will engender a plethora of positive inclusive development externalities. However, in implementing the suggested policy requirement, a distinction should be made between the mobile used to send money and the mobile used to pay bills online. Accordingly, while the recommendation for the mobile used to pay bills online is directly apparent, the corresponding recommendation on the mobile used to send money should be taken with caution. This is essentially because compared to the mobile used to pay bills online, the thresholds of the mobile used to send money are beyond policy range.

Third, reducing both income inequality and enhancing mobile money innovations simultaneously leads to more gender inclusion. Hence, beyond the remit of considering idiosyncratic policy measures of either reducing income inequality or increasing the penetration of mobile money innovations, simultaneous policies that engage the mitigation of income inequality and improvement of mobile money innovations should be considered. Fourth, the pertinence of the above three policy recommendations is contingent on three main factors. Accordingly, the findings depend on proxies for gender inclusion (women in business versus women in politics). The findings also depend on existing levels of gender inclusion (bottom quantiles versus top quantiles of gender inclusion) as well as the type of mobile money innovation (the mobile used to send money versus the mobile used to pay bills online).

Fifth, the underlying implications also double as managerial implications because 'women in business' is employed as an outcome variable in the study. This is because while the outcome variable of 'women in politics' speaks to the role played by women within the remit of political governance, the outcome variable of women in business, speaks to female managers. Accordingly, in the light of the findings, industry leaders should pay attention to the fact that the industry can contribute to improving the involvement of the female gender in business by among others, allocating funds for more research and development (R&D) in view of providing more innovations in mobile phones, especially as it pertains to using the mobile phone to send and receive money as well as the payment of bills. Moreover, policies of equal pay between men and women will go a long way to reducing income inequality which is essential for promoting gender economic inclusion. Furthermore, the main theoretical implication is that mobile money innovations support both the intensive and extensive margin theories on the relevance of inclusive finance in inclusive development within the remit of gender inclusion.

The results from this research admittedly allow space for future research, especially as it focuses on the engagement of other policy channels (i.e., positive economic measures) and policy syndromes (i.e. negative economic measures) through which innovations by means of mobile phones can affect gender inclusion in terms of women in politics and women in business. Given that income inequality, gender empowerment and financial inclusion through mobile money innovations are the main indicators of interest associated with SDGs targets, future research can consider other SDGs in order to provide more insights into the linkages among income inequality, financial inclusion and sustainable development. In this suggested future research direction, emphasis should be placed on the continents and regions in which concerns about exclusive development are most apparent.

Furthermore, as clarified in the methodology section, a limitation of the quantile regressions technique is that it can only be employed to obtain global impacts and therefore, country-specific studies are still recommended for policy implications that are specific to countries. Hence, in future research, cross-country cluster analysis on the extent of payment innovations should be considered to further elucidate the engagement of women in politics and business. For instance, countries in sub-Saharan Africa are different from political, economic, social and cultural perspectives (e.g., South Africa versus Somalia). Accounting for these factors in future research will add value to this field of research.

6. Abbreviations

SSA: Sub-Saharan Africa
SDGs: Sustainable Development Goals
GDP: Gross Domestic Product
ICT: Information and Communication Technology
GMM: Generalized Method of Moments
FDI: Foreign Direct Investment
OLS: Ordinary Least Squares

Table 1: Mobile phones used to send money, inequality and women in politics and business

