A G D I Working Paper

WP/19/035

Inequality, Information Technology and Inclusive Education in Sub-Saharan Africa [1]

Forthcoming: Technological Forecasting and Social Change

Simplice A. Asongu
Department of Economics, University of South Africa,
P O Box 392, UNISA 0003, Pretoria, South Africa
E-mails: asongus@afridev.org /
asongusimplice@yahoo.com

Stella-Maris I. Orim
School of Engineering, Environment and Computing,
Coventry University, Priory Street, Coventry CV1 5DH, UK
E-mail: S.Orim@coventry.ac.uk

Rexon T. Nting
The Business School, University of Wales,
Trinity Saint David, Winchester House,
11 Cranmer Road, London, UK, SW9 6EJ.
Emails: rexon.nting@uwtsd.ac.uk /
rexonting@hotmail.com

1 This working paper also appears in the Development Bank of Nigeria Working Paper Series.

2019 African Governance and Development Institute WP/19/035

Research Department

Inequality, Information Technology and Inclusive Education in Sub-Saharan Africa

Simplice Asongu, Stella-Maris I. Orim & Rexon T. Nting

January 2019

Abstract

This study examines linkages between inequality, information and communication technology (ICT) and inclusive education in order to establish inequality thresholds that should not be exceeded in order for ICT to promote inclusive education in 42 countries in sub-Saharan Africa for the period 2004-2014. The empirical evidence is based on the Generalized Method of Moments. The following findings are established. First, a Gini coefficient and an Atkinson index of respectively, 0.400 and 0.625 are income inequality thresholds that should not be exceeded in order for internet penetration to positively influence inclusive education. Second, a Gini coefficient, an Atkinson index and a Palma ratio of respectively, 0.574, 0.676 and 9.000 are thresholds of income inequality that if exceeded, fixed broadband subscriptions will no longer positively affect inclusive education. As a main policy implication, the established inequality thresholds should not be exceeded in order for ICT to promote inclusive education in sampled countries. Other implications in the light of Sustainable Development Goals (SDGs) are discussed.

JEL Classification: I24; I25; I39; O40; O55
Keywords: Education; Inequality; ICT; Sub-Saharan Africa

1. Introduction

Inclusive education is clearly articulated in the post-2015 development agenda of the United Nations Development Programme (UNDP), notably: SDG (Sustainable Development Goal) 4 (i.e. "*ensure inclusive and equitable quality education and promote lifelong learning opportunities for all*") and SDG 5 (i.e. "*achieve gender equality and empower all women and*

girls"). Moreover, inclusive development is central to most SDGs. The positioning of this study on inequality thresholds that dampen the favorable effect of information and communication technology (ICT) on inclusive education in sub-Saharan Africa (SSA) is motivated by three main factors, notably: (i) the relevance of inclusive development in SSA in the post-2015 sustainable development agenda; (ii) the importance on information and communication technology in development outcomes and (iii) gaps in the literature. These three factors are expanded in turn.

First, both policy and scholarly literature are consistent on the relevance of inclusive development in SSA in the light of the post-2015 SDG agenda. On the policy front, the UNDP has recently established that in order for countries in SSA to sustainably achieve poverty reduction initiatives, income inequality has to be reduced considerably (UNDP, 2017). This research focuses on the inclusive education dimension of sustainable development and assesses levels of income inequality that should not be exceeded if inclusive education is to be promoted in the sub-region. From a scholarly perspective, the conclusions of the UNDP are consistent with the findings of Bicaba, Brixiova and Ncube (2017): "*This paper examines its feasibility for Sub-Saharan Africa (SSA), the world's poorest but growing region. It finds that under plausible assumptions extreme poverty will not be eradicated in SSA by 2030, but it can be reduced to low levels through high growth and income redistribution towards the poor segments of the society*" (p. 93).It is also important to note that: (i) close to half of countries in SSA failed to achieve the Millennium Development Goal (MDG) extreme poverty target because of rising inequality (Ncube, Anyanwu & Hausken, 2014; Fosu, 2015; Asongu, 2018a; Tchamyou, 2019a, 2019b; Tchamyou, Erreygers & Cassimon, 2019); (ii) according to the World Bank, gender exclusion in SSA represents an estimated cost of 2.5 trillion USD (Nkurunziza, 2018;World Bank, 2018) and (iii) the female gender in SSA is the poorest in the world compared to other regions and continents (Hazel, 2010). The use of information technology in this research as an independent variable of interest is motivated by its relevance in promoting gender inclusion in the sub-region (Efobi, Tanakem & Asongu, 2018; Asongu & Odhiambo, 2018a).

Second, there is a growing body of literature on the importance of ICT in inclusive development in Africa. Some contemporary studies that have focused on this theme include: Afutu-Kotey, Gough and Owusu (2017), Abor, Amidu and Issahaku (2018), Asongu and Nwachukwu (2018), Minkoua Nzie, Bidogeza and Ngum (2018), Isszhaku, Humbani and Wiese (2018), Gosavi (2018) and Asongu and Odhiambo (2019a, 2019b). The attendant literature maintains that information and communication technologies can be leveraged for a

plethora of positive development externalities, *inter alia:* the promotion of doing business and entrepreneurship, access to finance, economic prosperity, sustainable development, enhancement of living standards, bridging of the rural-urban development divide and improvement of agricultural productivity. It is in the light of these insights that this research employs ICT as a policy tool by which inclusive education can be promoted, given a gap in the contemporary African inclusive development literature.

Third, the extant inclusive development literature in Africa can be covered in two main strands, notably: (i) studies on broad themes of inclusive development and (ii) research which is specifically focused on inclusive education. On the one hand, concerning the contemporary inclusive development studies, Kaulihowa and Adjasi (2018) have engaged nexuses between income inequality and external flows while De Magalhães and Santaeulàlia-Llopis (2018) are concerned with nexuses between consumption, the most poor and income levels. Sulemana and Kpienbaareh (2018) investigate connections between income inequality and corruption while Asongu and Kodila-Tedika (2017) and Asongu and le Roux (2019) attempt to understand the poverty tragedy of Africa from respectively, genetic make-up and dominant economic development models (i.e. the Washington Consensus and Beijing Model). Page and Söderbom (2015), Jones and Tarp (2015) and Asongu (2016) are interested in how development assistance can be rethought in the light of promoting socio-economic progress in Africa. Lang, Schneider, Kett, Cole and Groce (2019) are intrigued by policy development regarding disability inclusion in a range of African Union policies. Lorenzo and Coleridge (2019) concentrate on making inclusive development a reality while another strand of literature is concerned with linkages between information diffusion, financial access and positive income redistribution in thecontinent (Meniago & Asongu, 2018; Tchamyou, 2019a, 2019b).

On the other hand, in the contemporary inclusive education literature: Hui, Vickery, Njelesani and Cameron (2018) have focused on gender experiences of inclusive schooling for children that are affected with disabilities in East and West Africa while Clouder *et al*. (2018) have been concerned with the relevance of assistive technology in renegotiating the engagement of students with handicaps in North African higher institutions of learning. The perceptions of parents and teachers have been assessed by Magumise and Sefotho (2018). Other studies in this strand on disabilities include: the involvement of students with disabilities in South African institutions of higher learning (Mutanga, 2018) and the effect of inclusive intervention on teacher's readiness to impart knowledge to children that are affected by physical impairments (Carew, Deluca, Groce& Kett, 2019). Majoko (2018) has been

concerned with how inclusive and special teaching is effective in early education whereas Tlale and Romm (2018) have focused as systematic thinking and practices that enhance inclusive education.

The study closest to this research is Asongu and Nwachukwu (2018) which has investigated thresholds of education quality in the diffusion of knowledge with information technology for the promotion of inclusive human development. The empirical evidence is based on simultaneity-robust Fixed Effects regressions with data from forty-nine sub-Saharan African countries over the period 2000–2012. This research employs the Generalised Method of Moments (GMM) to assess levels of inequality that dampen the incidence of information technology on inclusive education in forty-two countries in SSA during the period 2004-2014. Hence, whereas the problem statement is different from the underlying study, more indicators are adopted in this research. For instance, instead of exclusively using mobile phone penetration as an ICT indicator, fixed broadband subscriptions and internet penetration are also used. Moreover, inclusive development is appreciated from three income inequality indicators, notably: the Gini coefficient, the Atkinson index and the Palma ratio[2].

