Information Technology for Development

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/titd20

The criticality of ICT-trade nexus on economic and inclusive growth

Bosede Ngozi Adeleye , Festus Adedoyin & Solomon Nathaniel

To cite this article: Bosede Ngozi Adeleye , Festus Adedoyin & Solomon Nathaniel (2020): The criticality of ICT-trade nexus on economic and inclusive growth, Information Technology for Development, DOI: 10.1080/02681102.2020.1840323

To link to this article: https://doi.org/10.1080/02681102.2020.1840323

Published online: 03 Nov 2020.

INFORMATION TECHNOLOGY FOR DEVELOPMENT
https://doi.org/10.1080/02681102.2020.1840323

Routledge
Taylor & Francis Group

The criticality of ICT-trade nexus on economic and inclusive growth

Bosede Ngozi Adeleye [a,b,c], Festus Adedoyin [d] and Solomon Nathaniel [e]

[a]Department of Economics and Development Studies, Covenant University, Ota, Nigeria; [b] Regional Centre of Expertise (RCE) Ogun, Ota, Nigeria; [c]Centre for Economic Policy and Development Research (CEPDeR), Covenant University, Ota, Nigeria; [d]Department of Accounting, Finance and Economics, Bournemouth University, Poole, UK; [e]Department of Economics, University of Lagos, Lagos, Nigeria

ABSTRACT

This paper contributes to the ICT-growth and trade-growth literature by investigating the ICT-trade nexus on economic and inclusive growth. That is, does ICT adoption enhance or distort the impact of trade on growth? With data on 53 African countries from 2005 to 2015 using mobile phones and fixed telephone subscriptions as indicators of ICT, findings provide evidence that (1) trade is a significant and positive predictor of growth, (2) the impact of trade on growth differs significantly across Africa's sub-regions, (3) the effect of ICT adoption differs significantly across sub-regions, (4) ICT innovation enhances the impact of trade on growth, and (5) the ICT-trade nexus differ significantly across sub-regions. The study submits that these variables are critical drivers of economic and inclusive growth in Africa. However, the lack of consistency of the results across the sub-regions suggests that the level of ICT is still undeveloped. Policy implications are discussed.

KEYWORDS

Economic growth; inclusive growth; human development index; trade openness; ICT

JEL CODES

C32; E13; E22; F14; F43; J24; O3; O11; O43; O47

1. Introduction

Economic growth in developing countries is contingent of many factors and information technology and foreign direct investment are chief among these (Adom et al., 2019; Boamah, 2017; Dunne & Masiyandima, 2017; Fanta & Makina, 2017; Gui-Diby, 2014). However, ICT is a more contemporary driver of growth compared to foreign direct investment (Donou-Adonsou, 2019; Myovella et al., 2020). From the leapfrogging hypothesis of Steinmueller (2001), developing and emerging economies can use information and communication technology (ICT) to *leapfrog* developmental stages (Adeleye & Eboagu, 2019; Niebel, 2014; Tallon & Kraemer, 2000). Recent literature (Adeleye & Eboagu, 2019; Albiman & Sulong, 2016; Minkoua Nzie et al., 2018) support the growth-enhancing function of ICT in Africa and surmise that information technology can lead to macroeconomic gains in the form of positive externalities (Ejemeyovwi & Osabuohien, 2018; Gosavi, 2018; Issahaku et al., 2018).

Correspondingly, ICT has shown to have a substantial impact on socio-economic development (Roztocki et al., 2019) and has significantly transformed individuals, organizations and societal relationships (Lee et al., 2018). With socio-economic development anchoring on the three pillars of human development index (HDI): life expectancy index, education index, and standard of living, it is sufficient to mention that ICT impacts on inclusive growth (Roztocki et al., 2017; Sein

CONTACT Bosede Ngozi Adeleye ngozi.adeleye@covenantuniversity.edu.ng ; PMB 112233, Ota, Ogun State, Nigeria; https://cruncheconometrix.com.ng

Heinz Roland Weistroffer is the accepting Associate Editor for this paper.

et al., 2018). Recent literature captures the relationship between ICT and inclusive growth concisely: health outcomes and well-being (Mengesha & Garfield, 2019; Palvia et al., 2018), culture and social beliefs (Ashraf et al., 2017; Roztocki & Weistroffer, 2016), well-being and poverty alleviation (Madon, 2000), education and growth of small businesses (Palvia et al., 2018), human capital and business growth (Kowal et al., 2019); capacity development (Jacobs et al., 2019); education and teaching methods (Donou-Adonsou, 2019; Stal & Paliwoda-Pękosz, 2019); governance and citizen trust (Mahmood et al., 2019); e-business processes (Rondović et al., 2019); and business environment and performance (Chowdhury, 2006; Lech, 2019).

Similarly, the theoretical literature is inundated with studies that emphasize the benefits of trade openness on economic growth, but its impact is still an open discourse among researchers. Significant findings from the literature (Calderon et al., 2004; Chang et al., 2009; Fetahi-Vehapi et al., 2016) reveal that open economies are more productive than countries which only produce for the domestic market. Since trade openness is a catalyst for productivity and growth, its impact is contingent on its weight on economic activity. A range of empirical studies (Dollar & Kraay, 2004; Frankel & Romer, 1999; Sachs & Warner, 1995) documented that trade and economic growth exhibit a positive relationship. For instance, from a sample of 122 countries, Sachs and Warner (1995) assess the impact of trade on growth and conclude that open economies exhibit higher growth patterns than protectionist economies.

Similarly, Frankel and Romer (1999) from a sample of 63 countries show that trade openness generates higher income levels. Likewise, Dollar and Kraay (2004) reveal that greater trade openness which is measured by trade volume yields increased growth rates. Besides, international trade encourages the efficient distribution of resources which precipitates higher growth that may be transformed into greater productivity, most especially to those countries associated with technology diffusion and knowledge spillovers. Empirical findings on the impact of trade on inclusive growth are mixed. While some studies show that trade improves socio-economic development (Dollar & Kraay, 2004; Hartmann & Hidalgo, 2017; Nourzad & Powell, 2003; Razmi & Yavari, 2012), others argue that trade distorts economic structures by tilting employment to skilled labor and capital which widens inequality gap (Jawaid & Waheed, 2017; Melitz, 2003; Milanovic & Squire, 2005).

This investigation becomes germane with ICT innovations sprouting across the globe. International trade is facilitated from several hi-tech channels which have made it easy to initiate and execute business deals across borders within the comforts of homes and offices. Hence, two crucial empirical incursions are made. (1) The documented evidence on the impact of trade and ICT on economic growth reveals a lacuna in the literature, which to the best of knowledge, has not been addressed. That is, does ICT adoption boost or distort the impact of trade on growth? (2) This paper enhances Roztocki et al. (2019) by interacting two of the four mentioned frameworks – the technological and business frameworks to understand the *total* or overall impact of trade on inclusive growth.