	Women in Politics						Women in Business					
	OLS	Q.10	Q.25	Q.50	Q.75	Q.90	OLS	Q.10	Q.25	Q.50	Q.75	Q.90
Constant	**59.457***	**43.114***	**53.120***	**62.314***	**64.483***	**69.079***	**56.477***	**36.943***	**51.332***	**59.385***	**61.847***	**68.799***
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Gini	**-0.067***	**-0.039***	**-0.063****	**-0.042***	-0.068	-0.067	**-0.268***	**-0.247***	**-0.248***	**-0.315***	**-0.261***	**-0.239***
	(0.000)	**(0.085)**	**(0.012)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Mobsen	0.022	**0.307***	**0.149***	**0.065***	-0.012	-0.049	-0.108	-0.169	**-0.266***	**-0.142***	0.0003	0.034
	(0.423)	**(0.000)**	**(0.056)**	**(0.038)**	(0.785)	(0.350)	(0.135)	(0.172)	**(0.009)**	**(0.030)**	(0.996)	(0.785)
Gini ×Mobsen	**0.0008***	-0.0007	0.00004	0.00008	0.0008	0.001	**0.002***	**0.004***	**0.004***	0.001	-0.001	0.001
	(0.074)	(0.541)	(0.791)	(0.875)	(0.284)	(0.167)	**(0.087)**	**(0.043)**	**(0.006)**	(0.143)	(0.435)	(0.525)
FinInDepth	**3.007***	**19.704***	3.408	**4.097***	**3.253***	0.330	**18.107***	-1.633	**23.172***	**28.282***	**23.927***	**12.649***
	(0.038)	**(0.000)**	(0.237)	**(0.000)**	**(0.051)**	(0.866)	**(0.000)**	(0.721)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.007)**
FinInAccess	**-11.305***	**-77.524***	-3.183	-0.646	**-3.452***	**-5.796***	**24.158***	**20.421***	**31.454***	**23.884***	**14.741***	**20.534***
	(0.000)	**(0.000)**	(0.360)	(0.645)	**(0.086)**	**(0.014)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
FinInEffic	**-4.990***	**3.412***	-3.034	**-8.325***	**-5.614***	**-5.802***	**11.339***	**13.333***	**7.457***	**11.597***	**15.497***	**16.196***
	(0.000)	**(0.059)**	(0.135)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.005)**	**(0.000)**	**(0.000)**	**(0.000)**
Inflation	**0.0006***	**0.0009***	0.0007	**0.0005***	**0.0007***	**0.002***	**-0.001***	**-0.003***	**-0.001***	-0.0008	-0.0009	**-0.001***
	(0.000)	**(0.086)**	(0.226)	**(0.040)**	**(0.032)**	**(0.000)**	**(0.000)**	**(0.002)**	**(0.038)**	(0.114)	(0.127)	**(0.098)**
Foreign aid	-0.007	0.007	-0.008	**-0.066***	**-0.056***	**-0.107***	**0.071***	**0.121***	0.027	**0.060***	**0.065***	-0.019
	(0.600)	(0.790)	(0.794)	**(0.000)**	**(0.004)**	**(0.000)**	**(0.002)**	**(0.024)**	(0.534)	**(0.034)**	**(0.066)**	(0.719)
Gov. Exp.	0.004	0.013	-0.0006	-0.003	0.010	**0.022***	**0.041***	**0.037***	**0.031***	**0.059***	**0.113***	0.012
	(0.308)	(0.293)	(0.763)	(0.529)	(0.212)	**(0.020)**	**(0.014)**	**(0.097)**	**(0.094)**	**(0.000)**	**(0.000)**	(0.584)
GDPg	**0.083***	0.012	**0.133***	**0.087***	0.044	0.010	**0.239***	0.058	**0.226****	**0.190***	**0.303***	**0.426***
	(0.009)	(0.846)	**(0.062)**	**(0.002)**	(0.278)	(0.830)	**(0.000)**	(0.609)	**(0.015)**	**(0.002)**	**(0.000)**	**(0.000)**
FDI	**0.110***	0.034	0.034	**0.075***	0.059	-0.034	**0.200***	0.056	**0.200****	**0.144***	**0.436***	**0.296***
	(0.005)	(0.560)	(0.565)	**(0.002)**	(0.088)	(0.402)	**(0.000)**	(0.557)	**(0.011)**	**(0.004)**	**(0.000)**	**(0.002)**
Remit	**-0.038***	-0.007	-0.019	**-0.031***	**-0.052***	**-0.063***	**-0.105***	**-0.069***	**-0.106***	**-0.114***	**-0.111***	**-0.129***
	(0.000)	(0.689)	(0.372)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.047)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Trade	**0.038***	**0.053***	**0.045***	**0.019***	**0.048***	**0.053***	**0.019***	**0.062***	0.002	0.010	0.010	0.022
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.046)**	**(0.001)**	(0.895)	(0.332)	(0.414)	(0.265)
Net Effects	-0.058	na	na	na	na	na	-0.247	-0.205	-0.206	na	na	na
Thresholds	83.750	na	na	na	na	na	134.000	61.750	62.000	na	na	na
R²/Pseudo R²	0.100	0.151	0.083	0.081	0.084	0.127	0.346	0.151	0.160	0.257	0.253	0.217
Fisher	**21.75***						**77.64***					
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 women in politics and women in business are least. Gini: Income Inequality. MobSend: Mobile phones used to send money. FinInDepth: Financial Institutions Depth. FinInAcc: Financial Institutions Access. FinInEffic: Financial Institutions Efficiency. Gov. Exp: Government Expenditure. GDPg: Gross Domestic Product growth. FDI: Foreign Direct Investment. Remit: remittances. The mean value of the mobile used to send money is 10.280. na: not applicable because at least one estimated coefficient needed for the computation of the net effect and/or threshold is not significant. The pseudo R-squared employed is the Koenker and Machado's.

