Journal of the Knowledge Economy (2024) 15:6079–6098
https://doi.org/10.1007/s13132-023-01209-9

ICTs and Globalisation in the African Labour Market

Gildas Dohba Dinga[1] · Mamadou Asngar Thierry[2] · Dobdinga Cletus Fonchamnyo[1] · Ongo Nkoa Bruno Emmanuel[3] · Giyoh Gideon Nginyu[1]

Received: 7 December 2021 / Accepted: 24 February 2023 / Published online: 2 May 2023

Abstract

This study investigates the effect of Information and Communication Technologies (ICTs) and globalisation on employment and labour productivity within 33 selected African economies between 1990 and 2019. The study employs the dynamic common correlation effect technique and the quantile technique to attain its objectives. Data is collected from the KOF globalisation database and the Conference Board Total Economy (2020) database. The results indicate that; both globalisation and ICTs have a significant positive effect on employment within the selected countries but the outcome tends to indicate heterogeneity at different quantiles considered. Meanwhile, ICT and globalisation improve labour productivity globally and at different quantiles within the selected African economies. The study recommends that African countries should intensify ICT usage by accelerating ICT education, providing quality energy and reducing connection prices. Also, we recommend the reduction of entrance barriers to job markets by giving better information of market labour and professionalise training.

Keywords ICTs · Employment · Labour productivity · Globalisation

✉ Gildas Dohba Dinga
gildoh1995@gmail.com

Mamadou Asngar Thierry
tmamad07@yahoo.fr

Dobdinga Cletus Fonchamnyo
dfonchamnyo@gmail.com

Ongo Nkoa Bruno Emmanuel
ongoema@yahoo.fr

Giyoh Gideon Nginyu
g2nginyu@gmail.com

[1] Faculty of Economics and Management sciences, The University of Bamenda, Bamenda, Cameroon

[2] Faculty of Economics and Management Sciences, University of Ndjamena, Ndjamena, Chad

[3] Faculty of Economics and Management Sciences, University of Dschang, Dschang, Cameroon

Introduction

Developing economies, especially those of the African continent still remain largely dependent on advanced economies for technological development and globalisation. This remains the prime source through which technology can flow from advanced economies to these developing economies. The inflow of these technologies affects different sectors of the economies including the labour market (Lefophane and Kalaba, 2021; UNDP, 2016). The past few decades have witnessed the revolution of work, recreation and communication by ICTs (Information and Communication Technologies) in the world at large, even though the digital divide between Africa and the rest of the world still remains evident. For example, the cost of internet between 2015 and 2019 in Africa fell from 12.5 to 8% of average income as compared to 4.1 to 2.7% and 3.5 to 1.5% in Asia and America respectively (Kazeem, 2019). Besides, ICTs have greatly impacted growth and structural change within industrialised and emerging countries (Jorgensen et al., 2006; Edquist & Henrekson, 2017; Saba and Ngepah, 2021; Haini & Wei Loon, 2022). A decent job and technological innovation are core pillars of the United Nations Development Goals (goals 8 and 9). Decent work is crucial in providing sustainable income and the creation of pathways for poverty alleviation (International labour organisation (ILO), 2020). At the advent of ICTs, many authors highlighted technological unemployment, positing that computerisation and automation lead to the disappearance of many jobs and laying off of employees (Abramova and Grishchenko, 2020; Attewell and Rule, 1984; Simon, 1960). However, information technology has been seen as a disruptive technology that plays a positive role in economic and social development (Peng et al., 2018; Kılıçaslan and Töngür, 2018). While advanced economies can be considered a good place to adapt to new technologies, their developing counterpart with a low level of human capital can face great difficulties adapting to these new technologies. In line with the views of Schumpeter's (1939), on the central place of technological innovation on all economic activities, the African Continent has continually sought the liberalisation of its economies to pave the way for the movement of capital and the transfer of technologies.

The liberalisation of the African market has paved the way for the continuous penetration and development of the ICT sector (Odongo, 2015). Africa possesses a bubbling start-up sector that is increasingly creating innovations that are meeting the continually changing continent and as such venture companies around the world have taken note and are increasingly moving resources to Africa with about 2 billion dollars invested in African start-ups as of 2019 (Kazeem, 2019; Elsner, 2021). Frey and Osborne (2013) have shown that the ICT revolution has put about 47% of jobs in the USA at risk, while Bowles (2014) underscores that the risk of jobs due to the ICT revolution is higher in Europe. This indicates that the development of ICTs can reduce the rate of available jobs within an economy. Sourcing from these studies (Frey and Osborne, 2013; Bowles, 2014; Lefophane and Kalaba, 2021), highlighting the pros and cons ICT plays in the job market of developed economies with advanced technology and the ICT sector, one is tempted to question the effect of ICTs in less developed economies like those

of Africa wherein technological development is still relatively low and the job market is highly unskilled. In an era wherein the world is frequently talked of as a global village, the African continent has not been indifferent to the issue of globalisation. Since the late 1990s, Africa has undergone an upward swing with regard to ICT infrastructural development, due to the fact that most African economies deregulated and liberalised the telecommunications sector (Song, 2016).

Africa's ICT infrastructure has significantly grown over the recent decades, statistics obtained from the internet world statistics (IWS, 2021) showed an average growth rate of the internet at 12.98% from 2000 to 2021 as compared to 88.3% for the rest of the world. Equally, there is an average internet penetration rate of 43% for African economies as compared to 68.6% for the rest of the world. Furthermore, the ITU (2019) estimated that there were 44.3 mobile phone subscriptions per 100 inhabitants in Africa in 2010 and this increased tremendously to 76.7 in 2018, from a mere 12.4 in 2005. In the same line, active mobile broadband subscriptions rose from 1.7 per 100 in 2010 to 30.7 in 2018. On the other hand, the ITU (2019) noted equally that only 26.3% of Africans were internet users in 2018. This represented an almost threefold increase from 2010 (9.9%) and a tenfold increase from 2005 (2.7%). Globally, internet users account for 51.4% of the population which is almost double the proportion in Africa. However, the IWS (2021) demonstrated that internet penetration in Africa averaged 39.3% in the first quarter of 2020 and this trend increased to 43% in 2021. The question as to the contribution of such a great increase in ICTs utilisation to the sectorial enhancement of African economies remains paramount.

According to the African Development Bank (2015), one-third of Africa's young people between 15 and 35 years old were unemployed, another one-third were vulnerably employed, and only one-sixth in wage employment. Equally, the International Labour Organization (ILO) global employment trends report of 2014 indicates that unemployment is currently about 7.7%. The ILO (2014) notes equally that many workers in Africa take unattractive jobs that are characterised by low pay, and little or no access to social protection and rights leading to a very high share of insecure employment, constituting almost 90% of total employment in Africa leading to low productivity. In the same vein, the International Labour Organization (2020) suggests that Africa's youth unemployment is the lowest in the world. Africa's youth unemployment dropped to 11.7% in 2012 and declined significantly over the last 8 years; the continent's youth unemployment is projected to further reduce to 10.6% in 2021 (ILO, 2020). Equally, the ILO (2020) noted that labour underutilisation was projected to increase from the observed 114.6 million in 2019 to 120.5 million by 2021.