To address these gaps in the ICT-growth and trade-growth literature, a sample of 53 African countries from 2005 to 2015 is used. The variables of interest are gross domestic product (a measure of economic growth), human development index (a proxy for inclusive growth), trade openness, mobile phone and fixed telephone subscriptions (as ICT indicators). This study attempts to answer four questions: (1) Does trade and ICT adoption significantly promote growth[1]? (2) Is the interaction of trade and ICT adoption significant to promote growth? (3) Does the effect of trade and ICT adoption significantly differ across Africa's sub-regions? (4) Is the moderating impact of ICT adoption on trade significantly different across the sub-regions? The empirical investigation employs the bootstrapping least squares dummy variables method (fixed effects) and dynamic one-step difference generalized method of moments technique. Our findings, for the most part, align with previous studies, but the novel contribution is that ICT enhances the impact of trade on both economic and inclusive growth in Africa. Other results suggest that across the five sub-regions, the ICT-trade nexus on growth significantly differs. The rest of the paper is structured as

follows: Section 2 reviews the extant literature; Section 3 presents the data and empirical approach; Section 4 discusses the results, and Section 5 concludes with policy recommendations.

2. Brief literature review

This section undertakes a brief review of related studies from two empirical standpoints: trade-growth and ICT-growth relations. Extensive work on the impact of trade and ICT on economic and inclusive growth has been covered in the literature howbeit with mixed results which are not unconnected to the scope of the study, indicators of ICT used, measures of trade openness, and empirical technique(s).

2.1. Trade-growth relation

Hypothetically, the literature on growth and international trade reveals that the latter stimulate long-term growth. That is, trade is an essential ingredient in the development path of many countries with increasingly significant impact on economic growth. Some strand of the literature finds that openness has a positive impact on economic growth (Keho, 2017; Kong et al., 2020; Kpomblekou & Wonyra, 2020; Manwa et al., 2019; Salahuddin & Gow, 2016; Zahonogo, 2016). For instance, Kong et al. (2020) investigate the role of trade on economic growth in China for the period 1994–2018 using the ARDL estimator. Trade openness exerts a positive impact on the country's growth, while an '*N*-type' relation was discovered between growth and trade openness.

Similarly, Chang et al. (2009) posit that the positive association between growth and trade may be significantly improved if complementary policies are undertaken. Also, Manwa et al. (2019) examine the influence of trade liberalization on economic growth in five Southern Africa countries adopting four trade liberalization indicators (tariff, trade ratio, real interest rate, and adjusted trade ratios). This study is novel compared to other similar studies on African countries. Their findings suggest that trade liberalization has very little influence on the economic growth of Swaziland, South Africa, Namibia, Lesotho, and Botswana over the last thirty years.

Calderon et al. (2004) find that trade has a positive impact on growth in high-income countries but does not exhibit similar growth effect in countries with low per capita income. Similarly, Salahuddin and Gow (2016) discover that openness to trade has been instrumental in the growth trajectory of South Africa from 1991 to 2013. The study further alluded to the fact that apart from trade openness; financial development and internet usage are essential to economic expansion in South Africa. The country may need to expand internet infrastructure and trade in order to sustain growth. Also, Freund and Bolaky (2008), using a sample of 126 countries submit that openness exerts a positive impact on per capita GDP. Their outcomes show that trade leads to higher standards of living in flexible economies, but not in rigid economies (Razmi & Yavari, 2012). Likewise, Zahonogo (2016) used the pooled mean group (PMG) estimator to explore the effect of trade on economic growth in 42 SSA countries from 1980 to 2012 and reported that trade openness has a positive impact on growth in one group and a negative relationship in another with subsequent distortion in income distribution (Adhikary, 2011; Jawaid & Waheed, 2017). Another strand finds that openness to trade has no impact on growth (Eriș & Ulașan, 2013; Were, 2015).

2.2. ICT-growth relation

Donou-Adonsou (2019) explores the influence of telecommunication infrastructure on economic growth in 45 SSA countries. The study divided SSA countries into two groups: those that have access to better education and those who do not. The findings suggest that the internet drives economic growth in the former, but there is no substantial evidence that the same could be valid for the latter. The study concludes that education is necessary for internet usage, but may not be relevant for mobile phone usage. In the same vein, Myovella et al. (2020) use the GMM estimator to examine

the effect of digitalization on economic growth in 74 countries encompassing SSA and Organisation for Economic Cooperation and Development (OECD) countries. The findings from the study reveal that digitalization is the fulcrum of growth in both SSA and OECD countries. However, the impact of mobile telecommunication on economic growth was high in SSA compared to OECD countries, while the influence of broadband internet was minimal in SSA than OECD countries. Lastly, as elucidated in the introductory part of this paper, ICT has impacted the three dimensions of human development index which symbolizes inclusive growth (Roztocki et al., 2019; Roztocki & Weistroffer, 2016).

Similarly, Adeleye and Eboagu (2019) using a sample of 54 countries from 2005 to 2015, estimate the relationship between ICT and economic growth. Employing a pooled ordinary least squares, random and fixed effects and system generalized method of moments models and further dividing the sample across five regions, the study showed a positive relationship between the ICT variables and economic growth. In particular, mobile subscriptions had a higher output elasticity than fixed telephone subscriptions across all estimated models. The study concluded that mobile telecommunication could enable Africa to skip the traditional development phases. Equally, Ejemeyovwi and Osabuohien (2018) apply the GMM technique to investigate the effect of mobile technology on economic growth in 15 Africa countries from 2004 to 2014. Surprisingly, the outcomes indicate that mobile technology has no meaningful impact on economic growth in Africa. However, the authors believe that the slow adoption of ICT in most African countries could be responsible for the insignificant impact of ICT on economic growth in the region. They call for an improvement in mobile technology to enhance economic growth in Africa.

Furthermore, Gruber and Koutroumpis (2011) using annual data from 192 countries covering the period 1990–2007 found that mobile telecommunications stimulate economic growth. Furthermore, the study shows that the contribution of telecommunication to GDP growth differed according to country income level as telecom contribution to annual GDP growth was 0.11% for low-income countries and 0.20% for high-income countries. Likewise, Ward and Zheng (2016) from a panel of 31 regions in China for the period 1991–2010 find that telecommunication is an essential contributor to economic growth in China. The study which employs a system GMM, apart from showing that mobile telecommunication had a more significant impact on growth than fixed telecommunication also reported regional variations in the impact of telecommunication on economic growth across the country.