Table 2: Mobile used to pay bills online, inequality and women in politics and business

	Women in Politics						Women in Business					
	OLS	Q.10	Q.25	Q.50	Q.75	Q.90	OLS	Q.10	Q.25	Q.50	Q.75	Q.90
Constant	59.048***	45.858***	55.138***	62.586***	64.165***	68.336***	55.409***	29.054***	49.176***	58.473***	63.379***	69.713***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gini	-0.070***	-0.083***	-0.095***	-0.052***	-0.067***	-0.068***	-0.240***	-0.113***	-0.198***	-0.294***	-0.242***	-0.224***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)
Mobpay	0.188***	0.457***	0.192	0.148*	0.013	-0.085	-0.056	0.083	-0.210	-0.079	0.016	0.075
	(0.001)	(0.007)	(0.293)	(0.050)	(0.879)	(0.441)	(0.716)	(0.761)	(0.317)	(0.577)	(0.921)	(0.783)
Gini ×Mobpay	0.003***	0.005*	0.004	0.0009	0.002*	0.003*	-0.0008	-0.0005	0.001	-0.002	-0.005**	0.002
	(0.000)	(0.054)	(0.127)	(0.467)	(0.055)	(0.055)	(0.746)	(0.912)	(0.648)	(0.431)	(0.042)	(0.669)
FinInDepth	1.895	6.096**	1.984	2.915**	3.078**	0.004	18.465***	0.739	23.901***	27.289***	24.341***	10.089**
	(0.194)	(0.036)	(0.528)	(0.025)	(0.039)	(0.998)	(0.000)	(0.875)	(0.000)	(0.000)	(0.000)	(0.033)
FinInAccess	-10.118***	-57.639***	-2.984	-0.339	-2.931	-4.086*	24.022***	30.304***	30.133***	23.827***	15.423***	24.013***
	(0.000)	(0.000)	(0.430)	(0.828)	(0.102)	(0.075)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
FinInEffic	-4.755***	4.978**	-2.013	-7.613***	-5.792***	-5.211***	11.025***	12.700***	7.795***	11.895***	12.504***	15.998***
	(0.000)	(0.014)	(0.360)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)
Inflation	0.0007***	0.0009	0.0007	0.0005*	0.0008***	0.002***	-0.001***	-0.002***	-0.002***	-0.0008	-0.001*	-0.001*
	(0.000)	(0.130)	(0.255)	(0.064)	(0.009)	(0.000)	(0.000)	(0.003)	(0.007)	(0.104)	(0.093)	(0.096)
Foreign aid	-0.022	-0.012	0.0003	-0.058***	-0.053***	-0.121***	0.078***	0.148	0.041	0.075***	0.061*	-0.052
	(0.128)	(0.723)	(0.992)	(0.000)	(0.002)	(0.000)	(0.001)	(0.007)	(0.331)	(0.008)	(0.062)	(0.342)
Gov. Exp.	0.005	0.023	0.007	-0.003	0.011	0.008	0.042**	0.037	0.024	0.052***	0.112***	0.020
	(0.210)	(0.102)	(0.653)	(0.590)	(0.133)	(0.380)	(0.013)	(0.107)	(0.170)	(0.000)	(0.000)	(0.387)
GDPg	0.073**	0.003	0.180**	0.093***	0.038	0.031	0.240***	0.051	0.186**	0.217***	0.266***	0.351***
	(0.021)	(0.957)	(0.021)	(0.004)	(0.294)	(0.499)	(0.000)	(0.661)	(0.037)	(0.000)	(0.000)	(0.003)
FDI	0.119***	0.110*	0.029	0.076***	0.063**	-0.020	0.197***	0.031	0.191**	0.142***	0.385***	0.378***
	(0.001)	(0.068)	(0.655)	(0.005)	(0.040)	(0.610)	(0.000)	(0.748)	(0.011)	(0.006)	(0.000)	(0.000)
Remit	-0.056***	-0.019	-0.036	-0.034***	-0.061***	-0.067***	-0.099***	-0.074**	-0.106***	-0.099***	-0.098***	-0.134***
	(0.000)	(0.387)	(0.136)	(0.001)	(0.000)	(0.000)	(0.000)	(0.040)	(0.000)	(0.000)	(0.000)	(0.000)
Trade	0.038***	0.038***	0.031**	0.014***	0.049***	0.055***	0.019*	0.062***	0.005	0.006	0.004	0.011
	(0.000)	(0.002)	(0.020)	(0.007)	(0.000)	(0.000)	(0.055)	(0.002)	(0.744)	(0.533)	(0.715)	(0.567)
Net Effects	-0.058	-0.064	na	na	-0.059	-0.056	na	na	na	na	-0.260	na
Thresholds	23.333	16.600	na	na	33.500	22.666	na	na	na	na	nsa	na
R²/Pseudo R²	0.140	0.200	0.106	0.087	0.090	0.131	0.345	0.147	0.160	0.260	0.257	0.215
Fisher	34.82***						83.19***					
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 women in politics and women in business are least. Gini: Income Inequality. MobApp: Mobile used to pay bills online. FinInDepth: Financial Institutions Depth. FinInAcc: Financial Institutions Access. FinInEffic: Financial Institutions Efficiency. Gov. Exp: Government Expenditure. GDPg: Gross Domestic Product growth. FDI: Foreign Direct Investment. Remit: remittances. The mean value of the mobile used to pay bills online is 3.718. 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 a negative synergy is apparent. The pseudo-R-squared employed is the Koenker and Machado's.