The theoretical nexus underpinning the connection between information and communication technology and inclusive development is in line with neoclassical theoretical foundations for socio-economic development which maintain that ICT is fundamental in the prosperity of nations and the redistribution of fruits pertaining to such economic prosperity (Abramowitz, 1986; Bernard & Jones, 1996; Kwan & Chiu, 2015; Asongu & Odhiambo, 2018a; Asongu Nwachukwu & Aziz, 2018). These ICT theoretical underpinnings have been used to motivate a contemporary strand of literature on the importance of information technology in the socio-economic progress of developing countries, namely: Asongu and le Roux (2017), Bongomin, Ntayi, Munene and Malinga(2018), Muthinja and Chipeta (2018), Uduji and Okolo-Obasi(2018), Asongu, le Roux, Nwachukwu and Pyke, (2019a) and Asongu, Nwachukwu and Pyke (2019b). These theoretical insights are expanded in greater detail in the following passages.

In line with the attendant narratives, socio-economic and human progress by means of information technology is apparent from a multitude of fronts, notably: (i) the possibility of limiting the physical relocation of users and hence, more efficient use of available resources (Ureta, 2008; Shaikh & Karjaluoto, 2015; Efobi *et al.*, 2018). (ii) ICT increases possibility boundaries and improves the timely availability of information which is important in the

[2] "Income inequality" and inequality are used interchangeably throughout this study.

reduction of asymmetric information which is a constraint in business processes, entrepreneurship and overall wellbeing (Smith, Spence & Rashid, 2011; Tchamyou, 2019b). (iii) The discussed two positive incidences of information technology on human and socio-economic improvements in society are associated with more positive externalities on the poor compared to their rich counterparts. In essence, as documented by Asongu (2015), women and girls particularly benefit from mobile technologies in terms of gender inclusion at schools and in economic participation.

The rest of the study is structured as follows. The review of the literature is covered in section 2 while the data and methodology are presented in section 3. Section 4 discloses and discusses the empirical findings. The research concludes with implications and future research directions in section 5.

2. Literature review

The section critically discusses the extant inclusive development literature that is highlighted in the introduction. Hence, the attendant studies are discussed in two main strands pertaining to, on the one hand, the broader themes of inclusive development and on the other, "inclusive education"-specific literature.

In the first strand on broad inclusive development themes, Kaulihowa and Adjasi (2018) have engaged nexuses between income inequality and external flows in terms of foreign direct investment (FDI). Accordingly, the authors test the effect of FDI on income inequality using a panel of 16 African countries for the period 1980-2013. Both non-linear effects and heterogeneity are accounted for using a Pooled Mean Group estimation strategy. The findings support a robust non-linear or U-shaped nexus between inequality and FDI. Accordingly, the findings show that FDI enhances the equitable distribution of income in the sampled countries. However, such effects decrease with improvements in FDI flows. According to the corresponding policy implications, though FDI could enhance economic growth, FDI-driven growth does not necessarily lead to inequality reduction. Hence, the study concludes by proposing that FDI should be tailored such that corresponding skill-biases are reduced and multiple ends of the labour market are targeted.

De Magalhães and Santaeulàlia-Llopis (2018) are concerned with nexuses between consumption, the most poor and income levels. Using panel-survey and cross-sectional data, the authors provide novel empirical insights into nexuses between wealth, income and consumption on three of the poorest nations in the world, namely: Malawi, Tanzania and Uganda. The research contributes to the literature by establishing two main nexuses, notably:

(i) low accumulation or low transmission from inequality in income to inequality in wealth and (ii) high consumption insurance or the low transmission from inequality in income to inequality in consumption. The study further shows that differences between urban and rural areas in SSA and between the United States and SSA reflect a negative nexus and by extension, a trade-off between consumption and accumulation of insurance.

Sulemana and Kpienbaareh (2018) investigate connections between income inequality and corruption. The authors contribute to the attendant literature by using an unbalanced dataset of 48 countries in SSA for the period 1996-2016. The results depart from prior findings in developed nations by showing that lower levels of corruption are linked with higher levels of inequality in income. These findings reveal the changing nature of the nexus between corruption and income inequality among countries with different income levels and trajectories. A reverse causality is also established between corruption and income inequality. Moreover, it is found that inequality in income is Granger-caused by corruption. A U-shaped nexus is further established between corruption and inequality in income in lower-middle and low income countries using ordinary least squares (OLS), fixed effects and random effects regressions.

Asongu and Kodila-Tedika (2017) investigate whether the Ashraf and Galor (2013) "Out of Africa Hypothesis" withstands empirical scrutiny in an exclusive African context. Accordingly, the research assesses if there is poverty in the African gene by revisiting the results of Ashraf and Galor (2013) and improving the "Out of Africa Hypothesis" to a "Genetic Diversity Hypothesis" that enables an assessment of a "Within Africa Analysis". The research is positioned on five main critiques of Ashraf and Galor pertaining to: restrictions in the understanding of space, a genetic diversity dummy for Africa, migratory patterns that exhibit linearity and underpinnings of African genetic diversity. The conclusion of Ashraf and Galor maintain that cross-country disparities in economic development can be elicited by diversity in genes through an inverted U-shaped or a Kuznets pattern. The findings of Asongu and Kodila-Tedika (2017) partly validate the attendant hypothesis within a contemporary analysis, although not in a historical analysis. The authors conclude that from a within-Africa comparative context, poverty is not apparent in the African gene.

Asongu and le Roux (2019) attempt to understand the poverty tragedy of Africa from the perspectives of dominant economic development models (i.e. the Washington Consensus and Beijing Model). Accordingly, the authors assess if conclusions from qualitative studies on a need to reconcile the Washington Consensus with the Beijing model withstand empirical scrutiny, by testing the hypothesis that relative to middle-income nations, countries with low-

income are more likely to enjoy better levels of inclusive development by prioritizing economic governance compared to political governance. The empirical evidence is premised on fixed effects regressions that are non-interactive and interactive in SSA using data from 2000 to 2012. The investigated hypothesis is confirmed by the empirical analysis and the authors recommend that in the post-2015 development agenda, low-income countries will benefits more from inclusive development by prioritizing economic governance.

Tchamyou (2019a) assess the importance of access to finance in moderating the incidence of lifelong learning and education in a sample of 48 countries in SSA using data for the period 1996 to 2014. Lifelong learning in the study is appreciated as the combined knowledge that is acquired in primary schooling, secondary schooling and tertiary schooling while access to finance is measured in terms of financial allocation efficiency, financial activity and financial depth. The involved indicators of inequality are: the Palma ratio, the Atkinson index and the Gini coefficient. Using the GMM estimation strategy, the study concludes that: (i) primary schooling interacts with the financial mechanisms to induce negative impacts on the Gini coefficient; (ii) lifelong learning has net negative incidences on the Gini index by means of financial allocation efficiency and financial deposit mechanisms and (iii)other schooling levels largely do not affect income inequality significantly through the engaged access to finance channels.

In another study, Tchamyou (2019b) examine the relevance of sharing information in moderating the influence of financial access on income inequality using 48 countries in SSA for the period 2004-2014. Public credit registries and private credit bureaus are proxies for information sharing while financial mechanisms of depth, activity, efficiency and size are taken on board. Using the GMM estimation approach, the research shows that a critical mass of 18.072 public credit registries coverage (% of adults) is essential to modulate the unconditional positive incidence of financial allocation efficiency on inequality. Concerning the relevance of private credit bureaus on the depth of financial access, both conditional and unconditional effects of financial depth are negative on inequality. In summary, the findings broadly show that income inequality can be mitigated if financial access is complemented with information sharing offices.

Lorenzo and Coleridge (2019) focused on ways of working together to make inclusive development a reality. They opined that inclusive development takes different forms in different countries due to the diversity in economic, social, political, and cultural contexts. The authors viewed disability as an additional layer of complexity in addressing injustice and oppression over many generations. They proposed possible ways in making the vision of

inclusive, sustainable development achievable, listing: avoiding dominance, promoting justice, and supporting positive identity as three enabling pillars for reciprocal relationships between development practitioners and disabled people. The authors further pointed out that inclusion and empowerment are the main strategies, as disabled people need to be seen as active contributors in their communities and not just advocates for their own issues.