With the low level of the aforementioned labour outcomes, African economies can reap from the fruit of integration and globalisation to better their labour market outcomes. Globalisation according to Gygli et al. (2019) and Dreher (2006) describes a process that eradicates international boundaries, integrates economies, cultures, technologies and governance and leads to complex relations of interdependence. As such, globalisation brings about growth, technology transfer and the inflow of capital which leads to increased productivity and the creation of new jobs (Mavodyo, 2022). Integration with the world markets bears prosperity promises for advanced and transitional economies, but this can equally be a source of hardship

(Rama, 2003). Inequality among workers can increase within economies if globalisation and integration tend to benefit workers with skills needed to adjust to organisational structures and new technological inflows, at the detriment of unskilled labourers (Wood, 1995). To maintain support for globalisation and pro-market policies within developing countries, job creation and inclusion should be given special attention since ignoring inclusion would risk making the mistake already evident in advanced economies (El Aynaoui et al., 2019). Whereas, most studies have tended to focus on the growth effect of ICT and technological innovation in general (Waverman et el., 2005; Nasab and Aghei 2009; Yeo, 2010; Fernandez-Portillo et al., 2020; David & Grobler, 2020; Niebel, 2018) the job market has been accorded little attention (Biagi and Falk, 2017; Abramova and Grishchenko, 2020). Faced with ICT development within a globalised market, ICTs can be intuitively perceived within the world and African economies as a mixed blessing, especially within the sphere of the labour market. Based on the aforementioned stylized facts and advances, the role played by ICTs and globalisation in the labour market of a continent (Africa) that has continuously lacked behind other continents becomes questionable and a call for concern for policymakers within the continent.

The contribution of this current study is in many folds. Firstly, the study seeks to examine the role played by ICT on job-creation (employment) and labour productivity within African economies using macro data. This is typically different from most previous studies that are mainly focused on industry and country-level analyses (Biagi and Falk, 2017; Abramova and Grishchenko, 2020; Kılıçaslan and Töngür, 2018) and equally on developed economies. Equally, the study deviates from the traditional measure of ICTs like access to telephone and internet as commonly used in literature (Asongu, and Asongu, 2019; Asongu and Odhiambo, 2020a; Ofori and Asongu, 2021). Instead, it makes use of ICT capital within an aggregated level. Such approach has been accorded little or no consideration to the best of our knowledge and in this light, the study makes a novel look at ICT penetration through the capital dimension. In addition, within the framework of a globalised world and given that African economies depend on developed countries in matters of technological advancement, this study equally seeks to assess the role played by globalisation on employment and labour productivity in the African context. Such dual analyses of labour market outcomes and equally the consideration of both the defacto and de-jure globalisation have not been accounted for within literature to the best of our knowledge. Equally, the study makes key advances in the methodological contribution by employing modern econometric approaches which account for cross-country interdependence, which have been given limited attention by most authors within the sphere of this domain.

The rest of the paper is organised as follows; the “Literature Review” section will look at the literature review, which will be followed by the “Methodological Framework” section, “Results and Discussions” section and finally, the “Conclusion and Policy” recommendation.

Literature Review

This section presents the theoretical and empirical relation that exists between ICT and labour market variables (employment and labour productivity) and equally globalisation and labour market relationships.

ICTs, Employment and Labour Productivity

Theoretically, the relationship between ICTs and employment can be viewed in two approaches which are the compensation and substitution mechanism. The compensation mechanism propounded by Marx (1961) posits that the market-oriented indirect effects of technological advancement may compensate for the labour-saving effects such that the changes in technology lead to employment generation in the long run. This indicates that the adoption and use of new technologies like ICTs can lead to lower production costs and the generation of new investments which consequently bring forth new jobs. On the other hand, the substitution effect states that as industries enhance their technologies, employment destruction emerges (Kılıçaslan and Töngür, 2018). This is generated by the fact that new technologies require less labour and as such the labour-saving effect of ICTs dominate. Based on this theoretical underpinning, one can posit that the outcome of the development of the ICT sector in the job market has produced both enhancing and destructive outcomes on the labour market.

ICTs have been empirically shown to play an essential role in many economic sectors such as industrialisation, economic growth, financial sector development, investment, employment, labour productivity and development (Muller, 2021; Asongu and Odhiambo, 2020b; Asongu and Asongu, 2019; Castro1 and Lope, 2021; Lefophane and Kalaba, 2021). ICTs have been measured within literature using different proxies and these different measures have a different effect on diverse economic indicators with employment and labour productivity not being indifferent. Basu (2007) highlighted that the use of workers with access to the broadband subscription, internet or mobile phones access as a measure of ICT has increased in recent years. These infrastructures can boost information access by job seekers, reduce transaction costs and improve information flow within firms. Equally, Baigi and Falk (2017) noted that digital connectivity can produce a direct and indirect negative effect on the demand for labour through labour shifting and saving technologies.

Empirically, a handful of studies have investigated the effect of ICTs on labour market outcomes. Using data from 10 European Union countries for the period 2002–2010, Biagi and Falk (2017) noted that the increase in ICT and e-commerce activities have not led to job creation for both manufacturing and service industries, and equally for small and medium-sized enterprises. Abramova and Grishchenko (2020) examined the effect of ICTs on labour productivity growth and employment between 2005 and 2017. Their result indicated that ICT's influence on labour productivity and employment is characterised by gradual changes and sustainability in some industries. On their part, Metu et al. (2020) using mobile phone subscribers and the number of internet users as proxies of ICT examined the role of ICT development on youth unemployment using the Instrumental Variable and the System

Generalised Method of Moment (SGMM) technique within a panel of 48 Sub Saharan African (SSA) economies between 1991 and 2018. Their outcome indicated that mobile phone subscribers reduce youth unemployment while internet usage was insignificant. Furthermore, using mobile phone penetration, internet penetration and fixed broadband subscriptions as measure of ICT for 42 SSA countries between 2004 and 2014, Asongu and Odhiambo (2020a) empirically showed that ICT enhancement beyond a certain threshold will mitigate gender inequality in the labour market. Equally, within a panel framework of 48 African countries, Asongu and Odhiambo (2020b) concluded that ICT is important in moderating financial access for enhanced female economic participation.