Appendices

Appendix 1: Definitions and sources of variables

Variables	Definitions	Sources
Women in Politics	Proportion of seats held by women in national parliament (%)	WDI (World Bank)
Women in Business	Women businesses and law index score (scale 1 – 100)	WDI (World Bank)
Income Inequality (Gini)	"The Gini coefficient is a measurement of the income distribution of a country's residents".	WDI (World Bank)
Mobile Send	The percentage of respondents who report using a mobile phone to send money in the past 12 months (% age 15+)	GFDD (World Bank)
Mobile Payment	The percentage of respondents who report using a mobile phone to pay bills in the past 12 months (% age 15+).	GFDD (World Bank)
Financial Institutions Depth Index	"*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*".	Findex (World Bank)
Financial Institutions Access Index	"*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*"	Findex (World Bank)
Financial Institutions Efficiency Index	"*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*".	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
Women in Politics	56.527	8.310	25.000	73.100	1680
Women in Business	54.703	15.147	17.500	91.900	1680
Inequality (Gini)	53.250	19.829	0.000	86.832	1680
Mobile Send	10.280	13.011	0.000	50.122	1680
Mobile Payment	3.718	5.154	0.000	37.104	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)

	WoPol	WoBiz	Gini	Mobsen	Mobpay	FID	FIA	FIE	Infl	NODA	Gov.	GDPg	FDI	Remit	Trade
WoPol	1.000														
WoBiz	0.098	1.000													
Gini	-0.127	-0.363	1.000												
Mobsen	0.126	-0.007	-0.051	1.000											
Mobpay	0.234	-0.058	-0.035	0.873	1.000										
FID	-0.014	0.299	0.001	0.024	0.056	1.000									
FIA	-0.092	0.406	-0.156	-0.081	-0.100	0.412	1.000								
FIE	-0.150	0.297	-0.034	-0.089	-0.087	0.312	0.305	1.000							
Infl	0.037	-0.072	0.012	-0.017	-0.017	-0.025	-0.022	0.001	1.000						
NODA	0.021	-0.098	0.097	0.083	0.117	-0.251	-0.164	-0.264	-0.013	1.000					
Gov.	0.018	0.095	0.017	0.016	0.001	0.036	0.018	0.073	-0.095	-0.092	1.000				
GDPg	0.055	0.114	0.005	0.043	0.044	0.001	0.029	0.069	-0.062	-0.017	0.146	1.000			
FDI	0.118	0.190	-0.094	-0.031	-0.040	0.058	0.196	-0.010	-0.017	0.069	0.031	0.081	1.000		
Remit	-0.016	-0.107	0.044	0.037	0.180	0.111	-0.013	-0.052	-0.009	0.034	0.088	0.031	0.014	1.000	
Trade	0.115	0.181	-0.040	-0.062	-0.005	0.255	0.380	0.005	-0.028	-0.056	0.083	0.059	0.308	0.305	1.000

WoPol: Women in Politics. WoBiz: Women in Business. Gini: the Gini Coefficient. Mobsen: Mobile phones used to send money. Mobpay: Mobile used to pay bills online. 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. Remit: remittances.