Lang, Schneider, Kett, Cole and Groce (2019) research on policy development emphasised on disability inclusion in a range of African Union policies. This focus was particularly in relation to disabled people in Africa and the relevance of contemporary debates in international development regarding the non- tokenistic inclusion and participation of marginalized groups in the policy- making process. They analysed nine policy or strategy documents produced by the African Union, covering the policy domains of education, health, employment and social protection which they identified as crucial to the inclusion of disabled people in international development. The analysis was according to seven discrete elements (rights, accessibility, inclusivity, implementation plans, budgetary allocations, enforcement mechanisms or disaggregated management information systems) using a rating scale of one to four, with four being the highest level of inclusion.

Their findings suggest poor levels of genuine inclusion as none of the policies reached 50% of the total possible score. '*Rights'* had the highest rating but was still at a low level, suggesting that there is recognition of the rights of disabled people to inclusion, but they found that this is not generally integrated within inclusive implementation plans, budgetary allocations, enforcement mechanisms or disaggregated management information systems for monitoring. They identified three key themes arising from their analysis which will be relevant for policy- makers and implementers, disabled people's organizations and other development organizations: (i) disabled people as key players in mainstream policy development, (ii) use of consistent and clear definitions of disability and (iii) explicit mention of disabled people as a targeted group. They concluded that the limited inclusion of disability within African Union policies is a lost opportunity that should be reviewed and rectified.

In the second strand on "inclusive education"-centric literature, Hui, Vickery, Njelesani and Cameron (2018) have focused on gender experiences of inclusive schooling for children that are affected with disabilities in East and West Africa, notably, in: Malawi, Niger, Togo, Zambia, Guinea and Sierra Leone. Interviews with stakeholders of policy, children and members of communities are analysed thematically to assess intersections that exist among education, disability and gender. The results show that girls and boys that have disabilities witness the same experiences of social exclusion within academic circles. They also show that

girls victim of disabilities were also impeded by sexual abuse and societal biases which were contrary to their education potential. Whereas boys with disabilities were ex-ante qualified as being more able, however their experiences of physical and emotional violence were largely overlooked. The study recommends that in order to reach heights of quality inclusive education for all, policies that foster safe and inclusive schooling, boost the ambition of girls with disabilities to unfold their educational careers and challenge negative attitudes of society that impede opportunities of education, should be encouraged.

Clouder *et al.* (2018) have been concerned with the relevance of assistive technology in renegotiating the engagement of students with handicaps in North African higher institutions of learning, notably: two in Morocco and one in Egypt. The purpose of the study has been to examine how future career opportunities and equal access to university education can be enhanced for students with disabilities by means of accessible assistive technology. An appreciative inquiry is employed by the authors to explore the incidence of outcomes and process of the project. The authors show how emphasis on assistive technology promotes collective study and individual agencies and by extension, tackles the invisibility of students that are victim of disabilities. The emerging empowerment mode from students is traceable to two principal characteristics that inform the wider debate on inclusive education, notably: the importance of technology as a moderator of change and the relevance of both top-down and bottom-up dynamics.

The perceptions of parents and teachers have been assessed by Magumise and Sefotho (2018) who have focused on Zimbabwean primary schools. Based on data gathered from 12 teachers and 12 parents related to learners in inclusive education, the results showed that the inclusive education perception of participants can be categorized into three groups, notably: mixed, positive and negative perceptions. The findings are presented in both a model and a tree diagram and discussed with implications for the plethora of concerned stakeholders. Mutanga (2018) is concerned with the engagement of students that are victim of disabilities in South African institutions of higher learning. From a qualitative research performed at the University of Venda and University of the Free State, 14 studies with disabilities are engaged in order to explore their lives and academic experiences. The findings of the study highlight some domains of inclusive development that policy makers need to pay attention to in order to comprehensively address the needs of students with disabilities.

Majoko (2018) has been concerned with how inclusive and special teachings are effective in early education. The author has investigated the effectiveness of inclusive and special teachings in Early Childhood Education (ECE) in Zimbabwe. The descriptive research

builds on a purposive sample of 21 inclusive and special ECE teachers. Throughout the analysis, a constant comparative data organization approach based on continual adjustment is employed to make sure that the codes are consistent with the participants' ranges in ideas. Ultimately, participants had positive commitment and attitudes as well as understood the stakes of their participation, although they were not adequately prepared in a professional manner on the management of inclusive and special teaching including attendant behavioral challenges specific in some children. Participants in the study institutionalized inclusive and effective practices of teaching in ECE which included: child-centred pedagogy, teacher-made tests, child placement information-based diagnosis, advocacy, collaboration, behavior management, techniques, approaches and various strategies of teaching. The research provides a springboard for future studies on the delivery of services in inclusive and special education in ECE.

Tlale and Romm (2018) have focused on systematic thinking and practices that enhance inclusive education by offering reflections from the interaction of research participations with the purpose of consolidating systematic action and the goal of promoting inclusive education in the rural area of South Africa's Eastern Cape. The authors reflect on how the engagements as well as the overall process are viewed by the participants, especially in the light of feedback they received. The authors further point to how one of them (i.e. Tlale) brings on board the idea of thinking systematically (to teachers, school governing body, school management and a district officer) as bound to the possibility of gathering information needed in a context of inclusive education that benefits learners in the school under consideration.

3. Data and methodology

3.1 Data

In the light of the introduction, the research focuses on forty-two countries in SSA and employs an unbalanced panel dataset of annual periodicity which spans from 2004 to 2014[3]. The motivations for the geographical and temporal scopes are determined by constraints in data availability when the study was carried-out. The data come from two main sources. First, the three inequality measurements are obtained from the Global Consumption and Income

[3]The 42 countries include: "Angola, Benin, Botswana, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo Democratic Republic, Congo Republic, Côte d'Ivoire, Djibouti, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome & Principe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda and Zambia".

Project (GCIP), namely: the Gini coefficient, the Atkinson index and the Palma ratio. The Gini coefficient is complemented with the Palma ratio and Atkinson index because it fails to capture extremities of the inequality distribution. This is not the case with the Palma ratio and Atkinson index which have been documented to capture tails of the inequality distribution. The employment of three measurements of inequality and corresponding justifications are consistent with contemporary African-centric inequality literature (Meniago & Asongu, 2018; Tchamyou, 2019a, 2019b; Tchamyou *et al*., 2019).

Second, the ICT, inclusive education and control variables are from the World Development Indicators of the World Bank. In accordance with Efobi *et al*. (2018), three ICT indicators are used, namely: mobile phone penetration, internet penetration and fixed broadband subscriptions.

The inclusive education indicator used in the study is the "primary and secondary enrolment" gender parity index[4]. The choice of this inclusive education indicator is motivated by both considerations for lifelong learning and the relevance of these educational levels in socio-economic development when countries are at initial stages of industrialization (Petrakis & Stamatakis, 2002; Asiedu, 2014; Tchamyou, 2017; Asongu & Tchamyou, 2016, 2019a, 2019b).

One control variable is adopted essentially for technical reasons. It is worthwhile to first all emphasize that the adoption of one control variable is not uncommon in the scholarly literature because the adopted GMM estimation approach is designed such that, the proliferation of instruments can substantially bias estimated coefficients. This is the case, even when the "collapse" option is taken on board in the estimation process. Attendant studies that have employed two control indicators or even no control variable in the GMM-centric literature in order to avoid the proliferation of instruments include: Bruno, De Bonis and Silvestrini (2012), Osabuohien and Efobi (2013) and Asongu and Nwachukwu (2017). The control variable is anticipated to have a negative incidence on the outcome variable because remittances have been documented in contemporary African development literature to increase social exclusion because majority of those migrating abroad are from wealthier segments of society (Asongu & Odhiambo, 2018b; Meniago& Asongu, 2018; Tchamyou, 2019a, 2019b). This literature supports the view that remittances contribute to more income inequality because most of the funds remitted back from abroad end-up further enriching wealthier households. This assertion has been confirmed by Asongu and Odhimabo (2018a) in

[4] "Primary and secondary education" and "inclusive primary and secondary education" are used interchangeably throughout the study.

recent gender inclusion literature. Appendix 1 provides the definitions and sources of the variables whereas the summary statistics is disclosed in Appendix 2. The corresponding correlation matrix is provided in Appendix 3.