Ndubuisi et al. (2021) investigated the effect of digital infrastructure on services sector employment for a panel of 45 SSA countries over the period 1996–2017, their outcome indicates that digital infrastructure has a positive effect on services sector employment in SSA. In the same light, Kılıçaslan and Töngür (2018) used firm-level data and employed the SGMM technique to analyse the impact of ICT capital on employment generation and destruction within the Turkish economy. Their outcome indicates that ICT has employment-enhancing effects in Turkish manufacturing. Equally, tangible ICT capital had a stronger positive effect than intangible ICT capital. Kurt and Kurt (2015) using data from 5 BRICS nations from 2000 to 2012 deduced a positive relationship between technological innovation and labour productivity.

While investigating the impact of ICTs on labour productivity in the EU, Relich (2017) concluded that selected ICT components have a positive and significant effect on labour productivity in EU countries. De Wet et al. (2016) concluded that ICT is generally perceived as positive on employees work and personal lives, but employees should make a conscious decision in managing their ICTs to decrease the negative impact thereof on their work and personal lives. Dua and Garg (2019) examined the determinants of labour productivity for Asia pacific countries between 1980 and 2014 and concluded that technological innovation and trade openness are key determinants of labour productivity. Chowdhury and Wolf (2003) on their part argue that innovation (ICT) has a negative effect on labour productivity within small and medium-sized enterprises in three East African countries (Kenya, Tanzania and Uganda). A neutral relationship between a firm's technological involvement and labour productivity is concluded by Okumu and Buyinza (2018).

Based on the different aforementioned empirical and theoretical works, one can deduce that the effect of ICTs on labour market outcome remains inconclusive. Most studies lay emphasis on advanced economies, less developed countries with low human capital while low technological advancement has been given limited consideration.

Globalisation, Employment and Labour Productivity

The role of Globalisation on labour market outcomes has been an issue of major debate in the past decades. The regulationist theory maintains that an improvement in economic globalisation prompts national decision-makers to reorient their social policies towards a market alignment (Jessop, 2002). Based on this thesis, decision-makers are apprehensive about national competitiveness in the global economy. In the context of employment policy, this implies that the adjustment is focused on policies

that increase the supply of labour. Meanwhile, the competing theory postulates that countries will seek to preserve the distinctive features of their welfare states due to an increase in economic globalisation (Rodrik, 1998;). In this regard, social policy produces an outcome of competitive advantage when it is harmonised with respect to the model of innovation, which differs substantially across liberal and coordinated market economies. This indicates that globalisation can influence labour market outcomes through the policy perspective adopted by policymakers (Näätänen 2015).

Empirically, Dauth et al. (2021) examined the impact of trade exposure on job biographies for 2.4 million manufacturing workers in Germany. They noted from their outcome that rising export opportunities lead to two important sources of earning gains. That is, on-the-job and employers switch within the same industry. Meanwhile, import shock mostly hurt low-skilled workers. Rama (2003) concluded among others that globalisation has no effect on the dispersion of wages across occupations. The result showed that economic openness which is a component of globalisation brings about job creation in some sectors and in others it leads to loss of employment, though the job loss is more intense at the initial stage. Hoekman and Winters (2005) established that globalisation improves labour market value within developing countries given that trade is a channel for enhancing technological advancement.

Musti (2018) examined the effect of globalisation on employment in Nigeria from 1970 to 2013. Their result indicated that economic and social aspects of globalisation increased employment in the short run whereas, in the long run, all the three aspects of globalisation that is, economic, political and social show a positive effect on employment. Aremo and Alagbile (2010) using an error correction model and data from the Nigerian economy settled that globalisation brings short and long-run adverse effects on employment. Aydiner-Avsar and Onaran (2010) while analysing the determinants of employment noted that the wage elasticity of employment increases after liberalisation. Meanwhile, the trade effect seems to have a low economic effect after controlling for output. The literature on globalisation and labour market outcome remains debatable based on the lack of a consensus among scholars. The few empirical findings on the effect of globalisation on labour market outcomes generally indicate a positive, negative and no significant effect on labour market outcome. Furthermore, empirical works examining globalisation on labour market outcome within the spheres of a developing region like Africa remain limited within the literature. In this regard, this study seeks to enhance the literature specifically in the case of Africa.

Methodological Framework

Specification of Empirical Model

Based on the objectives of this study, two models are used in this study inspired from the works of Greenaway et al. (1999), Milner and Wright (1998), Aydiner-Avsar and Onaran (2010), Kurt and Kurt (2015) and Relich (2017).

$$EMP_{it} = \alpha_0 + \alpha_1 ICT_{it} + \alpha_2 Glob_{it} + \alpha_j Z_{it} + \varepsilon_{it} \quad (1)$$

$$LPTY_{it} = \delta_0 + \delta_1 ICT_{it} + \delta_2 Glob_{it} + \delta_j W_{it} + \varepsilon_{it} \quad (2)$$

Model 1 presents the employment relation while model 2 states the labour productivity relation. EMP denotes employment and is measured as persons employed in thousands, ICT denotes information and telecommunication technology which is measured as the contribution of capital services provided by ICT Assets to GDP growth (consisting of ICT capital input multiplied by ICT capital share and averaged over 2 years), LPTY stands for labour productivity and is measured by Labour productivity per person employed in 2020 international dollars, converted using Purchasing Power Parity. Glob is the globalisation index which consists of both the defacto index that accounts for physical flows and activities and the de-jure index which accounts for the policies and conditions that in principle enable and foster flows and activities, Z and W are sets of other control variables used in the two models to evaluate consistency and robustness of the variables of interest and evaluate possible variation that these control variables can have on the baseline outcome. Among the different control variables used, we have total factor productivity (TFP) measured as the difference between GDP and labour quantity contribution, labour quality contribution and total capital contribution. Per capita income (GDPC) is measured by GDP per capita, population (POP) is calculated as mid-year population per thousand.

Data

The data is collected for 33 African economies between 1990 and 2019. The data on globalisation is collected from the Kaufmann et al. (2010) globalisation database meanwhile all the other variables are obtained from the conference board total economy (2020) database. variables are presented in Table 1.

From Table 1, the number of countries (N) and the time dimension (T) is equal across all variables (N*T = 990) indicating that we have a balanced panel. The mean value of EMP, LPTY and ICT are 8823.073, 20385.906, 0.539 and respective standard deviations of 10020.264, 29404.355, 0.705 indicating great dispersion from their averages since each of their standard deviations lie above the mean. Meanwhile, the standard deviation of GLOB, $GLOB_{df}$ and $GLOB_{dj}$ all lies below their mean values. These statistics indicate variations in dispersion patterns within the countries of the study.