3. Data and model

The study engages a panel data on 53 African countries from 2005 to 2015. On the need to allow more countries for a considerable representation of the continent[2], the scope is restricted to the start date of 2005, which becomes justifiable as most African countries show substantial loss of ICT data in pre-2005 years. Also, in evaluating the ICT-trade nexus on economic and inclusive growth, it becomes intrinsic to appraise this relationship alongside each sub-region. Hence, the full sample is split into five sub-samples across regional delineations[3] – Central Africa, East Africa, North Africa, Southern Africa and West Africa.

3.1. The variables

In line with similar studies, the indicator of economic growth is the gross domestic product (constant 2010 US$) (*GDP*); human development index (*HDI*) is the proxy for inclusive growth; trade openness (*TRADE*) captures a country's trading activities in the global market; two indicators of ICT adoption used are: mobile cellular subscription (*MOBILE*) and fixed telephone subscription (*TEL*). Individuals using the internet (% of population) (*INTERNET*) is included as a control variable (and not as an indicator of interest) because the internet is an enabler particularly for mobile phone users engaging in foreign trade. Other control variables are gross fixed capital formation (*GFCF*); and labor participation

rate (*LABOUR*). Inflation rate (*INFL*) is included for robustness checks. Lastly, interaction terms of trade and mobile phone subscription *(TRADE*MOBILE)* and trade and fixed telephone subscription *(TRADE*TEL)* are included to address the study questions. *HDI* is obtained from UNDP (2019) while the rest of the variables are sourced from World Bank (2019) World Development Indicators (WDI).

The indicators of economic growth, inclusive growth, trade openness, and ICT have been broadly expounded in the introduction and literature review sections, and in line with *a priori*, positive coefficients are expected for trade openness and ICT indicators. Other variables are explained in brief. *Gross fixed capital formation* measures the stock of fixed investment which comprises a net increase in physical assets within the measurement period. From Romer (1986) and Solow (1956), physical capital accumulation is an essential determinant of growth, and firms accumulate know-how through capital accumulation which can produce growing returns and promote economic growth. Also, this variable is included because a country that is open to international trade will require some level of absorptive capacity to produce, which in turns affects economic growth. Therefore, in line with expectation, a positive coefficient is envisaged.

Labour force participation rate is the proportion of the population age 15 and older that is economically active. Skilled labor is required for production, and it is an essential ingredient for growth (Jacobs et al., 2019; Jawaid & Waheed, 2017). More skilled labor engaged to handle machineries for production is an impetus for growth, but unskilled and untrained will be a drag on growth (Fetahi-Vehapi et al., 2016). Hence, the expected sign in indeterminate.

Internet usage is an enabler of global connectivity (Adeleye & Eboagu, 2019; Madon, 2000). This variable is included because to enhance trade across borders, persons require to have an internet connection on their mobile phones. Internet access can be via computers, internet-enabled mobile phones, digital television, and game machines such that business can be initiated and concluded with ease and within the comforts of homes and offices without having to travel to conclude such deals. A positive coefficient is expected upon estimation.

The study conjectures that trade, mobile phone and fixed telephone subscription is expected to positively impact economic growth, therefore, the interaction of trade and mobile phone usage *(TRADE*MOBILE)* and trade and fixed telephone subscription *(TRADE*TEL)* are also expected to be favorable to enhance the *total* impact of trade openness on economic growth. Lastly, rising price level, *inflation*, may have adverse consequences on the economy. Hence, a negative coefficient is expected.

3.2. Summary statistics and correlation analysis

Table 1 shows the statistics for the full and sub-regions. With the emphasis on the indicators of interest, the average GDP for the continent is US$34.9billion. Sao Tome and Principe shows the lowest in 2011 with US$126million while Nigeria has the highest at US$547billion in 2014. Across the sub-regions, the mean GDP value ranges between US$13.7billion (East Africa) and US$93.9billion (North Africa). On HDI, the average index for the region is 0.500, and the standard deviation of 0.11 indicates that the sub-regions hover around the sample mean. Among the sub-regions, North Africa has the highest average index of 0.63 and West Africa shows the lowest index of 0.45. Comparing Africa's HDI's statistics with the rest of the world (see Appendix Table A2) reveals that the region is below the world average of 0.697 confirming that socio-economic development in Africa is relatively low.

The mean trade value is 79.27. Data reveals that Southern Africa has the highest average trade openness (% of GDP) with 89.874, and Central Africa recorded the lowest with 73.84. The continent's average for mobile phone usage is 10.3million. Across the sub-regions, West Africa records the highest average mobile subscribers at 23.9million, followed by North Africa with 23.6 m users. Southern Africa has the highest average fixed telephone subscription, while the highest average for internet users is from North Africa. On average, gross fixed capital formation (% of GDP) which is highest in North Africa at 26.65, which is higher than the continent's average of 22.26. The

Table 1. Summary statistics.

	Total		Central Africa		East Africa	
Variables	Mean	SD	Mean	SD	Mean	SD
GDP	3.51E+10	7.54E+10	2.19E+10	2.84E+10	1.38E+10	1.40E+10
HDI	0.509462	0.112615	0.485091	0.101495	0.500797	0.094147
GFCF	22.34793	8.863339	22.37035	9.994872	22.09682	8.245295
LABOUR	67.60905	12.84562	72.45199	10.73972	73.56689	11.41366
INFLATION	53.12296	1030.434	8.324217	8.864306	199.1539	2101.628
TRADE	79.28849	38.21159	73.58401	32.80395	78.87396	44.57692
INTERNET	10.3229	12.37034	6.31319	7.085187	10.11988	12.5329
MOBILE	1.05E+07	1.89E+07	4269375	7057565	7531632	9846378
TEL	550619.1	1493043	193723.5	306248.6	107774.1	136948.2
	North Africa		South Africa		West Africa	
Variables	Mean	SD	Mean	SD	Mean	SD
GDP	9.39E+10	7.79E+10	4.40E+10	1.03E+11	2.96E+10	8.97E+10
HDI	0.631597	0.104145	0.551384	0.117967	0.449182	0.07467
GFCF	26.6503	9.419201	22.37391	7.238429	20.6741	8.794349
LABOUR	48.14523	3.186839	68.50589	13.10669	68.87922	8.456939
INFLATION	7.170792	7.217981	7.585632	4.53417	5.745547	6.846131
TRADE	76.11972	28.08454	89.87432	23.82406	78.09845	44.10526
INTERNET	21.06728	15.54834	11.70773	12.8682	7.173768	9.668342
MOBILE	2.36E+07	2.38E+07	9156587	1.85E+07	1.13E+07	2.39E+07
TEL	2485757	3039276	639786.1	1419525	167437.7	269320.5

Notes: For example: 3.51E+10 = 35,100,000,000.00; GDP: Gross domestic product; HDI: Human development index; GFCF: Gross fixed capital formation; TEL: Fixed telephone subscription.
Source: Authors' Computations.

lowest average value is recorded for West Africa at 20.67. The continent's average labor participation rate is 67.35. North Africa indicates the lowest with 48.15 while the highest is Central Africa with 72.45.