3.2 Methodology

3.2.1 GMM Specification

Following recent empirical literature focusing the GMM estimation, this research adopts the GMM estimation strategy for at least four main motivations (Tchamyou, 2019a, 2019b; Tchamyou *et al.*, 2019; Agoba, Abor, Osei & Sa-Aadu, 2019; Fosu & Abass, 2019). In the first criterion, the number of cross sections is higher than the corresponding number of periods in each country. In this case, the data structure is such that there are eleven periods (i.e. 2004-2014) from forty-four countries. Hence, it is obvious that 11 years is higher than the 42 countries in terms of numerical value. From the second criterion, some degree of persistence should be apparent in the behavior of data. In the light of the attendant literature, inclusive education is persistent because the correlation value between its levels and first difference series' is 0.988 which is higher than the established rule of thumb for confirming persistence (Asongu & Odhiambo, 2018c, 2019b). The third criterion pertains to the data structure and from the panel nature of the dataset, it is apparent that the empirical exercise accounts for cross-country differences in the estimation process. From the fourth criterion related to the concern of endogeneity, two considerations are worthwhile. On the one hand, by accounting for time-invariant omitted indicators, the estimation approach controls for the unobserved heterogeneity. On the other, the instrumentation process allows for the employment of internal instruments to control for simultaneity or reverse causality. Among the possible GMM alternatives available in the empirical literature, the approach adopted in this study is the difference GMM approach that has been improved by Roodman (2009a, 2009b) and established to limit the proliferation of instruments and restrict over-identification with an option that collapses instruments to mitigate instrument proliferation (Tchamyou, 2019a).

The following equations in level (1) and first difference (2) summarize the standard *system* GMM estimation procedure.

$$E_{i,t} = \sigma_0 + \sigma_1 E_{i,t-\tau} + \sigma_2 T_{i,t} + \sigma_3 I_{i,t} + \sigma_4 TI_{i,t} + \sigma_5 R_{i,t} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (1)$$

$$\begin{aligned} E_{i,t} - E_{i,t-\tau} = {} & \sigma_1 (E_{i,t-\tau} - E_{i,t-2\tau}) + \sigma_2 (T_{i,t} - T_{i,t-\tau}) + \sigma_3 (I_{i,t} - I_{i,t-\tau}) + \sigma_4 (TI_{i,t} - TI_{i,t-\tau}) \\ & + \sigma_5 (R_{i,t} - R_{i,t-\tau}) + (\xi_t - \xi_{t-\tau}) + (\varepsilon_{i,t} - \varepsilon_{i,t-\tau}) \end{aligned} \quad (2)$$

where, $E_{i,t}$ represents an indicator of inclusive education (i.e. "primary and secondary education") of country i in period t, σ_0 is a constant, T entails information technology(mobile phone penetration, internet penetration and fixed broadband subscriptions), I denotes an income inequality indicator (i.e. the Gini coefficient, the Atkinson index and the Palma ratio), TI reflects interactions between information technology and inequality indicators ("the Gini coefficient" × "mobile phones"; "the Atkinson index" × "mobile phones"; "the Palma ratio"×"mobile phones"; "the Gini coefficient" × "the internet"; "the Atkinson index" × "the internet"; "the Palma ratio"×"the internet"; "the Gini coefficient" × "fixed broadband subscriptions"; "the Atkinson index" × "fixed broadband subscriptions"; "the Palma ratio"×" fixed broadband subscriptions"), R is remittances, τ is the coefficient of auto-regression which is one in this study because one year lag appropriately captures past information, ξ_t is the time-specific constant, η_i is the country-specific effect and $\varepsilon_{i,t}$ the error term.

3.2.2 Identification and exclusion restrictions

In a GMM empirical strategy, the concepts of identification and exclusion restrictions are paramount for a robust specification. It is important to clarify that the process of identification entails the classification of variables in terms of predetermined and strictly exogenous variables. Following contemporary GMM-oriented literature, all explanatory variables are acknowledged as predetermined or endogenous explaining while years are considered to exhibit strict exogeneity. These explanatory variables consist of the independent of variables (i.e. information technology and inequality) as well as the control variable (i.e. remittances). In view of this identification process, the exclusion restriction assumption is such that the strictly exogenous indicator influences the outcome variable (or inclusive education) exclusively through the predetermined channels or exogenous components of the independent variables of interest. This assumption underpinning the identification process is consistent with contemporary GMM-centric literature (Asongu & Nwachukwu, 2016a; Tchamyou & Asongu, 2017; Boateng *et al*., 2018; Tchamyou *et al*., 2019). Roodman (2009b) is sympathetic to this approach because the author argues that time invariant variables can be feasibly employed as strictly exogenous variables because it is unlikely for these strictly exogenous variables to be endogenous upon a first difference series[5].

[5]Hence, the procedure for treating *ivstyle* (years) is 'iv (years, eq(diff))' whereas the *gmmstyle* is employed for predetermined variables.

In the light of the identification process above, the assumption of exclusion restriction is investigated with the Difference in Hansen Test (DHT) for the exogeneity of instruments. The alternative hypothesis of this test is the position that the adopted strictly exogenous variables are not valid instruments in the light of the fact that they affect the outcome variable beyond the proposed mechanisms or endogenous explaining variables. The null hypothesis of this test is the stance that the identification assumption holds: the adopted strictly exogenous variables affect inclusive education exclusively through the engaged independent variables of interest and control variables. This clarification of the GMM strategy is not different from more traditional GMM techniques which require that the alternative hypothesis of the Sargan/Hansen test should be rejected in order for the adopted instruments to exhibit strict exogeneity by influencing inclusive education exclusively through the proposed mechanisms (Beck, Demirgüç-Kunt & Levine, 2003; Asongu & Nwachukwu, 2016b; Amavilah, Asongu & Andrés, 2017).

4. Empirical results

The empirical findings are disclosed in this section in Table 1 which is divided into three main sections. Each section is associated with an ICT dynamic, notably: mobile phone penetration, internet penetration and fixed broadband subscriptions (in this order from the left-hand side to the right-hand side). Each ICT-oriented specification is further characterized by three sub-specifications pertaining to each of the three inequality variables, namely: the Gini coefficient, the Atkinson index and the Palma ratio.

Four principal criteria of information are adopted to assess the validity of each estimated model[6]. Following this model, with the exception of the sixth model for which the null hypothesis of the Hansen test is not rejected, the remaining estimated models are overwhelmingly valid. It is important to put the invalidity of the corresponding models into greater perspective. The Hansen test is traditionally preferred to the Sargan test because it is more robust, although it is also weakened by the proliferation of instruments. Conversely, the strength of the Sargan test is not attenuated by the proliferation of instruments. A measure of dealing with the problem or conflicting information criteria is to prefer the robust test (i.e. the

[6] "*First, the null hypothesis of the second-order Arellano and Bond autocorrelation test (AR (2) in difference for the absence of autocorrelation in the residuals should not be rejected. Second the Sargan and Hansen over-identification restrictions (OIR) tests should not be significant because their null hypotheses are the positions that instruments are valid or not correlated with the error terms. In essence, while the Sargan OIR test is not robust but not weakened by instruments, the Hansen OIR is robust but weakened by instruments. In order to restrict identification or limit the proliferation of instruments, we have ensured that instruments are lower than the number of cross-sections in most specifications. Third, the Difference in Hansen Test (DHT) for exogeneity of instruments is also employed to assess the validity of results from the Hansen OIR test. Fourth, a Fischer test for the joint validity of estimated coefficients is also provided*" (Asongu& De Moor, 2017, p.200).

Hansen) and limit instrument proliferation by ensuring that in the post-estimation diagnostic analysis, in each specification, the number of cross sections exceed the corresponding number of instruments.

Given the problem statement motivating this study (i.e. inequality thresholds that dampen the relevance of information technology in promoting inclusive education), the research follows Asongu (2018b) in the computation of critical masses at which further enhancement of inequality engenders unfavorable relationships between ICT and inclusive education. Therefore the research design is such that the established critical masses of inequality should not be exceeded in sampled countries if ICT is to continue promoting inclusive education. Therefore, this research expects positive unconditional effects from ICT on inclusive education and negative conditional impacts (or interactive effects between ICT and inequality) on inclusive education. Thus, with a negative interactive impact, there is a critical mass or inflexion point at which further increasing inequality completely dampens the positive unconditional effect of ICT on inclusive education.