Estimation Approach

The estimation approach employed in this study is the dynamic common correlation effect (DCCE) technique. The choice of this technique is motivated by many reasons. Firstly, the technique accounts for cross-sectional dependence (CD) among the countries of the study. Recently, many authors (Ali et al., 2020; Arain et al., 2019; and Neal, 2015; Fonchamnyo et al. 2022; Dinga et al. 2021) have criticised conventional techniques like ordinary least square, generalised method of moment (GMM), Mean Group (MG), two-stage least square (2SLS) among others due to their inability to account for cross-sectional dependence. This is vital because labour market outcome from one country does not only affect the economy alone but most often

Table 1 Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
EMP	990	8823.073	10020.264	214.014	74399.075
LPTY	990	20385.906	29404.355	1171.167	251453.92
ICT	960	0.539	0.705	−1.083	5.468
GLOB	990	46.724	10.102	22.356	72.354
GLOBdf	990	45.318	10.34	19.135	72.051
GLOBdj	990	48.11	11.279	19.98	81.288
POP	990	25923.382	30036.412	938.084	207698.62
TFP	990	−0.554	7.084	−109.659	80.469

produces spillover to other countries. Equally, biases in estimated outcome due to the sample size is equally corrected by the DCCE technique either using the recursive technique or the Jackknife approach (Ditzen, 2016). In addition, it provides a new approach to estimating heterogeneous panel models using CCE and it further presents a test for cross-sectional dependence within each model estimated.

In order to check for the robustness of the outcome and to equally check for possible heterogeneity in the outcome, we employ the quantile-on-quantile estimation technique proposed by Powell (2015). The panel quantile technique helps to appraise the regression coefficient for distinct quantile distributions which cannot be achieved by other panel estimation approaches (Anser et al. 2021). Equally, the panel quantile technique addresses time-invariant shocks at different quantile distributions, which is not possible with other panel approaches like DCCE that rather capture country-specific time-variant shocks at a given time interval. Therefore, both statistical techniques used are important in explaining the parameters estimated with robust extrapolations.

Before proceeding with the estimation, key pre-tests are equally employed in order to validate the adopted estimation technique. Primarily, we perform a test for cross-sectional dependence in order to ascertain country interdependence and to choose between first or second-generation tests. The Pesaran (2004) and (2015) cross-sectional dependence tests are employed in this study. Meanwhile, the cross-section augmented Dickey-Fuller (CADF, Pesaran 2003) and the cross-sectional augmented Im Pesaran Shin (CIPS, Pesaran 2007) second generational unit root tests are employed to detect the variables' order of integration. Finally, the Westerlund (2007) second-generation cointegration test is applied to ascertain the existence of a long-run relationship among the variables. This second-generation test is chosen based on their ability to reduce the distortionary effect of cross-sectional dependence (Pesaran, 2003).

Results and Discussions

Figure 1 in the appendix shows means fitted lines which make use of the preliminary relation between globalisation and ICTs on labour productivity and employment. The figure depicts an inverse relationship between employment and ICTs, employment and globalisation whereas a positive relationship is demonstrated between

ICTs and labour productivity, globalisation and Labour productivity. Equally, the pairwise correlation of the variables presented in Table 9 appendix 2 equally indicates a negative relationship between employment and ICT as well as globalisation and per capita GDP. Furthermore, a positive pairwise correlation is established between labour productivity, ICTs capital and globalisation. Such descriptive outcomes will mean increased ICT penetration and globalisation, reduced employment in Africa and equally lead to improvement in labour productivity in African countries. Table 2 presents the results of the error cross-sectional dependence test. The outcome indicates that the null hypothesis of no cross-sectional dependence is rejected for both tests at the 1% significance level, implying that there exists cross-sectional dependence within the countries of our study.

This implies that there exist shocks that affect all the cross-sectional units of our panel with differentials in their impact on each country, and with such differentials arising from sources like institutions, absorptive capacity and technological rigidities among others. In order to account for such differentials, we chose second-generation pre-estimation tests and regressions techniques that account for such cross-sectional dependence.

Table 3 presents the results of the unit root test. All variables are in the natural log form. The CADF and the CIPS second-generation tests are chosen based on their ability to take into consideration cross-sectional dependence. From the outcome, variables like LICT, LEMP, LLPTY and LGDPPC are stationary at first difference implying that they follow an I(1) process. Whereas, all the other variables of our study are stationary at level implying they follow an I(0) process.

Table 4 indicates the output of the panel Westerlund (2007) second-generation cointegration test for our dependent variables and the key explanatory variables. The results indicate that among the four statistics of the test for each relation, at least two reject the null hypothesis of no cointegration and hence confirm the existence of cointegration, implying that labour productivity and employment move together with ICT and globalisation variables in the long run. With the validation of our different pre-test results, we proceed to estimate our model using the dynamic common correlation effect technique. The coefficient of the estimated outcome presented is regarded as long-run elasticities since they are natural log coefficients.

Table 5 displays the results of the employment equation. The outcome indicates that for the different specifications (models 1 to 5) examined, ICT has a positive and statistically significant effect on the employment level. This implies that an increase in the rate of ICT capital leads to an increase in employment in the selected African countries. Also, boosting the inflow of ICT capital enhances the employment status of African economies by creating new jobs and opening new markets. These results are in line with the

Table 2 Cross sectional dependence

Model	Pesaran CD_{2004} test		Pesaran CD_{2015} test	
	Test statistics	*p*-value	Test statistics	*p*-value
LEMP model	120.38***	0.000	121.975***	0.000
LLPTY Model	52.07***	0.000	121.928***	0.000

***Denote 1% significant level

Table 3 Panel unit root

Variables	CADF CV (−2.54, −2.61, −2.73)		CIPS CV (−2.54, −2.61, −2.73)	Decision
	t-bar statistics	*p*-value	CIPS statistics	
LEMP	−2.390	0.313	−2.314	
D(LEMP)	−2.804***	0.001	−3.754***	I(1)
LLPTY	−1.819	0.999	−1.991	
D(LLPTY)	−3.568***	0.000	−4.719	I(1)
LICT	−1.956	0.984	−2.235	
D(LICT)	−3.846***	0.000	−4.963	I(1)
TFP	−3.504***	0.000	−4.658	I(0)
LPOP	−2.650**	0.019	−2.741	I(0)
LGLOB	−2.842***	0.001	−3.071	I(0)
LGLOBDJ	−2.733**	0.005	−2.880	I(0)
LGLOBDF	−2.866***	0.000	−3.170	I(0)
LGDPC	−2.102	0.897	−2.446	
D(LGDPC)	−3.729***	0.000	−4.509	I(1)

***,**,*Denote 1%, 5% and 10% significant levels

Table 4 Panel cointegration outcome

Test statistics	ICT	GLOB	GLOBDJ	GLOBDF
LEMP				
Gt	−3.064*** (0.001)	−7.052*** (0.000)	−8.430*** (0.000)	−5.949*** (0.000)
Ga	−14.89*** (0.000)	−18.93*** (0.000)	−16.26*** (0.000)	−22.07*** (0.000)
Pt	3.547 (1.000)	−1.555* (0.060)	−1.982** (0.024)	−0.116 (0.454)
Pa	−1.915** (0.028)	−9.942*** (0.000)	−12.79*** (0.000)	−3.553*** (0.000)
LLPTY				
Gt	−6.925*** (0.000)	−9.220*** (0.000)	−7.433*** (0.000)	−11.95*** (0.000)
Ga	−1.347* (0.089)	−4.285*** (0.000)	−5.237*** (0.000)	−4.715*** (0.000)
Pt	−1.182 (0.119)	3.104 (0.999)	2.677 (0.996)	0.798 (0.788)
Pa	−3.115*** (0.001)	−0.456 (0.324)	−0.504 (0.307)	−2.756*** (0.003)