Table 2 details the pairwise correlation, which measures the relative association among the regressors and dependent variables. Except for gross fixed capital formation (*GFCF*) and inflation, the regressors have statistically significant relationships with economic growth howbeit with varying signs. Similar to all having statistically significant association with *HDI* except for inflation. A cursory look at Table 2 indicates no presence of multicollinearity among the covariates as all correlation statistics are below 0.75.

3.3. The model

To address the questions of whether trade openness has a significant impact on economic and inclusive growth and if its impact is influenced or hampered by ICT adoption, this paper adopts the empirical approach of Adeleye and Eboagu (2019) and specifies each dependent variable as a linear function of trade openness, ICT indicators (*MOBILE* and *TEL*) and other control variables. The ICT-trade nexus is represented by the interaction of trade with each ICT indicator and the explicit form of the models are specified as:

$$\ln Y_{it} = \xi_0 + \xi_1 \ln TRADE_{it} + \xi_2 \ln MOBILE_{it} + \xi_3 \ln(TRADE{*}MOBILE)_{it} + \xi_4 \boldsymbol{Z}'_{it} + \omega_i + \lambda_t + e_{it} \quad (1)$$

$$\ln Y_{it} = a_0 + a_1 \ln TRADE_{it} + a_2 \ln TEL_{it} + a_3 \ln(TRADE{*}TEL)_{it} + a_4 \boldsymbol{X}'_{it} + \eta_i + \delta_t + v_{it} \quad (2)$$

Where Y_{it} represents the dependent variables (economic and inclusive growth); $\ln MOBILE_{it}$, and $\ln TEL_{it}$ are the natural logarithms of ICT innovation (mobile subscription and fixed telephone subscribers); $\boldsymbol{Z}'_{it}$ and $\boldsymbol{X}'_{it}$ are the vectors of control variables (internet usage, gross fixed capital formation, labor participation) in natural logarithms; ω_i and η_i indicate country dummies; λ_t and δ_t represent year dummies (which controls for common shocks such as the global financial crises of 2008–2009), and e_{it} and v_{it} are the general error terms.

Note, the signs of the coefficients of the interaction terms, ξ_3 and a_3 evaluate if the interaction of ICT adoption (mobile phone usage and fixed telephone subscription) on trade enhances or distorts the impact of trade on economic growth. A positive sign indicates that ICT boosts trade performance on growth and vice versa. The total effect of trade on growth given mobile phone usage is computed as:

$$\frac{\partial \ln Y}{\partial \ln TRADE} = \xi_1 + \xi_3 \ln MOBILE \quad (3)$$

Table 2. Correlation matrix.

Variables	GDP	HDI	GFCF	LAB	INFL	TR	INT	MOB	TEL
GDP	1.000								
HDI	0.496***	1.000							
GFCF	0.077	0.240***	1.000						
LABOUR	−0.353***	−0.483***	−0.0687	1.000					
INFLATION	−0.0273	−0.0324	−0.170***	0.0613	1.000				
TRADE	−0.149**	0.336***	0.202***	−0.156***	0.0184	1.000			
INTERNET	0.500***	0.749***	0.186***	−0.408***	−0.0209	0.0761	1.000		
MOBILE	0.827***	0.275***	0.0712	−0.189***	−0.0354	−0.260***	0.488***	1.000	
TEL	0.767***	0.527***	0.0705	−0.413***	0.0277	−0.151**	0.532***	0.685***	1.000

Notes: *** and ** represent statistical significance at the 0.1% and 1% levels, respectively, GDP: Gross domestic product; HDI: Human development index; GFCF: Gross fixed capital formation; LAB: Labour; TR: Trade; INF: Inflation; INT: Internet usage; MOB: Mobile subscription; TEL: Fixed telephone subscription.
Source: Authors' Computations.

Similarly, the total effect of trade on growth given telephone users is expressed as:

$$\frac{\partial \ln Y}{\partial \ln TRADE} = a_1 + a_3 \ln TEL \tag{4}$$

So, if ξ_3, $a_3 > 0$ it implies that ICT innovation is an enhancer of trade on growth. However, if ξ_3, $a_3 < 0$, the overall impact of trade on growth depends on the magnitude of the negative. If the negative sign of ξ_3, a_3 outweighs the positive sign of ξ_1, a_1 then ICT innovation distorts the impact of trade on growth. On the contrary, if the negative sign of ξ_3, a_3 is less than the positive sign of ξ_1, a_1 it implies that the distortionary influence of ICT is not sufficient to inhibit the positive effect of trade on growth. Finally, if ξ_3, $a_3 = 0$ it is an indication that the interaction of ICT innovation with trade has no significant impact on growth.

To methodically draw the significance of trade and ICT innovation on growth, the study adopts the use of static and dynamic models. Similar studies use these estimation approaches (Niebel, 2014; Adeleye & Eboagu, 2019). The static technique is the bootstrapped least squares dummy variables (*LSDV*) technique, also known as 'fixed effects' that account for heterogeneities across the panels using dummy variables. At the same time, the dynamic model is the Arellano and Bond (1991) one-step difference generalized method of moments (*difference-GMM*) estimator technique[4] Which corrects for endogeneity, cross-sectional dependence, serial correlation and heteroscedasticity by including instruments that are uncorrelated with the regressors in the underlying routine during estimation. Another argument for engaging dynamic panel data modeling is due to the potentially endogenous estimators of the OLS technique which may be biased upwards. For the difference-GMM, the validity of instruments used determines the consistency of the parameters that emanates from such estimator. Two specification tests put forward by Arellano and Bond (1991) to examine the validity of the instruments is the Hansen statistic and second-order serial correlation *AR*(2). Failure to reject the null hypotheses of *over-identifying restrictions are* valid, and no second-order serial correlation gives credence to the results. Lastly, the adoption of static and dynamic techniques serve as robustness for one another in order to observe the consistency of the impact of trade and ICT on growth.