As a point of illustration, in the fifth column of Table 1, 0.400 (0.002/0.005) represents the critical mass of the Gini coefficient that should not be exceeded in order for internet penetration to have a positive unconditional effect on inclusive education. In this computation, 0.002 is the unconditional impact of internet penetration on inclusive education whereas 0.005 represents the conditional effect from the interaction between the Gini coefficient and internet penetration. It follows from the computed threshold that a Gini coefficient of above 0.400 is not favorable for internet penetration to induce a positive effect on inclusive education.

The following findings can be established from the results disclosed in Table 1. First, a Gini coefficient and an Atkinson index of respectively, 0.400 and 0.625 are income inequality thresholds that should not be exceeded in order for internet penetration to positively influence inclusive education. Second, a Gini coefficient, an Atkinson index and a Palma ratio of respectively, 0.574, 0.676 and 9.000 are thresholds of income inequality that if exceeded, fixed broadband subscriptions will no longer positively affect inclusive education. Third, where the control variable is significant, an expected sign is consistently apparent.

Table 1: ICT, Inequality and Inclusive "Primary and Secondary School Education"

	Dependent variable: Inclusive "Primary and Secondary School Education" (PSSE)								
	Mobile Phone Penetration			Internet Penetration			Fixed BroadBand Subscriptions		
	Gini	Atkinson	Palma	Gini	Atkinson	Palma	Gini	Atkinson	Palma
PSSE(-1)	**0.983*** **	**0.969*** **	**1.033*** **	**0.994*** **	**0.974*** **	**1.013*** **	**0.961*** **	**0.950*** **	**0.991*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Mobile Phone(Mob)	0.0005	-0.00009	**-0.0004*** **	---	---	---	---	---	---
	(0.348)	(0.791)	**(0.003)**						
Internet	---	---	---	**0.002*** **	**0.005*** **	0.00005	---	---	---
				(0.008)	**(0.001)**	(0.763)			
BroadBand	---	---	---	---	---	---	**0.050*** **	**0.023*** **	**0.009*** **
							(0.000)	**(0.002)**	**(0.000)**
Gini Coefficient (Gini)	**0.131***	---	---	0.029	---	---	**0.168*** **	---	---
	(0.053)			(0.144)			**(0.000)**		
Atkinson Index (Atkinson)	---	0.021	---	---	**0.083** **	---	---	**0.074***	---
		(0.514)			**(0.019)**			**(0.069)**	
Palma Ratio(Palma)	---	---	**-0.002***	---	---	**-0.002** **	---	---	**0.002*** **
			(0.068)			**(0.026)**			**(0.000)**
Mob × Gini	-0.001	---	---	---	---	---	---	---	---
	(0.213)								
Mob × Atkinson	---	-0.00009	---	---	---	---	---	---	---
		(0.854)							
Mob × Palma	---	---	**0.00003***	---	---	---	---	---	---
			(0.081)						
Internet × Gini	---	---	---	**-0.005*** **	---	---	---	---	---
				(0.005)					
Internet × Atkinson	---	---	---	---	**-0.008*** **	---	---	---	---
					(0.001)				
Internet × Palma	---	---	---	---	---	**-0.00005** **	---	---	---
						(0.048)			
BroadBand × Gini	---	---	---	---	---	---	**-0.087*** **	---	---
							(0.000)		
BroadBand × Atkinson	---	---	---	---	---	---	---	**-0.034*** **	---
								(0.001)	
BroadBand × Palma	---	---	---	---	---	---	---	---	**-0.001*** **
									(0.000)
Remittances	-0.00009	0.00002	**-0.0002***	**-0.0005*** **	-0.0002	-0.0001	-0.00006	-0.0001	**-0.0003*** **
	(0.489)	(0.910)	**(0.095)**	**(0.001)**	(0.102)	(0.412)	(0.648)	(0.369)	**(0.007)**
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Thresholds	na	na	nsa	0.400	0.625	na	0.574	0.676	9.000
AR(1)	(0.021)	(0.022)	(0.020)	(0.025)	(0.023)	(0.029)	(0.028)	(0.028)	(0.025)
AR(2)	**(0.254)**	**(0.252)**	**(0.264)**	**(0.112)**	**(0.118)**	**(0.114)**	**(0.150)**	**(0.152)**	**(0.138)**
Sargan OIR	(0.001)	(0.008)	(0.002)	(0.000)	(0.000)	(0.000)	(0.084)	(0.067)	(0.037)
Hansen OIR	**(0.117)**	**(0.153)**	**(0.215)**	**(0.363)**	(0.037)	**(0.387)**	**(0.435)**	**(0.391)**	**(0.552)**
DHT for instruments									
(a)Instruments in levels									
H excluding group	(0.009)	(0.022)	(0.020)	(0.041)	(0.070)	(0.086)	**(0.254)**	**(0.108)**	**(0.103)**
Dif(null, H=exogenous)	**(0.617)**	**(0.528)**	**(0.690)**	**(0.777)**	(0.082)	**(0.659)**	**(0.498)**	**(0.617)**	**(0.815)**
(b) IV (years, eq(diff))									
H excluding group	**(0.261)**	**(0.014)**	**(0.151)**	**(0.346)**	**(0.362)**	**(0.149)**	**(0.216)**	**(0.643)**	**(0.202)**
Dif(null, H=exogenous)	**(0.122)**	**(0.624)**	**(0.307)**	**(0.359)**	**(0.029)**	**(0.545)**	**(0.531)**	**(0.293)**	**(0.682)**
Fisher	**347630*** **	**984.40*** **	**208817*** **	**2358*** **	**1342*** **	**786.18*** **	**92421*** **	**4047.97*** **	**1467.23*** **
Instruments	28	28	28	28	28	28	28	28	28
Countries	33	33	33	33	33	33	31	31	31
Observations	230	230	230	225	225	225	207	207	207

***,**,*: significance levels at 1%, 5% and 10% respectively. DHT: Difference in Hansen Test for Exogeneity of Instruments Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. The significance of bold values is twofold. 1) The significance of estimated coefficients and the Wald statistics. 2) The failure to reject the null hypotheses of: a) no autocorrelation in the AR(1) & AR(2) tests and; b) the validity of the instruments in the Sargan and Hansen OIR tests. 45.330, 7.676 and 0.643 are respectively mean values of mobile phone penetration, internet penetration and fixed broadband subscriptions. na: not applicable because at least one estimated coefficient needed for the computation of net effects is not significant. nsa: not specifically applicable because the conditional effect between ICT and inequality is not negative.

5. Concluding implications and future research directions

This study has examined linkages between inequality, information and communication technology (ICT) and inclusive education in order to establish inequality thresholds that

should not be exceeded in order for ICT to promote inclusive education in 42 countries in sub-Saharan Africa for the period 2004-2014. Three indicators of inequality are employed, namely: the Gini coefficient, the Atkinson index and the Palma ratio. Inclusive education is gender parity "primary and secondary school enrolment". Adopted ICT indicators are: mobile phone penetration, internet penetration and fixed broadband subscriptions. The empirical evidence is based on the Generalised Method of Moments. The following findings are established. First, a Gini coefficient and an Atkinson index of respectively, 0.400 and 0.625 are income inequality thresholds that should not be exceeded in order for internet penetration to positively influence inclusive education. Second, a Gini coefficient, an Atkinson index and a Palma ratio of respectively, 0.574, 0.676 and 9.000, are thresholds of income inequality that if exceeded, fixed broadband subscriptions will no longer positively affect inclusive education. As a main policy implication, the established inequality thresholds should not be exceeded in order for ICT to promote inclusive education in sampled countries. It is worthwhile to discuss this main policy implication with more specific details.

As established from the findings, income inequality inhibits access to information technology and such interaction has ramifications on inclusive access to education. Obviously, the ultimate incidence on inclusive education is negative because the positive responsiveness of inclusive education to information technology is a negative function of inequality. In other words, while information technology can promote the enrolment of more girls in primary and secondary schools, growing income inequality would negatively affect the enrolment of more girls in these institutions of learning. Two logical channels can be used to elucidate this tendency, which by extension also double as implications. On the one hand, the findings provide credence to the Fosu conjecture on nexuses between income, inequality and inclusive development (Fosu, 2008, 2009, 2010a, 2015). The conjecture maintains that the promotion of inclusive development in Africa is hampered by existing levels of inequality[7].