***,**,*Denote 1%, 5% and 10% significant levels

works of Kılıçaslan and Töngür (2018), Kurt and Kurt (2015), Wet et al. (2016), Metu et al. (2020), Asongu and Odhiambo (2020a) but contradict the outcome of Biagi and Falk (2017), Equally, the outcome indicates that globalisation is significantly associated with increased employment within African countries. However, looking at the outcome

in column 5, the defacto dimension of globalisation is playing a more significant role than the de-jure dimension. This implies that the physical flows of globalisation are more employment friendly than the policies and conditions that in principle foster globalisation. This implies that reducing barriers to globalisation within African economies permits fluidity of exchange and enhances productivity which leads to the hiring of new workers. The results are in line with the works of Hoekman and Winters (2005), Musti (2018), but contrary to Aremo and Alagbile (2010). The result equally shows the goodness of fit given that the F-statistics is significant at the 1% level for all the models. In addition, the existence of cross-sectional dependence is validated for the models.

Table 6 presents the outcome of the different estimated models of the labour productivity equation. The results show that though ICT capital improves labour productivity, it is not significant for the baseline models (6 and 7) and only becomes significant when we control for total factor productivity and population changes. This implies that the influence of ICTs on labour productivity within the selected countries is dependent on other factors. This outcome is similar to that of Abramova and Grishchenko (2020). Globalisation is seen to exert a positive and statistically significant effect on labour productivity for all

Table 5 Employment regression output

Variables	(1)	(2)	(3)	(4)	(5)
L.LEMP	0.373***	0.401***	0.364***	0.394***	0.363***
	(0.0852)	(0.0931)	(0.0835)	(0.0936)	(0.101)
D.LICT	0.0222*	0.0191*	0.0195*	0.0169*	0.0225**
	(0.0115)	(0.0100)	(0.0115)	(0.00955)	(0.0102)
LGLOB	0.0405*	0.0727*	0.0584*	0.0905**	
	(0.0243)	(0.0388)	(0.0312)	(0.0356)	
LGLOBDJ					0.0301
					(0.0548)
LGLOBDF					0.0729**
					(0.0320)
D.LGDPC			0.107*	0.142**	0.149*
			(0.0574)	(0.0698)	(0.0812)
LPOP		−0.0215		−0.0240	−0.0347
		(0.0212)		(0.0238)	(0.0298)
Constant	−0.148	−0.0419	−0.222*	−0.0792	−0.0381
	(0.0964)	(0.115)	(0.125)	(0.151)	(0.222)
Observations	896	896	896	896	896
Cd stats	4.84	7.26	4.86	6.36	1.95
	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)
F stats	9.26	6.60	6.49	5.48	3.80
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Number of groups	32	32	32	32	32

CD stats and F stats denote cross-sectional dependence statistics and F statistics [] are *p*-values

Standard errors in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

specifications. Though globalisation is positive, model 9 shows that the defacto dimension is more significant than the de-jure. All the models indicate a significant coefficient for the F-statistics and CD test, implying goodness of fit.

In order to examine how time-invariant shocks can influence the obtained outcome and equally evaluate the differentials in outcomes that can be produced by countries at different quantiles, we estimate the models using the quantile-on-quantile technique proposed by Powell (2015). The outcome of the employment equation for the quantile regression shown in Table 7 indicates that for the four quantiles considered, an increase in ICT capital is seen to significantly increase employment within three quantiles (Q40, Q60 and Q80) whereas, it is seen to significantly decrease employment at the 20th quantile. These results are very vital due to the fact that they indicate that at the initial level of the introduction of ICTs, jobs are lost. As such technologies continue to penetrate the African economies subsequently leading to an increase in employment. Moreover, the two dimensions of globalisation are on their part seen to produce differences in outcomes for different quantiles examined. While the de-jure dimension of globalisation indicates a positive effect on employment generation in the 40th and 60th quantiles, the

Table 6 Labour productivity regression output

VARIABLES	(6)	(7)	(8)	(9)
L.LLPTY	0.203***	0.163**	0.0820*	0.937***
	(0.073)	(0.072)	(0.042)	(0.048)
D.LICT	0.0457	0.0292	0.0257*	0.1358*
	(0.045)	(0.040)	(0.014)	(0. .078)
LGLOB		0.4155**	0. 0931*	
		(0. 182)	(0. 050)	
LGLOBDJ				0.251*
				(0.133)
LGLOBDF				0.126**
				(0.060)
LPOP			0.112	-0.0261
			(0.153)	(0.174)
LTFP			0.843***	0.808***
			(0.092)	(0.099)
Constant	0.00797*	−0.179	−4.830***	−3.953***
	(0.0041)	(0.185)	(0.906)	(1.122)
Observations	896	896	896	896
Cd stats	7.48 [0.00]	9.98 [0.00]	10.15 [0.00]	1.85 [0.00]
F stats	2.23 [0.00]	3.30 [0.00]	3.00 [0.00]	6.79 [0.00]
Number of groups	32	32	32	32

CD stats and F stats denote cross-sectional dependence statistics and F statistics, [] are *p*-values

Standard errors in parentheses ()

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

relationship is seen to be negative for the 20th and 80th quantiles. On the other hand, the defacto dimension of globalisation is negative for the 20th and 40th and positive for the 60th and 80th quantiles. This indicates that globalisation has a mixed influence on employment. As such, the dimensions of globalisation are critical to substantiate policy appraisal. Actual international flow activities (defacto) reduce employment at the lower quantiles and subsequently increase employment at the upper quantiles. Whereas, policies and conditions that foster international flow indicate an initial negative influence on job creation, which subsequently produces positive outcomes at the middle quantiles and becomes negative at the upper quantiles.

In the same perspective, the labour productivity quantile regression outcome (Table 8) indicates that ICT and the two dimensions of globalisation are all positively related to labour productivity for all four quantiles, but ICT is not statistically significant for the 80th quantile. This result indicates that ICT and globalisation generally affect labour productivity more than employment within the labour market. This is economically insightful since ICT capital flow can directly impact the job market through the creation of new jobs but will relatively take a slower pace to boost productivity.