4. Results and discussions

This section presents empirical findings which fill essential gaps in the trade-growth and ICT-growth literature on Africa by showcasing findings on whether trade openness individually promotes economic and inclusive growth and/or if its interaction with ICT innovation enhances or alters its impact on growth. Estimations begin with an alternate analysis of the models with *MOBILE* and *TEL* and their interactions with *TRADE* as shown in Table 3. The composite LSDV results also incorporate robustness checks. Columns [1] and [2] relate to the primary analysis for economic growth, while columns [3] and [4] relate to inclusive growth. Their corresponding robustness checks with *INFLATION* as an additional control variable are reflected in columns [5] to [8]. The GMM results grouped into 'main' and 'robustness' are shown in Table 4. The main results for the sub-regions are shown in Tables 5 and 6, while their corresponding robustness checks are in Appendix Tables A3 and A4. Interpretations of the results from the two estimation techniques are taken in turns.

4.1. Full sample results

Starting with the bootstrapping least squares dummy variables (LSDV) results in Table 3, trade openness is a statistically significant positive predictor of economic growth but has no significant impact on inclusive growth. Its impact on economic growth is statistically significant at the 1% level and suggestive of an elastic relationship. This outcome which is consistent with Fetahi-Vehapi et al. (2016) implies that trade openness is an essential contributor to growth in Africa and that an increase in trade leads to an increase in growth across the continent. On inclusive growth, aside from the fact

Table 3. Bootstrap least squares dummy variables results.

	Main Regressions				Robustness Checks			
	GDP, log		HDI		GDP, log		HDI	
Variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Constant	365.3193***	−120.1533***	11.5584***	8.0439***	374.2423***	−142.2247***	12.1485***	8.5993***
	(15.51)	(−2.64)	(4.11)	(2.61)	(12.98)	(−3.26)	(4.66)	(3.69)
GFCF, log	0.0487	0.0021	0.0136**	0.0166***	0.0671	−0.1428	0.0125*	0.0160**
	(0.80)	(0.02)	(2.40)	(2.87)	(1.28)	(−1.18)	(1.76)	(2.06)
LABOUR, log	−0.7712***	−0.7268**	−0.0513***	−0.0621***	−0.7672***	−0.5925**	−0.0478**	−0.0598***
	(−4.12)	(−1.96)	(−2.72)	(−3.07)	(−3.25)	(−2.26)	(−2.01)	(−2.77)
INFLATION					0.0000	−0.0001	−0.0000	−0.0000
					(0.01)	(−0.08)	(−0.01)	(−0.04)
TRADE, log	2.1248***	2.4785***	−0.0613	−0.0000	2.9117***	2.3274***	0.0099	0.0065
	(2.87)	(3.47)	(−0.94)	(−0.00)	(3.31)	(3.74)	(0.14)	(0.19)
INTERNET, log	0.1967***	0.0355	0.0593***	0.0486***	0.1974***	−0.0020	0.0595***	0.0502***
	(6.22)	(0.57)	(20.52)	(14.11)	(6.32)	(−0.03)	(17.56)	(15.79)
MOBILE, log	1.4309***		−0.0333*		1.6511***		−0.0137	
	(7.64)		(−1.90)		(7.18)		(−0.72)	
TRADE*MOBILE, log	−0.1374***		0.0078*		−0.1855***		0.0035	
	(−2.97)		(1.82)		(−3.38)		(0.76)	
FIXED TEL, log		1.6442***		−0.0143		1.6163***		−0.0140
		(6.05)		(−1.04)		(6.39)		(−1.07)
TRADE*TEL, log		−0.2299***		0.0060*		−0.2191***		0.0060*
		(−3.66)		(1.84)		(−3.57)		(1.90)
Central Africa	1.3933***	1.2080***	0.0523***	0.0625***	1.3263***	1.3774***	0.0470***	0.0557***
	(13.76)	(8.31)	(6.38)	(7.29)	(12.39)	(9.98)	(5.62)	(5.75)
East Africa	0.3333***	0.4003**	0.0331***	0.0421***	0.3374***	0.4459***	0.0352***	0.0443***
	(5.06)	(2.55)	(5.14)	(7.53)	(4.87)	(3.02)	(6.52)	(7.62)
North Africa	0.3126***	0.0416	0.0762***	0.0582***	0.2716**	0.1384	0.0745***	0.0562***
	(3.51)	(0.23)	(5.46)	(4.61)	(2.56)	(1.10)	(4.50)	(3.80)
Southern Africa	0.6523***	0.1026	0.0634***	0.0575***	0.6294***	0.1307	0.0615***	0.0549***
	(7.31)	(0.98)	(6.06)	(6.28)	(9.60)	(1.16)	(6.67)	(7.01)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	489	476	489	476	480	469	480	469
Bootstrap Replications	50	49	50	50	50	49	50	49

Notes: ***, **, *are statistical significance at the 1%, 5% and 10% levels respectively; *t*-statistics in () are based on bootstrapped standard errors from 50 replications; GFCF = Gross fixed capital formation.
Source: Authors' Computations.

Table 4. One-step difference GMM results.

	Main Regressions				Robustness Checks			
Variables	GDP, log [9]	GDP, log [10]	HDI [11]	HDI [12]	GDP, log [13]	GDP, log [14]	HDI [15]	HDI [16]
GDP_1, log	0.1501	0.5163***			0.2706*	0.5620***		
	(1.08)	(2.98)			(1.95)	(3.51)		
HDI_1			1.9085***	2.3382***			2.0612***	2.1395**
			(4.26)	(3.21)			(4.15)	(2.64)
GFCF, log	0.1431	0.1275***	−0.0235	0.0765**	−0.1413	0.1102**	−0.0179	0.1025***
	(0.50)	(2.70)	(−0.82)	(2.52)	(−0.34)	(2.34)	(−0.60)	(3.16)
LABOUR, log	−0.3135	−0.2588	−0.1171	0.0337	−0.8879	−0.3038	−0.1575*	−0.0272
	(−0.46)	(−0.84)	(−1.43)	(0.34)	(−1.24)	(−1.07)	(−1.88)	(−0.22)
INFLATION					0.0000	0.0000	0.0000	0.0000
					(0.04)	(0.15)	(0.85)	(1.07)
TRADE, log	1.4001**	0.3960	0.1515**	0.1643**	1.9821*	0.4782	0.1301*	0.1743
	(2.57)	(1.41)	(2.23)	(2.01)	(1.87)	(1.59)	(1.76)	(1.67)
INTERNET, log	0.2040	0.0614*	−0.0041	0.0074	0.1439	0.0620**	0.0012	0.0130
	(1.22)	(1.88)	(−0.46)	(0.36)	(1.06)	(2.04)	(0.14)	(0.58)
MOBILE, log	0.6720***		0.0812***		0.8678***		0.0738***	
	(4.25)		(3.89)		(3.61)		(3.49)	
TRADE*MOBILE, log	−0.1158***		−0.0092**		−0.1443**		−0.0076*	
	(−3.59)		(−2.32)		(−2.53)		(−1.75)	
FIXED TEL, log		0.2319**		0.1146***		0.2515**		0.1289**
		(2.21)		(2.79)		(2.23)		(2.36)
TRADE*TEL, log		−0.0556**		−0.0179**		−0.0605**		−0.0189*
		(−2.29)		(−2.33)		(−2.30)		(−1.96)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Obs.	393	383	393	377	387	377	387	373
F Statistic	62.612	227.090	81.443	30.032	91.793	230.421	82.351	31.118
Instruments/Groups	30/48	37/49	33/48	33/48	30/47	37/48	33/47	33/47
AR(2)/Hansen Stat	0.068/0.127	0.571/0.572	0.735/0.712	0.545/0.617	0.084/0.498	0.514/0.457	0.536/0.325	0.379/0.724

Notes: ***, **, *are statistical significance at the 1%, 5% and 10% levels respectively; *t*-statistics in () are based on White heteroscedasticity-consistent std. errors; GFCF = Gross fixed capital formation.
Source: Authors' Computations.