On the other hand, the findings have cultural implications that are consistent with existing stereotypes on male education vis-à-vis female education. Accordingly, it can be deduced from the results that when income inequality levels have surpassed established

[7]To put this Fosu conjecture into more perspective: "*The study finds that the responsiveness of poverty to income is a decreasing function of inequality*" (Fosu, 2010b, p. 818); "*The responsiveness of poverty to income is a decreasing function of inequality, and the inequality elasticity of poverty is actually larger than the income elasticity of poverty*" (Fosu, 2010c, p. 1432); and "*In general, high initial levels of inequality limit the effectiveness of growth in reducing poverty while growing inequality increases poverty directly for a given level of growth*" (Fosu, 2011, p. 11).

thresholds, less girls are enrolled in primary and secondary schools most probably because in poor households, the education of the male child is prioritized over the education of the female child, granting that, the girl is considered as the property of another family after marriage (Elu, 2018). Hence, growing income inequality has a higher negative incidence on the education of the girl child compared to the male child. In what follows, other implications are discussed in the light of Sustainable Development Goals (SDGs).

It is relevant to emphasize that education is closely attached to other SDGs, notably: education is fundamental in the achievement of almost all SDGs and other dimensions of SDGs exert positive effects on education. For examples: minimal conditions of social wellbeing are required for the realization of SDG-1 pertaining to least poverty; SDG-2 on hunger, SDG-3 on health, SDG-5 related to gender equality, SDG-8 concerning employment and SDG-10 on economic equality. Hence, considerable setbacks in any of these SDG targets can substantially diminish the ability of pupils and students to receive quality education. Furthermore, worse damage can result from cumulative deprivation in these underlying SDGs.

SDG-4 on quality education is also connected to other SDGs because it is the source of specialized knowledge and awareness that are linked to sustainable environmental management and exhaustible resources. Accordingly, conducive education programs can be carefully tailored to promote SDG-6 on sanitation and water management, SDG-7 on the efficient use of energy and SDG-13 on climate change and SDG-15 on the prevention of variations on the ecosystem. Hence, education engenders a multitude of externalities that address potential adverse consequences on associated SDGs for better social conditions that contribute towards the mitigation of hunger, unemployment, disease, poverty, *inter alia*.

Ultimately, inclusive education systems that are accompanied with better education quality could create the relevant knowledge economy that is essential for the SDG-17 on Global Partnership for Sustainable Development. The discussed complementarity between inclusive education and other SDGs can be more conveniently achieved if inequality levels are maintained as low as possible. Accordingly, we have established negative interactive effects between income inequality and ICT which is an indication that income inequality levels should be kept as low as possible, given that socio-economic development externalities from economic growth are higher when income inequality levels of low, compared to when income inequality is high (Asongu & Kodila-Tedika, 2018).

The positive unconditional effects of ICT on inclusive education is a further indication that the penetration of information technology should be enhanced in sampled countries in

order to promote inclusive development and by extension, other related development externalities. Given the context of this study on gender equality, ICT policies that are designed to encourage universal access and reach of information technology should be tailored to ensure that females are endowed with equal opportunities to ICT as their male counterparts. In summary, the findings in this study are broadly consistent with the scholarly and policy literature, notably: the importance of gender inclusion in sustainable development (Robison, 2015); the relevance of information technology in unlocking the potential for women (World Bank, 2015) and the importance of ICT in female participation in the formal economic sector (Efobi *et al*., 2018).

It will be worthwhile for future studies to consider other indicators of inclusive education in order to extend findings in this study. Moreover, given the panel evidence, in order to provide more room for policy implications, relevant estimation techniques should be considered within the framework of country-specific studies. Accordingly, the main shortcoming of the GMM estimation approach is that country-specific effects are theoretically and practically eliminated in the modeling exercise in order to control for the endogeneity pertaining to the correlation between the lagged inclusive education variable and country-specific effects. Moreover, future studies can also examine if the established thresholds withstand empirical scrutiny using alternative threshold methodologies such as the Panel Threshold Regression (PTR) method proposed by Hansen (1999) because while it requires a balanced dataset, the dataset in this research is unbalanced. Moreover, within this alternative framework, categorizing countries in terms of initial levels of inequality can produce more policy thresholds. Accordingly, sub-sampling in terms of inequality levels within the GMM framework will lead to estimated coefficients that do not pass post-estimation diagnostic tests, owing to instrument proliferation, even when the option of collapsing instruments is involved in the specification exercise.

Appendices

Appendix 1: Definitions of Variables

Variables	Signs	Definitions of variables (Measurements)	Sources
Inclusive Education	PSSE	School enrolment, primary and secondary (gross), gender parity index (GPI)	WDI
Mobile Phones	Mobile	Mobile cellular subscriptions (per 100 people)	WDI
Internet	Internet	Internet users (per 100 people)	WDI
Fixed Broad Band	BroadB	Fixed broadband subscriptions (per 100 people)	WDI
Gini Index	Gini	"*The Gini index is a measurement of the income distribution of a country's residents*".	GCIP
Atkinson Index	Atkinson	"*The Atkinson index measures inequality bydetermining which end of the distribution contributed most to the observed inequality*".	GCIP
Palma Ratio	Palma	"*The Palma ratio is defined as the ratio of the richest 10% of the population's share of gross national income divided by the poorest 40%'s share*".	GCIP
Remittances	Remit	Remittance inflows to GDP (%)	WDI

WDI: World Bank Development Indicators of the World Bank. GCIP: Global Consumption and Income Project.

Appendix 2: Summary statistics (2004-2014)

	Mean	SD	Minimum	Maximum	Obs
Primary & Secondary School Enrolment	0.919	0.111	0.600	1.105	307
Mobile Phone Penetration	45.330	37.282	0.209	171.375	558
Internet Penetration	7.676	10.153	0.031	54.26	453
Fixed Broad Band	0.643	1.969	0.000	14.569	369
Gini Coefficient	0.586	0.034	0.488	0.851	461
Atkinson Index	0.705	0.058	0.509	0.834	461
Palma Ratio	6.457	1.477	3.015	14.434	461
Remittances	4.313	6.817	0.00003	50.818	416

S.D: Standard Deviation.

Appendix 3: Correlation matrix (uniform sample size: 141)

	ICT Dynamics			Inequality				
PSSE	Mobile	Internet	BroadB	Gini	Atkinson	Palma	Remit	
1.000	0.450	0.503	0.349	0.408	0.320	0.389	0.285	PSSE
	1.000	0.811	0.654	0.154	0.147	0.177	0.007	Mobile
		1.000	0.827	0.141	0.059	0.078	0.008	Internet
			1.000	-0.025	-0.052	-0.065	-0.107	BroadB
				1.000	0.809	0.914	0.145	Gini
					1.000	0.939	0.318	Atkinson
						1.000	0.245	Palma
							1.000	Remit

PSSE: Primary and Secondary School Enrolment. Mobile: Mobile Phone Penetration. Internet: Internet Penetration. BroadB: Fixed Broadband Subscriptions. Gini: the Gin coefficient. Atkinson: the Atkinson index. Palma: the Palma ratio. Remit: Remittances.

References

Abor, J. Y., Amidu, Y., &Issahaku, H., (2018). "Mobile Telephony, Financial Inclusion and Inclusive Growth", *Journal of African Business*, 18(4), pp. 430-453.

Agoba, A. M., Abor, J., Osei, K. A., & Sa-Aadu, J. (2019). "Do independent Central Banks Exhibit Varied Bahaviour in Election and Non-Election Years: The Case of Fiscal Policy in Africa". *Journal of African Business*, DOI: 10.1080/15228916.2019.1584263.

Abramowitz, M. (1986)."Catching-up, forging ahead or falling behind", *Journal of Economic History*, 46(2), pp. 385-406.

Afutu-Kotey, R. L., Gough, K. W., & Owusu, G., (2017). "Young Entrepreneurs in the Mobile Telephony Sector in Ghana: From Necessities to Aspirations", Journal of African Business, 18(4), pp. 476-491.

Amavilah, V., Asongu, S. A., & Andrés, A. R., (2017). "Effects of globalization on peace and stability: Implications for governance and the knowledge economy of African countries", *Technological Forecasting and Social Change*, 122 (September), pp. 91-103.