Conclusion and Policy

This study had as its objective to analyse the effect of ICTs development and globalisation on two dimensions of labour market outcomes (employment and labour productivity). A panel of 33 African economies was selected from

Table 7 Employment regression for quantiles

Variables	(1) Q20	(2) Q40	(3) Q60	(4) Q80
LICT	−0.0205***	0.0419***	0.0745***	0.0247***
	(0.00172)	(0.00572)	(0.0118)	(0.00221)
LGLOBDJ	−0.0222	0.0315	0.171***	−0.298***
	(0.0179)	(0.0326)	(0.0275)	(0.0107)
LGLOBDF	−0.194***	−0.0776***	0.137***	0.0512***
	(0.0111)	(0.0250)	(0.0208)	(0.0104)
LGDPC	−0.108***	−0.131***	0.125***	0.0629***
	(0.00156)	(0.000831)	(0.00322)	(0.00581)
LTFP	−0.0134***	−0.00284***	0.00282***	0.0146***
	(0.000940)	(0.000845)	(0.000936)	(0.000884)
LPOP	1.011***	0.994***	0.999***	0.955***
	(0.00179)	(0.00155)	(0.00718)	(0.00138)
Observations	960	960	960	960
Number of groups	32	32	32	32

Standard errors in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

the period 1990 to 2019. Cross-sectional dependence tests were employed to ascertain the presence of cross-sectional dependence. Due to cross-sectional dependence, second-generation tests for unit root and cointegration were employed. The estimation techniques chosen were the dynamic common correlation approach of Chudik and Pesaran (2015) and the quantile-on-quantile approach proposed by Powell (2015). The result indicates that both ICTs and globalisation play a significant role in the labour market outcome within Africa. The main practical implication from the study is that ICTs and globalisation can be consolidated in order to ameliorate employment stakes in Africa and equally boost productivity generally in Africa. Therefore, to enhance sustainable development goals such as decent jobs and growth, it is paramount for African countries to address concerns that are related to globalisation and investment in the ICT sector. Based on the outcomes and implications, this study recommends that African countries should encourage human capital formation so as to ease the penetration of ICTs in order to boost employment and labour productivity. In addition, African countries should intensify the use of ICTs by accelerating ICT education, good energy quality and reduction of connection costs. Also, we recommend the reduction of entrance barriers to the job market by giving better information of the labour market and professionalise training. Equally, globalisation should be enhanced through policies like reductions in tariff barriers and limited trade restrictions so as to enhance labour market outcomes.

There are some limitations and caveats to this study. Firstly, the study period was limited by data availability. Therefore, for robustness checks, future studies could extend the study period. Equally, for more specific country-level and sub-regional

Table 8 labour productivity regression for quantiles output

Variables	(1) Q20	(2) Q40	(3) Q60	(4) Q80
LICT	0.0180**	0.0304***	0.221***	0.0171
	(0.00750)	(0.00188)	(0.0501)	(0.0240)
LGLOBDJ	1.187***	0.823***	1.303***	1.261***
	(0.239)	(0.0698)	(0.117)	(0.0411)
LGLOBDF	1.728***	2.086***	0.926***	1.771***
	(0.155)	(0.0437)	(0.269)	(0.0710)
LTFP	−0.0982***	−0.0804***	−0.0552***	0.0669
	(0.00202)	(0.00234)	(0.00969)	(0.0503)
LPOP	−0.357***	−0.380***	−0.125***	−0.251***
	(0.00423)	(0.00419)	(0.0239)	(0.00659)
Observations	960	960	960	960
Number of groups	32	32	32	32

Standard errors in parentheses

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

recommendations, future studies could consider country-specific scrutiny and

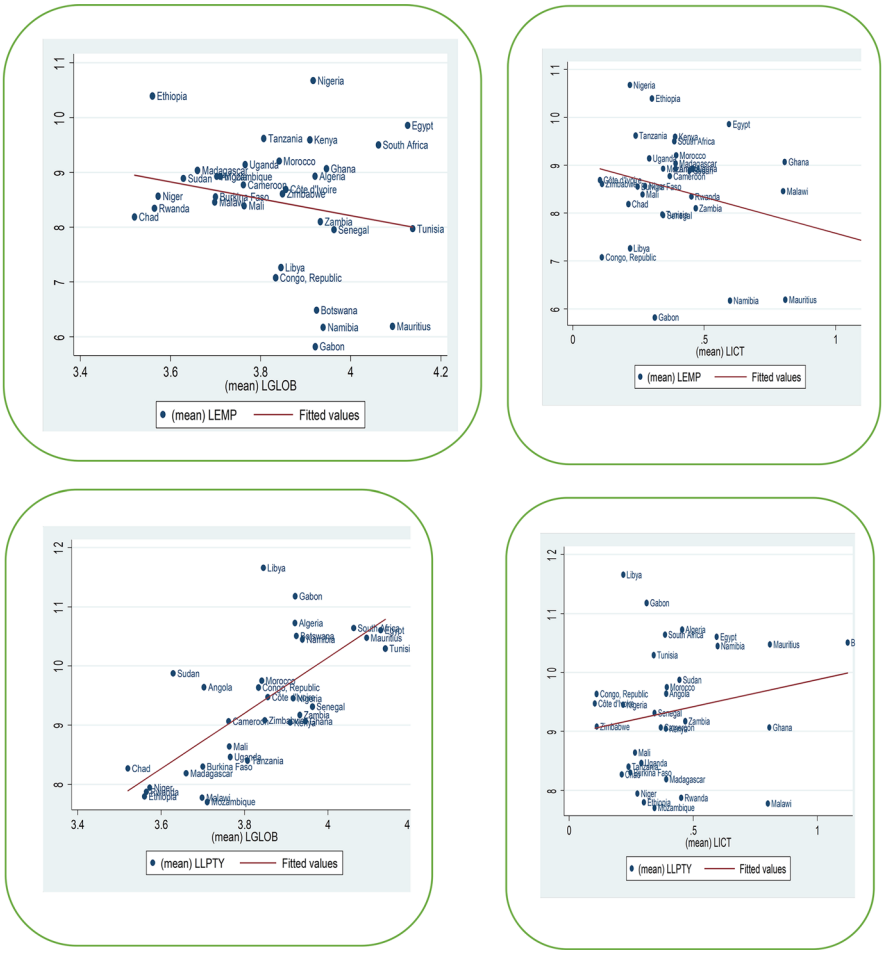

Figure 1 Fitted mean correlation Graph.

sub-regional appraisal within the African context.

Table 9 Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) LEMP	1.000								
(2) LLPTY	−0.428	1.000							
(3) LICT	−0.087	0.098	1.000						
(4) LGLOB	−0.068	0.595	0.147	1.000					
(5) LGLOBDJ	−0.004	0.509	0.175	0.930	1.000				
(6) LGLOBDF	−0.117	0.597	0.097	0.930	0.731	1.000			
(7) LPOP	0.980	−0.316	−0.088	−0.003	0.056	−0.054	1.000		
(8) LGDPC	−0.425	0.981	0.109	0.591	0.502	0.594	−0.348	1.000	
(9) LTFP	0.036	−0.050	0.018	−0.025	−0.021	−0.027	0.031	−0.049	1.000

Appendix 1

Appendix 2

Data Availability Data are from secondary sources that are publicly available.