References

Abdulqadir, I. A., &Asongu, S. A. (2022). "The asymmetric effect of internet access on economic growth in sub-Saharan Africa", *Economic Analysis and Policy*, 73(March), pp. 44-61.

Achuo, E. D., Asongu, S. A., &Tchamyou, V. S., (2022). "Women empowerment and environmental sustainability in Africa", *ASPROWORDA Working Paper* No. WP/22/004, Yaoundé.

Aghion, P., & Bolton, P., (2005). "A theory on trickle-down growth and development", *Review of Economic Studies*, 64(2), pp. 151-172.

Asongu, S. A., (2017). "Assessing marginal, threshold, and net effects of financial globalisation on financial development in Africa", *Journal of Multinational Financial Management*, 40(June), pp. 103-114.

Asongu, S. A., Adegboye, A., & Nnanna, J., (2021a). "Promoting female economic inclusion for tax performance in Sub-Saharan Africa". *Economic Analysis and Policy*, 69(March), pp. 159-170.

Asongu, S. A., Biekpe, N., &Cassimon, D., (2020). " Understanding the greater diffusion of mobile money innovations in Africa", *Telecommunications Policy*, 44(8), September 2020, 102000.

Asongu, S. A., Biekpe, N., &Cassimon, D., (2021b). "On the diffusion of mobile phone innovations for financial inclusion", *Technology in Society*, 65 (May), 101542.

Asongu, S. A., & le Roux, S., (2019). "Understanding Sub-Saharan Africa's Extreme Poverty Tragedy", *International Journal of Public Administration*, 42(6), pp. 457-467.

Asongu, S. A., &Nting, R. T., (2022). "The role of finance in inclusive human development in Africa revisited", *Journal of Economic and Administrative Sciences*, 38(2), pp. 345-370.

Asongu, S. A.,&Nwachukwu, J. (2016). "Rational asymmetric development, Piketty and poverty in Africa". *The European Journal of Comparative Economics*, 13(2), pp. 221-246.

Asongu, S. A., & Odhiambo, N. M., (2018a). "ICT, Financial Access and Gender Inclusion in the Formal Economic Sector: Evidence from Africa", *African Finance Journal*,20(2), pp. 46-66.

Asongu, S. A., & Odhiambo, N. M., (2018b). "Information asymmetry, financialization, and financial access", *International Finance*, 21(3), pp. 297-315.

Asongu, S. A., & Odhiambo, N. M., (2020). "Inequality and the Economic Participation of Women in Sub-Saharan Africa: An Empirical Investigation", *African Journal of Economic and Management Studies*, 11(2) pp. 193-206.

Asongu, S. A., Nounamo, Y., Njangang, H., &Tadadjeu, S. (2021c). "Gender inclusive

intermediary education, financial stability and female employment in the industry in SubSaharan Africa". *Finance Research Letters*, 43(November), 101968.

Asongu, S. A., Soumtang, B., &Edoh, O. M. (2021a). "Financial institutions, poverty and severity of poverty in Sub-Saharan Africa". *European Xtramile Centre of African Studies Working Paper* No.21/081 Liège.

Awel, Y., &Yitbarek, E., (2022). "Mobile money demand in utility bill payments: A WTP estimate from Ethiopia", *Journal of Development Effectiveness*, 14(1), pp. 56-75.

Bae, K., Han, D., & Sohn, H., (2012). "Importance of Access to Finance in Reducing Income Inequality and Poverty Level", *International Review of Public Administration,* 17(1), pp. 1-24.

Batabyal, S., & Chowdhury, A., (2015). "Curbing Corruption, Financial Development and Income Inequality", *Progress in Development Studies,* 15(1), pp. 49-72.

Beck, T., Demirgüç-Kunt, A., & Levine, R., (2007). "Finance, inequality and the poor." *Journal of Economic Growth*, 12(1), pp. 27-49.