Ashraf, Q., & Galor, O., (2013). "The Out of Africa Hypothesis, Human Genetic Diversity, and Comparative Economic Development". *American Economic Review*, 103(1), pp. 1-46.

Asiedu, E., (2014). "Does Foreign Aid in Education Promote Economic Growth? Evidence From Sub-Saharan Africa", *Journal of African Development*, 16(1), pp. 37-59.

Asongu, S. A., (2015). "The impact of mobile phone penetration on African inequality", *International Journal of Social Economics*, 42(8), pp.706-716.

Asongu, S. A., (2016). "Reinventing Foreign Aid for Inclusive and Sustainable Development: Kuznets, Piketty and the Great Policy Reversal", *Journal of Economic Surveys*, 30(4),pp. 736–755.

Asongu, S. A., (2018a). "Comparative sustainable development in sub- Saharan Africa", *Sustainable Development*,26(6), pp. 638-651.

Asongu, S. A. (2018b). "CO2 emission thresholds for inclusive human development in sub-Saharan Africa", *Environmental Science and Pollution Science*, 25(26), pp. 26005–26019.

Asongu S. A. & De Moor, L., (2017). "Financial globalisation dynamic thresholds for financial development: evidence from Africa", *European Journal of Development Research*, 29(1), pp. 192–212.

Asongu, S. A., & Kodila-Tedika, O., (2017). "Is Poverty in the African DNA (Gene)?",*South African Journal of Economics*, 85(4), pp. 533-552.

Asongu, S. A., & Kodila-Tedika, O., (2018). "Institutions and Poverty: A Critical Comment Based on Evolving Currents and Debates", *Social Indicators Research*, 139(1), pp 99–117.

Asongu, S. A., & le Roux, S., (2017). "Enhancing ICT for inclusive human development in Sub-Saharan Africa", *Technological Forecasting and Social Change*, 118(May), pp. 44-54.

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., & Nwachukwu, J. C., (2016a). "The Role of Governance in Mobile Phones for Inclusive Human Development in Sub-Saharan Africa", *Technovation*, 55-56 (September-October), pp. 1-13.

Asongu, S.A, & Nwachukwu, J. C., (2016b)."Foreign aid and governance in Africa", *International Review of Applied Economics*, 30(1), pp. 69-88.

Asongu, S. A., & Nwachukwu, J. C., (2017)." Foreign Aid and Inclusive Development: Updated Evidence from Africa, 2005–2012", *Social Science Quarterly*, 98(1), pp. 282-298.

Asongu, S. A., & Nwachukwu, J. C., (2018)."Educational quality thresholds in the diffusion of knowledge with mobile phones for inclusive human development in sub-Saharan Africa", *Technological Forecasting and Social Change*, 129(April), pp. 164-172.

Asongu, S. A., Nwachukwu, J. C., & Aziz, A., (2018). "Determinants of Mobile Phone Penetration: Panel Threshold Evidence from Sub-Saharan Africa", *Journal of Global Information Technology Management*, 21(2), pp. 81-110.

Asongu, S. A., le Roux, S., Nwachukwu, J. C., & Pyke, C., (2019a)."The Mobile Phone as an Argument for Good Governance in Sub-Saharan Africa", *Information Technology & People*, DOI: 10.1108/ITP-01-2018-0011.

Asongu, S. A., Nwachukwu, J. C., & Pyke, C., (2019b). "The Comparative Economics of ICT, Environmental Degradation and Inclusive Human Development in Sub-Saharan Africa", *Social Indicators Research*, DOI: 10.1007%2Fs11205-018-2009-x.

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)."Basic formal education quality, information technology, and inclusive human development in sub- Saharan Africa", *Sustainable Development*. DOI: 10.1002/sd.1914.

Asongu, S. A., & Odhiambo, N. M., (2018c). "Environmental Degradation and Inclusive Human Development in Sub- Saharan Africa", *Sustainable Development*, DOI: 10.1002/sd.1858.

Asongu, S. A., & Odhiambo, N. M., (2019a). "How Enhancing Information and Communication Technology has affected Inequality in Africa for Sustainable Development: An Empirical Investigation", *Sustainable Development*. DOI: 10.1002/sd.1929.

Asongu, S. A., & Odhiambo, N. M., (2019b).“Basic formal education quality, information technology, and inclusive human development in sub- Saharan Africa”, *Sustainable Development*. DOI: 10.1002/sd.1914.

Asongu, S. A., & Tchamyou, V. S., (2016). “The impact of entrepreneurship on knowledge economy”, *Journal of Entrepreneurship in Emerging Economies*, 8(1), pp. 101-131.

Asongu, S. A., & Tchamyou, V. S., (2019a). “Foreign Aid, Education and Lifelong Learning in Africa”, *Journal of the Knowledge Economy*,10(1), pp. 126–146.

Asongu, S. A., & Tchamyou, V. S. (2019b). “Human Capital, Knowledge Creation, Knowledge Diffusion, Institutions and Economic Incentives: South Korea versus Africa”, *Contemporary Social Science*. DOI: 10.1080/21582041.2018.1457170.

Beck, T., Demirgüç-Kunt, A., & Levine, R., (2003), “Law and finance: why does legal origin matter?”,*Journal of Comparative Economics*, 31(4), pp. 653-675.

Bernard, A., & Jones, C. (1996).“Technology and convergence”, *The Economic Journal*, 106 (437), pp. 1037-1044.

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.

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.

Bongomin, G. O. C., Ntayi, J. M., Munene J. C., & Malinga, C. A., (2018). “Mobile Money and Financial Inclusion in Sub-Saharan Africa: the Moderating Role of Social Networks”, *Journal of African Business,*18(4), pp. 361-384.

Bruno, G., De Bonis, R., & Silvestrini, A., (2012). “Do financial systems converge? New evidence from financial assets in OECD countries”. *Journal of Comparative Economics*, 40(1), pp. 141-155.

Carew, M. T., Deluca, M., Groce, N., & Kett, M., (2019). “The impact of an inclusive education intervention on teacher preparedness to educate children with disabilities within the Lakes Region of Kenya”, *International Journal of Inclusive Education*,23(3), pp. 229-244.

Clouder, J., Cawston, J., Wimpenny, K., Mehanna, A. K. A., Hdouch, Y., Raissouni, I., & Selmaoui, K., (2018). “The role of assistive technology in renegotiating the inclusion of students with disabilities in higher education in North Africa”, *Studies in Higher Education*, DOI: 10.1080/03075079.2018.1437721.

De Magalhães, L., & Santaeulàlia-Llopis, R., (2018). “The consumption, income, and wealth of the poorest: An empirical analysis of economic inequality in rural and urban Sub-Saharan Africa for macroeconomists”, *Journal of Development Studies*, 134(September), pp. 350-371.

Efobi, U. R., Tanaken, B. V., & Asongu, S. A., (2018). “Female Economic Participation with

Information and Communication Technology Advancement: Evidence from Sub- Saharan Africa", *South African Journal of Economics*, 86(2), pp. 231-246.

Elu, J., (2018). "Gender and Science Education in Sub-Saharan Africa-Keynote address at the African Development Bank/African Finance and Economic Association Luncheon, Chicago, January 7, 2017", *Journal of African Development*, 20(2), pp. 105-110.

Fosu, A. K. (2015). "Growth, Inequality and Poverty in Sub-Saharan Africa: Recent Progress in a Global Context", *Oxford Development Studies*, 43(1), pp. 44-59.

Fosu, A. K., (2008). "Inequality and the Growth-Poverty Nexus: Specification Empirics Using African Data", *Applied Economics Letters*, 15(7), pp. 563-566.

Fosu, A. K., (2009). "Inequality and the Impact of Growth on Poverty: Comparative Evidence for Sub-Saharan Africa", *Journal of Development Studies*, 45(5), pp. 726-745.

Fosu, A. K., (2010a). "The Effect of Income Distribution on the Ability of Growth to Reduce Poverty: Evidence from Rural and Urban African Economies", *American Journal of Economics and Sociology*, 69(3), pp. 1034-1053.

Fosu, A. K., (2010b). "Does Inequality Constrain Poverty Reduction Programs? Evidence from Africa", *Journal of Policy Modeling*, 32(6), pp. 818-827.

Fosu, A. K., (2010c). "Inequality, Income and Poverty: Comparative Global Evidence", *Social Sciences Quarterly*, 91(5), pp. 1432-1446.