Table 5. Bootstrap least squares dummy variables results for sub-regions (mobile phones).

	GDP, log					HDI				
Variables	Central Afr.	East Afr.	North Afr.	Southern Afr.	West Afr.	Central Afr.	East Afr.	North Afr.	Southern Afr.	West Afr.
Constant	308.0737***	379.2490***	151.0158**	359.6834***	453.0657***	25.7418***	3.0809	1.0717	20.3512**	7.2088*
	(2.75)	(8.37)	(2.47)	(5.98)	(10.21)	(3.06)	(0.93)	(0.11)	(2.52)	(1.82)
GFCF, log	0.3115	0.1713**	−0.6656***	0.7573***	0.1136	0.0293	0.0222***	−0.1385***	0.1333***	−0.0087
	(0.84)	(2.14)	(−3.02)	(4.96)	(1.48)	(1.03)	(3.03)	(−3.55)	(6.21)	(−1.33)
LABOUR, log	2.2571***	−0.4163	0.9660	−1.1285***	−0.8943***	−0.1450**	−0.0511**	−0.2768	0.3020***	0.0377
	(4.47)	(−1.59)	(0.66)	(−4.20)	(−3.01)	(−2.31)	(−2.02)	(−0.96)	(4.54)	(1.23)
TRADE, log	−2.5268	0.2733	−9.8366***	−1.4918	1.5395*	−0.1351	−0.0834	−0.0032	0.9025	0.0931
	(−0.87)	(0.31)	(−4.16)	(−0.69)	(1.69)	(−0.44)	(−0.60)	(−0.01)	(1.64)	(0.96)
INTERNET, log	0.3918***	0.1346***	−0.2294*	0.4301***	0.0843	0.0905***	0.0417***	−0.0095	0.1391***	0.0500***
	(3.19)	(4.17)	(−1.76)	(8.04)	(1.33)	(6.51)	(14.78)	(−0.33)	(15.01)	(10.30)
MOBILE, log	−0.5182	0.8134***	−1.4288**	0.6180	1.5429***	−0.0654	−0.0362	0.0185	0.2868*	0.0093
	(−0.65)	(3.35)	(−2.43)	(0.96)	(6.32)	(−0.77)	(−1.00)	(0.13)	(1.78)	(0.35)
TRADE*MOBILE, log	0.2735	0.0071	0.6070***	0.0150	−0.1308**	0.0117	0.0087	0.0137	−0.0722*	−0.0026
	(1.38)	(0.12)	(4.22)	(0.10)	(−2.17)	(0.57)	(0.96)	(0.39)	(−1.86)	(−0.39)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Obs.	74	106	66	87	156	74	106	66	87	156
Bootstrap Replications	42	46	42	45	50	42	43	46	44	49

Notes: ***, **, *are statistical significance at the 1%, 5% and 10% levels respectively; *t*-statistics in () are based on bootstrapped standard errors from 50 replications; GFCF = Gross fixed capital formation.
Source: Authors' Computations.

Table 6. Bootstrap least squares dummy variables results for sub-regions (fixed telephone).

	GDP, log					HDI				
Variables	Central Afr.	East Afr.	North Afr.	Southern Afr.	West Afr.	Central Afr.	East Afr.	North Afr.	Southern Afr.	West Afr.
Constant	27.5083	−169.9592	−178.6916***	−38.0312	−259.7557***	20.0164***	−0.7826	−33.8781***	25.6752***	8.5860**
	(0.37)	(−1.42)	(−2.75)	(−0.76)	(−4.59)	(3.00)	(−0.20)	(−3.06)	(4.71)	(1.99)
GFCF, log	0.3136	0.3882	0.1497	0.3479	−0.7352***	−0.0688**	0.0062	−0.0953***	0.0511*	−0.0042
	(1.28)	(1.38)	(0.89)	(1.43)	(−6.00)	(−2.28)	(0.70)	(−3.55)	(1.71)	(−0.55)
LABOUR, log	0.7319**	3.0088***	0.2136	1.7165***	−1.8221***	−0.2230***	−0.0213	−0.2130	0.0512	0.0154
	(2.27)	(3.14)	(0.20)	(3.58)	(−3.40)	(−5.44)	(−0.74)	(−1.25)	(0.88)	(0.57)
TRADE, log	−3.1932**	10.9123***	−5.8405***	14.5187***	5.2446***	0.7484***	0.2518***	−0.4904**	−1.1248***	−0.0338
	(−2.38)	(3.80)	(−4.68)	(7.00)	(3.34)	(4.23)	(4.17)	(−1.98)	(−3.94)	(−0.76)
INTERNET, log	0.2950***	−0.0281	−0.2222	0.4214***	−0.1457*	0.0730***	0.0409***	−0.0443*	0.0808***	0.0480***
	(3.14)	(−0.20)	(−1.51)	(3.39)	(−1.88)	(7.85)	(11.68)	(−1.85)	(8.67)	(9.75)
FIXED TEL, log	−1.1999**	4.6240***	−0.8869**	6.1749***	3.2293***	0.2620***	0.0782***	−0.1507**	−0.3862***	−0.0364*
	(−2.52)	(4.06)	(−2.27)	(8.88)	(4.95)	(4.13)	(3.27)	(−2.03)	(−4.05)	(−1.81)
TRADE*TEL, log	0.4236***	−0.9670***	0.3836***	−1.2886***	−0.5342***	−0.0656***	−0.0200***	0.0499***	0.0971***	0.0090**
	(3.56)	(−3.51)	(3.86)	(−7.86)	(−3.52)	(−4.03)	(−3.62)	(2.62)	(4.38)	(2.11)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Observations	71	103	66	87	149	71	103	66	87	149
Bootstrap Replications	42	43	44	46	50	36	46	47	46	49

Notes: ***, **, *are statistical significance at the 1%, 5% and 10% levels respectively; *t*-statistics in () are based on bootstrapped standard errors from 50 replications; GFCF = Gross fixed capital formation.
Source: Authors' Computations.

that the coefficient is statistically not significant, the sign of the coefficient aligns with the outcomes of some studies that trade distorts economic structures which ultimately widens inequality (Jawaid & Waheed, 2017; Milanovic & Squire, 2005).