Bezinna, F., Brown, M., &Marmarà, V-A.(2022). "Gender balance in national parliament: voters' perceptions towards the gender corrective mechanism in Malta", *Democratization*, 29(4), pp. 655-672.

Biais, B., Bisiere, C., Bouvard, M., &Casamatta, C. (2019). "The blockchain folk theorem". *The Review of Financial Studies*, 32(5), pp. 1662–1715.

Biais, B., Bisiere, C., Bouvard, M., Casamatta, C., &Menkveld, A. J. (2020). "Equilibrium bitcoin pricing". Available at SSRN 3261063

Bicaba, Z., Brixiova, Z., & Ncube, M., (2017). "Can Extreme Poverty in Sub-Saharan Africa be Eliminated by 2030?," *Journal of African Development*, 19(2), pp. 93-110.

Billger, S. M., & Goel, R. K., (2009), "Do existing corruption levels matter in controlling corruption? Cross-country quantile regression estimates", *Journal of Development Economics*, 90(2), pp. 299-305.

Black, S. E., & Lynch, L. M., (1996). "Human-capital investments and productivity". *American Economic Review*, 86(2), pp. 263-267.

Boateng, A., Asongu, S. A., Akamavi, R., &Tchamyou, V. S., (2018). "Information Asymmetry and Market Power in the African Banking Industry", *Journal of Multinational Financial Management*, 44, (March), pp. 69-83.

Brambor, T., Clark, W. M., & Golder, M. (2006). "Understanding Interaction Models: Improving Empirical Analyses", *Political Analysis*, 14 (1), pp. 63-82.

Chipote, P., Mgxekwa, B., & Godza, P., (2014). "Impact of Financial Liberalization on Economic Growth: A Case Study of South Africa", *Mediterranean Journal of Social Sciences*, 5(23), pp. 1-8.

Chiu, J., &Koeppl, T. V. (2019). "The economics of cryptocurrencies–bitcoin and beyond". *Bank of Canada Staff Working Paper* (2019-40).

Chiwira, O., Bakwena, M., Mupimpila, C., & Tlhalefang, J. B., (2016). "Integration, Inclusion, Development in the Financial Sector and Economic Growth Linkage in SADC: Empirical Review", *British Journal of Economics, Management & Trade, 11*(4), pp. 1-15.

Choi, M., &Rocheteau, G. (2021). "Money mining and price dynamics". *American Economic Journal Macroeconomics*, 13(4), pp. 246-294.

Coffie, C. P. K., Hongjiang, Z., Mensah, I. A., Kiconco, R., & Simon, A. E. O., (2021). "Determinants of FinTech payment services diffusion by SMEs in Sub-Saharan Africa: evidence from Ghana", *Information Technology for Development*, 27(3), pp. 539-560.

Easley, D., O'Hara, M., &Basu, S. (2019). "From mining to markets: The evolution of bitcoin transaction fees". *Journal of Financial Economics*, 134 (1), 91–109.

Evans, D. S., & Jovanovic, B. (1989). "An estimated model of entrepreneurial choice under liquidity constraints". *The Journal of Political Economy*, 1(1), pp. 808-827.

Eyal, I., &Sirer, E. G. (2014). Majority is not enough: Bitcoin mining is vulnerable. In International conference on financial cryptography and data security (pp. 436–454).

Flanagan, F., & Walker, M., (2021). "How can unions use Artificial Intelligence to build power? The use of AI chatbots for labourorganising in the US and Australia", *New Technology, Work and Employment*, 36(2), pp. 159-176.

Freeman, R.B. (2005)."The Advent ofOpen-source Unionism", *Critical Perspectives on International Business*, 1(2/3), pp. 79-92.

Galor, O., &Moav, O., (2004). "From physical to human capital accumulation: Inequality and the process of development", *Review of Economic Studies*, 71(4), pp. 1001-1026.

Galor, O., &Zeira, J., (1993). "Income Distribution and Macroeconomics", *Review of Economics*, 60(1), pp. 35-52.

Geelan, T., (2021). "Introduction to the Special Issue - The internet, social media and trade union revitalization: Still behind the digital curve or catching up?", *New Technology, Work and Employment*, 36(2), pp. 123-139.

Greenwood, J., & Jovanovic, B.,(1990). "Financial development, growth and the distribution of income", *Journal of Political Economy*, 98(5), pp.1076-1107.