Declarations

Competing Interests The authors declare no competing interests.

References

Abramova, N., & Grishchenko, N. (2020). ICTs, Labour productivity and employment: Sustainability in industries in Russia. *Procedia Manufacturing, 43*, 299–305.

African Development Bank. (2015). *Annual Report 2015*, www.afdb.org

Ali, S., Yusop, Z., Kaliappan, S. R., & Chin, L. (2020). Dynamic common correlated effects of trade openness, FDI, and institutional performance on environmental quality: Evidence from OIC countries. *Environmental Science Pollution Research, 27*(11671–11682), 1–12. https://doi.org/10.1007/s11356-020-07768-7

Anser, M. K., Ahmad, M., Khan, M. A., Zaman, K., Nassani, A. A., Askar, S. E., ... & Kabbani, A. (2021). The role of information and communication technologies in mitigating carbon emissions: evidence from panel quantile regression. *Environmental Science and Pollution Research, 28*, 21065–21084.

Arain, H., Han, L., & Meo, M. S. (2019). Nexus of FDI, population, energy production, and water resources in south Asia: A fresh inside from dynamic common correlation effects (DCCE). *Environmental Science and pollution research, 26*(7), 27128–27137.

Aremo, A. G., & Alagbile, M. A. (2010). Empirical analysis of the impact of globalisation on labor force utilization: Evidence from Nigeria. *African Economic and Business Review, 8*(1), 1–18.

Asongu, S. A., & Asongu, N. (2019). The role of mobile phones in governance-driven technology exports in Sub-Saharan Africa. *Journal of the Knowledge Economy, 10*(2), 849–867.

Asongu, S. A., & Odhiambo, N. M. (2020). Inequality and gender inclusion: Minimum ICT policy thresholds for promoting female employment in Sub-Saharan Africa. *Telecommunications Policy, 44*(4), 101900.

Asongu, S. A., & Odhiambo, N. M. (2020). The mobile phone, information sharing, and financial sector development in Africa: A quantile regression approach. *Journal of the Knowledge Economy, 11*(3), 1234–1269.

Attewell, P., & Rule, J. (1984). Computing and organizations: What we know and what we don't know. *Communications of the ACM, 27*(12), 1184–1192.

Aydiner-Avsar, N., & Onaran, Ö. (2010). The determinants of employment: A sectoral analysis for Turkey. *The Developing Economies, 48*(2), 203–231.

Basu, S. (2007). *Global perspectives on e-commerce taxation law* (1st ed.). London: Routledge. https://doi.org/10.4324/9781315584973

Biagi, F., & Falk, M. (2017). The impact of ICT and e-commerce on employment in Europe. *Journal of Policy Modeling, 39*(1), 1–18.

Bowles, J. (2014) Chart of the Week: 54% of EU jobs at risk of computerisation. Bruegel. org, website http://bruegel.org/2014/07/chart-of-the-week-54-of-eu-jobs-at-risk-of-computerisation/, accessed March, 4, 2018.

Castro, C., & Lopes, C. (2021). Digital government and sustainable development. *Journal of the Knowledge Economy, 13*(2), 1–24.

Chowdhury, S. K., & Wolf, S. (2003). *Use of ICTs and the economic performance of SMEs in East Africa (No.2003/06)*. WIDER Discussion Paper, Helsinki.

Chudik, A., & Pesaran, M. H. (2015). Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. *Journal of Econometrics, 188*(2), 393–420.

Dauth, W., Findeisen, S., & Suedekum, J. (2021). Adjusting to globalization in Germany. *Journal of Labor Economics, 39*(1), 263–302.

David, O. O., & Grobler, W. (2020). Information and communication technology penetration level as an impetus for economic growth and development in Africa. *Economic research-Ekonomska istraživanja, 33*(1), 1394–1418.

De Wet, W., Koekemoer, E., & Nel, J. A. (2016). Exploring the impact of information and communication technology on employees' work and personal lives. *SA Journal of Industrial Psychology, 42*(1), 1–11.

Dinga, G. D., Fonchamnyo, D. C., & Achuo, E. D. (2021). Primal–dual approach to environmental Kuznets curve hypothesis: A demand and supply side analyses of environmental degradation. *Environmental Science and Pollution Research, 29*(11), 16484–16502.

Ditzen, J. (2016). *Xtdcce: Estimating dynamic common correlation effects in STATA*. In United Kingdom Stata Users Group meetings 2016(NO. 08), Stata Users. http://repec.org/usug2016/ditzen_uksug16

Dreher, A. (2006). Does globalization affect growth? Evidence from a new index of globalization. *Applied Economics, 38*(10), 1091–1110.

Dua, P., & Garg, N. K. (2019). Determinants of labour productivity: Comparison between developing and developed countries of Asia-Pacific. *Pacific Economic Review, 24*(5), 686–704.

Edquist, H., & Henrekson, M. (2017). Do R&D and ICT affect total factor productivity growth differently? *Telecommunications Policy, 41*(2), 106–119.

El Aynaoui, K., Ibourk, A., & Loungani, P. (2019). Making globalization Inclusive: Job creation and wage inequality in developing economies. *Open Economies Review, 30*(5), 837–840.

Elsner, D. (2021). Where can companies find opportunities in Africa?. https://yeutter-institute.unl.edu/student-pdfs/Elsner-briefingpaper-01272021.

Fernández-Portillo, A., Almodóvar-González, M., & Hernández-Mogollón, R. (2020). Impact of ICT development on economic growth. A study of OECD European union countries. *Technology in Society, 63*, 101420.

Fonchamnyo, D. C., Emmanuel, O. N. B., & Dinga, G. D. (2022). The effects of trade, foreign direct investment, and economic growth on environmental quality and overshoot: A dynamic common correlation effects approach. *SN Business & Economics, 1*(10), 1–27.

Frey, C. B., & Osborne, M. (2013). *The future of employment*. Oxford Martin School. https://www.oxfordmartin.ox.ac.uk/

Greenaway, D., Robert, C., & Wright, P. (1999). An empirical assessment of the impact of trade on employment in the United Kingdom. *European Journal of Political Economy, 15*(3), 485–500.

Gygli, S., Haelg, F., Potrafke, N., & Sturm, J. E. (2019). The KOF globalisation index–revisited. *The Review of International Organizations, 14*, 543–574.

Haini, H., & Wei Loon, P. (2022). Information communication technologies, globalisation and growth: Evidence from the ASEAN economies. *Economic Papers: A Journal of Applied Economics and Policy, 41*(1), 34–53.