The impact of *MOBILE* and *TEL* on growth is asymmetric. While both exert positive and statistically significant effects on economic growth at the 1% level but the impact on inclusive growth is negative and statistically significant for *MOBILE* (*not* significant for TEL). The positive and significant relationship aligns with previous studies (Adeleye & Eboagu, 2019; Chavula, 2013; Ghosh, 2016; Imbert & Papp, 2015; Osabuohien, 2008) and suggests that ICT induces economic growth across Africa. Exhibiting an elastic relationship, a percentage change in ICT innovation leads to between 2.12 and 1.64 per cent increase in economic growth, on average, *ceteris paribus*. The significant negative effect of ICT on inclusive growth somewhat aligns with Johnson (2016) who finds that ICT-adopting and ICT-deficient economies are characterized by moderate level of inclusiveness, relatively less robust ICT infrastructure, low human capital, high level of poverty and inequality, relatively high unemployment rate, and massive digital divide.

GFCF drives inclusiveness at the 1% and 5% levels and supports the business framework of Roztocki et al. (2019) that infrastructures provide the enabling environment for business with ultimate impact on inclusive growth. Contrarily, the insignificant impact of *GFCF* on economic growth is not unconnected to the low-absorptive capacities of developing economies with poor industrial infrastructures to drive such growth (Adeleye & Eboagu, 2019; Lach, 2010). *LABOUR,* on the other hand, hurts economic growth with a statistically significant relationship ranging from 1% to 10%. Specifically, a 1 per cent increase in *LABOUR* will cause a decrease of 0.59–0.77 per cent in economic growth, on average, *ceteris paribus*. This outcome shows that unskilled labor is a drag on growth (Adeleye & Eboagu, 2019; Ongo & Vukenkeng, 2014).

On the contribution of ICT innovation to the trade-growth nexus, the coefficients of the interaction terms which indicate whether ICT innovation enhances or distorts trade openness are negative (positive) across all model specifications for economic (inclusive) growth. For economic growth, the magnitude of the negatives determines the influence of ICT innovation. For instance, in columns [1] and [5], the differential[5] of 1.9874 (that is, 2.1248–0.1374) and 2.7262 (that is, 2.9117–0.1855) gives the *total* effect of trade on growth given *MOBILE* which shows that the negative interaction is not sufficient to dampen the positive impact of trade on economic growth. Considering the interactions of both *TRADE* and *TEL* in columns [2] and [6], the *total* impact of trade on economic growth amounts to 2.7262 and 2.1083, respectively. Though trade has an insignificant impact on inclusiveness, the interaction with *MOBILE* in column [3] is growth-enhancing. The *overall* effect of trade on inclusive growth sums up to −0.0535 (that is, −0.0613 + 0.0078). In order words, *MOBILE* diminishes the insignificance of trade on inclusive growth. Columns [4] and [6] reveal that interactions with *TEL* improve the impact of trade of inclusive growth by 0.006 and 0.0125, respectively. These are significant contributions to the literature as it corroborates to the growth-enhancing impact of trade openness. These findings give some empirical support to the multi-dimensional frameworks of Roztocki et al. (2019) by showing that ICT innovation not only supports trade or the business framework but improves socio-economic conditions as well. Lastly, the respective intercepts of the sub-regions show similar patterns across the two primary and corresponding robustness models. The constant term represents the intercept for the base sub-region (West Africa). Central, East, North, and Southern Africa show to have higher intercepts than the base sub-region in the *MOBILE* models for both economic and inclusive growth, but only the intercepts of Central and East Africa is significantly higher than that of West Africa in the *TEL* models.

In seven out of eight models, the GMM estimations represented in Table 4 reveal that growth is persistent in Africa, given the positive and statistically significant coefficients of the lagged dependent variables. That is, a percentage increase in the previous year's economic growth contributes 0.27–0.56 per cent to economic growth and between 1.91–2.33 to inclusive growth, on average, *ceteris paribus*. Contrary to the LSDV results, trade openness exerts a positive impact on both categories of growth. The coefficients of the indicators of ICT are also positive and statistically significant

at 1% and 5% levels, respectively. The interactions of trade with ICT indicators are negative and statistically significant at the 1%, 5% and 10% levels, respectively. Previous interpretation holds. That is, the interaction with ICT is not sufficient to dampen the *total* positive effect of trade on both economic and inclusive growth. Lastly, while controlling for year dummies, the goodness-of-fit of the models shows that the *F*-statistics indicate that the regressors are jointly significant in explaining economic growth; there is no evidence of second-order serial correlation given the indicated *p*-values while the null hypothesis of instruments validity cannot be rejected at the 5% significance level. Hence, the results obtained from these augmented regressions can be used for inferences.

4.2. Sub-samples results

The results for the sub-samples are shown in Tables 5 (for mobile phones) and 6 (fixed telephones) with each region having its corresponding economic and inclusive growth results. Emphasis will center mainly on the individual and interactive effects of *TRADE*, *MOBILE*, and *TEL* on growth. Starting with Table 5, *TRADE* significantly decreases economic growth in North Africa (−9.837) at the 1% level, it increases same in West Africa (1.539) at the 10% level. Across all the sub-regions, trade has no impact on inclusive growth. *MOBILE* boosts economic growth in East Africa (0.813) and West Africa (1.543) at the 1% significant level but reduces trade in North Africa (−1.429). The *TRADE*MOBILE* interaction is positive for North Africa (0.6070) and negative for West Africa (−0.1308). It leads to the conclusion that ICT innovation reduces the negative impact of trade on economic growth (−9.2296, North Africa) and is not sufficient to dampen the positive impact of trade on economic growth (1.4087, West Africa). On inclusiveness, both trade and mobile subscription with their interaction show weak significance across the sub-regions.

Contrarily, the results of Table 6 reveal that individually trade and fixed telephone subscription contribute to economic and inclusive growth in Central Africa while they indicate asymmetric effects in the rest of the sub-regions at varying statistical significance levels. Positive coefficients support previous studies on the growth-enhancing impact of ICT. The magnitude of these coefficients may suggest that increase in ICT adoption leads to increased investments in the telecommunications sector equipment, which contributes directly to growth. In part, ICT innovation leads to faster economic transactions and socio-economic interactions. The demand for ICT services also contributes to the establishment of telecommunication service companies, and the creation of jobs which all contribute to boosting overall economic activities in Africa. Needless to say that the presence of ICT boosts both economic and inclusive growth.