Hennebert, M.-A., Pasquier, V., & Lévesque, C. (2021). "What do unions do… withdigital technologies? An affordance approach". *New Technology, Work and Employment*, 36(2), 177–200.

Huberman, G., Leshno, J., &Moallemi, C. C. (2021). "Monopoly without a monopolist: An economic analysis of the bitcoin payment system". *The Review of Economic Studies*, 88(6), pp. 3011–3040.

Holtz-Eakin, D., Joulfaian, D., & Rosen, H. S., (1994). "Sticking it out: Entrepreneurial survival and liquidity constraints". *Journal of Political Economy*, 102(1), pp. 53-75.

Khera, P., Ogawa, S., Sahay, R., &Vasishth, M., (2022). "Women in Fintech: As Leaders and Users." IMF Working Paper, Washington.

Kim, K., (2022). "Assessing the impact of mobile money on improving the financial inclusion of Nairobi women", *Journal of Gender Studies*, 30(3), pp. 306-322.

Koenker, R., & Bassett, Jr. G., (1978). "Regression quantiles", *Econometrica*, 46(1), pp. 33-50.

Koenker, R., & Hallock, F.K., (2001), "Quantile regression", *Journal of Economic Perspectives*, 15(4), pp.143-156.

Koomson, I., Bukari, C., &Villano, R. A., (2021). "Mobile money adoption and response to idiosyncratic shocks: Empirics from five selected countries in sub-Saharan AfricaMobile money adoption and response to idiosyncratic shocks". *Technological Forecasting and Social Change*, 167(June), 120728.

Lashitew, A. A., van Tulder, R., & Liasse, Y., (2019). "Mobile phones for financial inclusion: What explains the diffusion of mobile money innovations?",*Research Policy*, 48(5), pp. 1201-1215.

Loko, B., & Yang, Y. (2022). *Fintech, Female Employment, and Gender Inequality*. International Monetary Fund.

Min, C., Shen, F., & Yu, W., (2021). "Removing Incivility from Google: What determines the number of government content take-down requests?" *Government Information Quarterly*, 38(1), 101542.

Moufakkir, M., & Mohammed, Q., (2020). "The Linkage between FinTech Adoption and Financial Inclusion." In *Impact of Financial Technology (FinTech) on Islamic Finance and Financial Stability*, 193–209. IGI Global.

Mndolwa, F. D., & Alhassan A . L. (2020). "Gender disparities in financial inclusion: Insights from Tanzania", *African Development Review*, 32(4), pp. 578-590.

Nchofoung, T. N., & Asongu, S. A., (2022a). "ICT for sustainable development: Global comparative evidence of globalisation thresholds". *Telecommunications Policy*, 46(5), 102296

Nchofoung, T. N., & Asongu, S. A., (2022b). "Effects of infrastructures on environmental quality contingent on trade openness and governance dynamics in Africa", *Renewable Energy*, 189(April), 152-163.

Nchofoung, T.N., Achuo, E.D. &Asongu, S.A., (2021). "Resource rents and inclusive human development in developing countries". *Resources Policy*, 74(4), 102382.

Nchofoung, T. N., Asongu, S. A., Kengdo, A. A. N., (2022). "Linear and non-linear effects of infrastructures on inclusive human development in Africa", *African Development Review*, 34(1), pp. 81-96.

Ngono, J. F. L., (2021). "Financing women's entrepreneurship in Sub-Saharan Africa: bank, microfinance and mobile money", *Labor History*, 62(1), pp. 59-73.

Nwani, S. E, &Osuji, E., (2020). "Poverty in Sub-Saharan Africa: The dynamics of population, energy consumption and misery index", *International Journal of Management, Economics and Social Sciences*, 9(4), pp. 247-270.

Odhiambo, N. M., (2014). "Financial Systems and Economic Growth in South Africa: A Dynamic Complementarity Test", *International Review of Applied Economics*, 28(1), pp. 83-101.

Ofori, I. K., Armah, M. K., Taale, F., &Ofori, P. E., (2021). "Addressing the severity and intensity of poverty in Sub-Saharan Africa: how relevant is the ICT and financial development pathway?" *Heliyon*, 7(10), e08156.