Hoekman, B., & Winters, L. A. (2005). *Trade and employment: Stylised facts and research findings (Working Paper #3676)*. World Bank Policy Research Working Papers. https://ideas.repec.org/p/wbk/wbrwps/3676.html

International labour Organization ILO, (2020). Report on employment in Africa (Re-Africa) Tackling the youth employment challenge–International Labour Office : ILO, 2020.

Internet World Statistics (IWS, 2021). Usage and population statistics. Retrieved https://www.internetworldstats.com/stats1.htm

ITU. (2019). *Telecom World report*, 2019. https://www.itu.int/en/ITUTELECOM/Pages/world2019.aspx

Jessop, B. (2002). *The future of the capitalist state* (p. 2002). Polity Press.

Jørgensen, S., Kort, P. M., & Dockner, E. J. (2006). Venture capital financed investments in intellectual capital. *Journal of Economic Dynamics and Control, 30*(11), 2339–2361.

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2010) *Worldwide Governance Indicators*. World Bank Group.

Kazeem, Y. (2019). *The biggest trends in African tech and startups in 2019*. Quartz Africa. https://qz-com.translate.goog/africa/1777241/the-biggest-trends-in-african-techstartups-and-innovation-2019?

Kılıçaslan, Y., & Töngür, Ü. (2018). *The use of ICT and employment generation.* The Economic Research Forum(ERF).

Kurt, S., & Kurt, Ü. (2015). Innovation and labour productivity in BRICS countries: Panel causality and co-integration. *Procedia-Social and Behavioral Sciences, 195*, 1295–1302.

Lefophane, M. H., & Kalaba, M. (2021). Estimating effects of ICT intensity on productivity, employment and output in South Africa: An industry-level analysis. *Information Technology for Development, 28*(2), 346–371.

Marx, K. (1961). *Capital* (1st ed., pp. 748–749). Moscow: Foreign LanguagesPublishing House.

Mavodyo, E. (2022). What makes economic globalisation work for sub-Saharan Africa? *Development Southern Africa*, 1–16. https://doi.org/10.1080/0376835X.2022.2042198

Metu, A. G., Ajudua, E., Eboh, I., Ukeje, C., & Madichie, C. (2020). Ending youth unemployment in sub-saharan Africa: Does ICT development have any role? *African Development Review, 32*, S20–S31.

Milner, C., & Wright, P. (1998). Modelling labour market adjustment to trade liberalisation in an industrialising economy. *Economic Journal, 108*(447), 509–528.

Müller, P. (2021). Impacts of inward FDIs and ICT penetration on the industrialisation of Sub-Saharan African countries. *Structural Change and Economic Dynamics, 56*, 265–279. https://doi.org/10.1016/j.strueco.2020.12.0

Musti, B. M. (2018). Impact of globalisation on employment in Nigeria. *International Economic Journal, 32*(1), 43–52.

Näätänen, A. M. (2015). The impact of economic globalization on the employment policies in 19 western democracies from 1985 to 2010. Limited change or radical shift towards workfare? *Social Sciences, 4*(3), 700–717.

Nasab, E. H., & Aghaei, M. (2009). The effect of ICT on economic growth: Further evidence. *International Bulletin of Business Administration, 5*(2), 46–56.

Ndubuisi, G., Otioma, C., & Tetteh, G. K. (2021). Digital infrastructure and employment in services: Evidence from Sub-Saharan African countries. *Telecommunications Policy, 45*(8), 102153.

Neal, T. (2015). *Estimating heterogeneous coefficients in panel data models with endogenous regressors and common factors*. Work blacking paper. University of South Wales. http://www.uq.edu.au/economics/PHD2015/

Niebel, T. (2018). ICT and economic growth–Comparing developing, emerging and developed countries. *World Development, 104*, 197–211.

Odongo, A. O. (2015). Research on ICT development in Africa countries focusing on benefits, trends, challenges, and solutions. *Computing in Research and Development in Africa*, 143–176. https://doi.org/10.1145/2691195.2691226

Ofori, I. K., & Asongu, S. A. (2021). ICT diffusion, foreign direct investment and inclusive growth in Sub-Saharan Africa. *Telematics and Informatics, 65*, 101718.

Okumu, I. M., & Buyinza, F. (2018). Labour productivity among small-and medium-scale enterprises in Uganda: The role of innovation. *Journal of Innovation and Entrepreneurship, 7*(1), 1–17.

Peng, G., Wang, Y., & Han, G. (2018). Information technology and employment: The impact of job tasks and worker skills. *Journal of Industrial Relations, 60*(2), 201–223.
Pesaran, M. H. (2003). Simple panel unit root test in the presence of cross section dependence. In *University of Cambridge, Faculty of Economics (DAE)*. Cambridge Working Papers in Economics 0346.
Pesaran, M. H. (2004). *General diagnostic tests for cross section dependence in panels* (Cambridge working papers in economics, no. 435; CESifo working paper, no. 1229). https://docs.iza.org/dp1240
Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Economics, 22*(2), 265–312.
Pesaran, M. H. (2015). Testing weak cross sectional dependence in large panels. *Econometric reviews, 34*, 1089–1117.
Powell, D. (2015). *Quantile regression with nonadditive fixed effects*. RAND labor and population working paper. http://works.bepress.com/david_powell/1/
Rama, M. (2003). *Globalization and workers in developing countries*. World Bank Policy Research Working Paper No. 2958.
Relich, M. (2017). The impact of ICT on labor productivity in the EU. *Information technology for development, 23*(4), 706–722.
Rodrik, D. (1998). Why do more open economies have larger governments? *Journal of Political Economy, 106*, 997–1932.
Saba, C. S., & Ngepah, N. (2021). ICT Diffusion, industrialisation and economic growth nexus: An international cross-country analysis. *Journal of the Knowledge Economy, 13*(3), 2030–2069.
Schumpeter, J. A. (1939). *Business cycles* (Vol. 1, pp. 161–174). New York: Mcgraw-hill.
Simon, H. A. (1960). The new science of management decision. In *l'Université du Michigan, Volume 3 de Ford distinguished lectures*. psycnet.apa.org
Song, S. (2016). Africa Telecoms Infrastructure in 2015. *Many Possibilities, 13*.
UNDP (United Nations Development Programme). (2016). *Goal 9: Industry, innovation and infrastructure*.New York: UNDP. https://www.globalgoals.org/
Waverman, L., Meschi, M., & Fuss, M. (2005). Africa: The impact of mobile phones. *The Vodafone Policy Paper Series, 15*(2), 16–30.
Westerlund, J. (2007). Testing for error correction in panel data. *Oxford Bulletin of Economics and Statistics, 69*, 709–748.
Wood, A. (1995). How trade hurt unskilled workers. *Journal of Economic perspectives, 9*(3), 57–80.
Yeo, B. J. (2010). Driving the knowledge economy: Explaining the impact of regional innovation capacity on economic performance. *Contemporary Management Research, 6*(1).