Fosu, A. K., (2011). "Growth, Inequality and Poverty Reduction in Developing Countries: Recent Global Evidence", *UNU WIDER Working Paper* No.2011/01, Helsinki.

Fosu, A. K., & Abass, A. F.,(2019). "Domestic Credit and Export Diversification: Africa from a Global Perspective", *Journal of African Business*.
DOI: 10.1080/15228916.2019.1582295.

Gosavi, A., (2018). "Can Mobile Money Help Firms Mitigate the Problem of Access to Finance in Eastern sub-Saharan Africa", *Journal of African Business*, 18(4), pp. 343-360.

Hansen, B. E., (1999). "Threshold effects in non-dynamic panels: Estimation, testing, and inference", *Journal of Econometrics*, 93(2), pp. 345-368.

Hazel, M., (2010). "Poverty among Women in Sub-Saharan Africa: A Review of Selected Issues", *Journal of International Women's Studies*, 11(4), pp. 50-72.

Hui, N., Vickery, E., Njelesani, J., & Cameron, D., (2018). "Gendered experiences of inclusive education for children with disabilities in West and East Africa", *International Journal of Inclusive Education*, 22(5), pp. 457-474.

Humbani, M., & Wiese, M., (2018). "A Cashless Society for All: Determining Consumers' Readiness to Adopt Mobile Payment Services", *Journal of African Business*, 18(4), pp. 409-429.

Issahaku, H., Abu, B. M., & Nkegbe, P. K., (2018). "Does the Use of Mobile Phones by Smallholder Maize Farmers Affect Productivity in Ghana?", *Journal of African Business,*19(3), pp. 302-322.

Lang, R., Schneider, M., Kett, M., Cole, E., & Groce, N. (2019). "Policy development: An analysis of disability inclusion in a selection of African Union policies". *Development Policy Review*, *37*(2), pp.155-175.

Lorenzo, T., & Coleridge, P. (2019). Working Together: Making Inclusive Development a Reality. In *The Palgrave Handbook of Disability and Citizenship in the Global South* (pp. 233-247). Palgrave Macmillan, Cham.

Jones, S., & Tarp, F., (2015). "Priorities for Boosting Employment in Sub-Saharan Africa: Evidence for Mozambique", *African Development Review*, 27(S1), pp. 56–70.

Kaulihowa, T., &Adjasi, C., (2018). "FDI and income inequality in Africa", *Oxford Development Studies*, 46(2), pp. 250-265.

Kwan, L.Y-Y, & Chiu, C-Y (2015). "Country variations in diiferent innovation outputs: The interactive effect of institutional support and human capital", *Journal of Organisational Behavior*, 36(7), pp. 1050-1070.

Magumise, J. & Sefotho, M. M., (2018). "Parent and teacher perceptions of inclusive education in Zimbabwe", *International Journal of Inclusive Education*, DOI: 10.1080/13603116.2018.1468497.

Majoko, T., (2018). "Effectiveness of special and inclusive teaching in early childhood education in Zimbabwe", *Early Child Development and Care*, 188(6), pp. 785-799.

Meniago, C., & Asongu, S. A., (2018). "Revisiting the finance-inequality nexus in a panel of African countries", *Research in International Business and Finance*, 46 (December), pp. 399-419.

MinkouaNzie, J. R., Bidogeza, J. C., &Ngum, N. A., (2018)."Mobile phone use, transaction costs, and price: Evidence from rural vegetable farmers in Cameroon", *Journal of African Business*, 19(3), pp. 323-342.

Mutanga, O., (2018). "Inclusion of Students with Disabilities in South African Higher Education", *International Journal of Disability, Development and Education*, 65(2), pp. 229-242.

Muthinja, M. M., & Chipeta, C., (2018). "What Drives Financial Innovations in Kenya's Commercial Banks? An Empirical Study on Firm and Macro-Level Drivers of Branchless Banking", *Journal of African Business*, 18(4), pp. 385-408.

Ncube, M., Anyanwu, J. C., &Hausken, K., (2014). "Inequality, Economic Growth and Poverty in the Middle East and North Africa (MENA)", *African Development Review*, 26(3), pp. 435-453.

Nkurunziza, M., (2018). "Sub-Saharan Africa, losing $2.5 trillion due to gender inequality – World Bank", *The New Times* https://www.newtimes.co.rw/business/sub-saharan-africa-losing-25-trillion-due-gender-inequality-world-bank (Accessed: 01/01/2018).

Osabuohien, E. S., & Efobi, U. R., (2013). "Africa's money in Africa", *South African Journal of Economics*, 81(2), pp. 292-306.

Page, J., &Söderbom, M., (2015). "Is Small Beautiful? Small Enterprise, Aid and Employment in Africa", *African Development Review*, 27(S1), pp. 44–55.

Petrakis, P. E., & Stamatakis, D. (2002). "Growth and educational levels: a comparative analysis". *Economics of Education Review*, 21(2), pp. 513-521.

Robinson, M., (2015). "Why gender equality is key to sustainable development", *World Economic Forum*. https://www.weforum.org/agenda/2015/03/why-gender-equality-is-integral-to-sustainable-development/ (Accessed: 02/01/2018).

Roodman, D., (2009a). "A Note on the Theme of Too Many Instruments", *Oxford Bulletin of Economics and Statistics*, 71(1), pp. 135-158.

Roodman, D., (2009b). "How to do xtabond2: An introduction to difference and system GMM in Stata", *Stata Journal*, 9(1), pp. 86-136.

Sulemana, I., &Kpienbaareh, D., (2018). "An empirical examination of the relationship between income inequality and corruption in Africa", *Economic Analysis and Policy*,60(December), pp. 27-42.

Shaikh, A.A., & Karjaluoto, H. (2015)."Mobile banking adoption: A literature review", *Telematics and Informatics*, 32(1), pp. 129-142.

Smith, M.L., Spence, R., & Rashid, A. (2011)."Mobile phones and expanding human capabilities", *Information Technologies and International Development*, 7(3), pp. 77-88.

Tchamyou, S. V., (2017). "The Role of Knowledge Economy in African Business", *Journal of the Knowledge Economy*, 8(4), pp. 1189-1228.

Tchamyou, V. S., (2019a). "Education, Lifelong learning, Inequality and Financial access: Evidence from African countries". *Contemporary Social Science*. DOI: 10.1080/21582041.2018.1433314.

Tchamyou, V. S., (2019b)."The Role of Information Sharing in Modulating the Effect of Financial Access on Inequality". *Journal of African Business*. DOI: 10.1080/15228916.2019.1584262.

Tchamyou, V. S., & Asongu, S. A., (2017)."Information Sharing and Financial Sector Development in Africa", *Journal of African Business*, 18(7), pp. 24-49.

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

Tlale, L. D. N., & Romm, N. R. A. (2018). "Systemic Thinking and Practice Toward Facilitating Inclusive Education: Reflections on a Case of Co-Generated Knowledge and Action in South Africa", *Systemic Practice and Action Research*, 31(2), pp 105-120.

Uduji, J.I. & Okolo-Obasi, E. N., (2018). "Young rural women's participation in the e-wallet programme and usage intensity of modern agricultural inputs in Nigeria", *Gender, Technology and Development*, 22(1), pp. 59-81.

Ureta, S. (2008)."Mobilising poverty?: Mobile phone use and everyday spatial mobility among low-income families in Santiago", *Chile, Information Society*, 24(2), pp. 83-92.

UN (2017). "UNDP launches study on income inequality in sub-Saharan Africa", *United Nations Development Programme*. http://www.undp.org/content/undp/en/home/presscenter/pressreleases/2017/09/21/undp-launches-study-on-income-inequality-in-sub-saharan-africa.html (Accessed: 09/01/2019).

World Bank (2015). "Unlocking the Potential of Women through Technology for Sri Lanka's Development", Washington: The World Bank.http://www.worldbank.org/en/news/feature/2015/04/09/unlocking-potentialwomen-technology-ict-development (Accessed: 05/12/2016).

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

Xavier, R., & Margarita, L.,(2016). "The SDGs and inclusive education for all: From special education to addressing social inequalities", *Briefing Paper, Austrian Foundation for Development Research* (ÖFSE), No. 14, Austrian Foundation for Development Research (ÖFSE), Vienna.