Ofori, I.K., Obeng, C.K. &Asongu, S.A. (2022). "What Really Drives Economic Growth in Sub-Saharan Africa? Evidence from the Lasso Regularization and Inferential Techniques". Journal of the Knowledge Economy. https://doi.org/10.1007/s13132-022-01055-1

Orji, A., Aguegboh, E., & Anthony-Orji, O. I., (2015). "Real Sector Output and Financial Liberalisation in Nigeria", *Journal of Infrastructure Development, 7*(2), pp. 136-150.

Osabuohien, E.,&Karakara, A. A. (2018). "ICT Usage, Mobile Money and Financial Access ofWomen in Ghana". *Africagrowth Agenda Journal*, 15(1), pp. 14-18.

Pagnotta, E. (2022). "Decentralizing money: Bitcoin prices and blockchain security". *The Review of Financial Studies*, 35(2),pp. 866–907.

Saleh, F. (2021). "Blockchain without waste: Proof-of-stake". *The Review of Financial Studies*, 34(3), pp. 1156–1190.

Schilling, L., & Uhlig, H. (2019). "Some simple bitcoin economics". *Journal of Monetary Economics*, 106, pp. 16–26.

Serbeh, R., Adjei, P. O-W., &Forkuor, D., (2022). "Financial inclusion of rural households in the mobile money era: insights from Ghana", *Development in Practice*, 32(1), pp. 16-28.

Sioson, E. P., & Kim, C-J., (2019). "Closing the Gender Gap in Financial Inclusion through Fintech." Asian Development Bank, Ivory Coast.

Staples, R., &Whittall, M. (2021). "The dilemma of social media for German work councils representing qualified employees—the case of a German car manufacturer",*New Technology, Work and Employment*, 36(2), pp. 140-158.

Suri, T., & Jack W., (2016). "The Long-Run Poverty and Gender Impacts of Mobile Money." *Science* 354 (6317). American Association for the Advancement of Science: 1288–1292.

Tchamyou, V. S., (2019)."The Role of Information Sharing in Modulating the Effect of Financial Access on Inequality". *Journal of African Business*, 20(3), pp. 317-338.

Tchamyou, V. S., (2020). "Education, Lifelong learning, Inequality and Financial access: Evidence from African countries".*Contemporary Social Science*, 15(1), pp. 7-25.

Tchamyou, V. S., (2021). "Financial access, governance and the persistence of inequality in Africa: Mechanisms and policy instruments". *Journal of Public Affairs*, 21(2), e2201.

Tchamyou, V. S., &Asongu, S. A., (2017a). Information sharing and financial sector development in Africa, *Journal of African Business*, 18(1), pp. 24-49.

Tchamyou, S. A., &Asongu, S. A., (2017b). "Conditional market timing in the mutual fund industry", *Research in International Business and Finance*, 42(December), pp. 1355-1366.

Tchamyou, V.S., Erreygers, G., &Cassimon, D., (2019a). "Inequality, ICT and Financial Access in Africa", *Technological Forecasting and Social Change*,139(February), pp. 169-184.

Tchamyou, V. S., Asongu, S. A., &Odhiambo, N. M., (2019b). "The role of ICT in modulating the effect of education and lifelong learning on income inequality and economic growth in Africa", *African Development Review*, 31(3), pp. 261-274.

Tok, Y W. & Heng, D., (2022). "Fintech: Financial Inclusion or Exclusion?" SSRN Scholarly Paper. Rochester, NY.https://papers.ssrn.com/abstract=4117830.

United Nations (2013). A New Global Partnership: Eradicate Poverty and Transform Economies Through Sustainable Development, The Report of the High-Level Panel of Eminent Persons on the Post-2015 Development Agenda. http://www.un.org/sg/management/pdf/HLP_P2015_Report.pdf (Accessed: 07/12/2014).

Whittall, M., Knudsen H. &Huijgen F., (2009)."European Works Councils: Identity and the Role ofInformation and Communication Technology", *European Journal of Industrial Relations*, 15(2), pp. 167-185.

World Bank (2018). "Globally, Countries Lose $160 Trillion in Wealth Due to Earnings Gaps 26 Between Women and Men", The World Bank. https://www.worldbank.org/en/news/pressrelease/2018/05/30/globally-countries-lose-160-trillion-in-wealth-due-to-earnings-gapsbetween-women-and-men (Accessed: 03/01/2018).

Yeyouomo, A. K., Asongu, S. A., & Agyemang-Mintah, P., (2023). "Fintechs and the financial inclusion gender gap in Sub-Saharan African countries", *Women's Studies International Forum*,97 (March–April), 102695.