In real terms, the *overall* impact of trade on economic growth given *TEL* is −2.7696 (Central Africa), 9.9453 (East Africa), −5.5469 (North Africa), 13.2301 (Southern Africa), and 4.47104 (West Africa). Similarly, the *total* impact on inclusive growth is 0.6828 (Central Africa), 0.2318 (East Africa), −0.4405 (North Africa), −0.10277 (Southern Africa), and −0.0248 (West Africa). Comparative statics of the sub-regions from the mobile phone models show that West Africa has the most extensive trade and ICT elasticities on economic growth with no corresponding impact on inclusive growth. For the fixed telephone models, Southern Africa has the most extensive trade and ICT elasticities on economic growth, while Central Africa has the largest trade and ICT elasticities on inclusive growth. Also from the results, the enhancing impact of ICT adoption in Central and North Africa is not large enough to reverse the distortionary impact of trade on economic growth and inclusive growth in North, Southern, and West Africa. These outcomes are significant findings and contributions to the literature. For robustness checks, *INFLATION* is added to the models, and the outcomes (see Appendix Table A3 and A4) are not significantly different from the main results.

5. Summary and policy recommendation

With data on 53 African countries from 2005 to 2015 and using mobile phones and fixed telephone subscriptions as the indicators of ICT, the study engages the bootstrapped LSDV and dynamic

(difference GMM) approaches to examine the ICT-trade nexus on economic and inclusive growth. In broader terms, this paper addresses four research questions among which is whether trade openness significantly impacts economic and inclusive growth and if the adoption of ICT influences or hinders the impact of trade on growth? Specifically, this study concludes that (1) ICT adoption significantly promote economic and inclusive growth; (2) the negative interaction of trade and ICT is not sufficient to dampen the enhancing-impact of trade on economic growth; (3) the effect of trade and ICT adoption significantly differ across Africa's sub-regions; and (4) the moderating impact of ICT adoption on trade significantly different across the sub-regions. Given the consistency of the full sample results about the three indicators of interest (trade, mobile phones and fixed telephone subscription), the study submits that these variables are critical drivers of growth in Africa. However, the lack of consistency of the results across the sub-regions suggests that the level of ICT is still undeveloped, and the benefits of international trade are yet to be adequately harnessed. Furthermore, ICT enables trade in some sub-regions while inhibiting trade (though minimally) in others may point to the different spate of ICT development across the sub-regions.

In conclusion, some suggested policy measures are as follows: (1) to harness the gains from trade, African goods must be competitive at the global markets, (2) there is the need to relax trade restrictions and remove barriers, (3) the practical take off, and implementation of the Africa Continental Free Trade Agreement (AfCFTA) will go a long way in synergising trade relations within the African continent, and (4) the rising use of ICT innovation particularly mobile phones calls for the need to regulate the sector to ease accessibility and at a reduced cost. Overall, policymakers, regulators and governments must cooperate to initiate and implement policies that will engender increased trading to boost economic growth. With available data, the monotonic impact of trade on economic growth may be taken up in future.

Notes

1. For simplicity, *growth* refers to both economic and inclusive growth except where either is specifically mentioned.
2. Somalia dropped due to lack of sufficient data on the human development index (a proxy for inclusive growth).
3. See Appendix Table A1 for the list of countries and their respective regions.
4. Perhaps, because regressors and instruments outnumber the cross-sections, our model is not robust to the use of the system generalised method of moments (GMM) approach. Several simulations yielded statistically insignificant results, and in most cases, the diagnostics are returned by dotted (.) signs.
5. The differential is obtained by deducting the coefficient of the interaction term from that of trade openness.

Notes on contributors

Bosede Ngozi Adeleye an alumnus of University of Sussex, UK holds a PhD degree in Economics from Covenant University, Nigeria. She is quantitative-inclined with strong proficiency in Stata and EViews analytical software. She is the creator and tutor of *CrunchEconometrix* https://cruncheconometrix.com.ng a digital platform designed to teach hands-on applied econometrics to beginners, intermediate, and advanced level users. Her YouTube Channel https://www.youtube.com/c/CrunchEconometrix which has gathered more than 1.5million views has 144 videos and over 15,000 subscribers. Her research interests revolve around issues related to Sustainable Development Goals (SGDs). She is a reviewer to several international journals.

Festus Fatai Adedoyin is a demonstrator at the Department of Accounting, Economics and Finance, Bournemouth University, UK. His research interests span across tourism economics, energy economics, tourism taxation and consumer behavior. He has published in top tier environmental and energy economics journals, including *Journal of Environmental Management*, *Current Issues in Tourism* amongst others.

Solomon Nathaniel is a PhD scholar (Advance Stage) at the University of Lagos, Nigeria and teaches economics at the Lagos State University, Nigeria. He has published in a variety of Journals indexed in the Web of Science core collections such as *Science of The Total Environment*, *Environmental Science and Pollution Research*, *Geojournal*, *Journal of Public Affairs*, *Heliyon*, *Logforum*, *Serbian Journal of Management*, *Global Business Review* to mention a few.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Bosede Ngozi Adeleye http://orcid.org/0000-0002-1274-714X
Festus Adedoyin http://orcid.org/0000-0002-3586-2570
Solomon Nathaniel http://orcid.org/0000-0001-7623-9526

References

Adeleye, N., & Eboagu, C. (2019). Evaluation of ICT development and economic growth in Africa. *NETNOMICS: Economic Research and Electronic Networking*, *20*(1), 31–53. https://doi.org/10.1007/s11066-019-09131-6

Adhikary, B. K. (2011). FDI, trade openness, capital formation, and economic growth in Bangladesh: A linkage analysis. *International Journal of Business and Management*, *6*(1), 1–16. https://doi.org/10.5539/ijbm.v6n1p16

Adom, P. K., Opoku, E. E. O., & Yan, I. K. M. (2019). Energy demand–FDI nexus in Africa: Do FDIs induce dichotomous paths? *Energy Economics*, *81*, 928–941. https://doi.org/10.1016/j.eneco.2019.05.030

Albiman, M. M., & Sulong, Z. (2016). The role of ICT use to the economic growth in Sub Saharan African region (SSA). *Journal of Science and Technology Policy Management*, *7*(3), 306–329. https://doi.org/10.1108/JSTPM-06-2016-0010

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment. *Review of Economic Studies*, *58*(1), 277–297. https://doi.org/10.2307/2297968

Ashraf, M., Grunfeld, H., Hoque, M. R., & Alam, K. (2017). An extended conceptual framework to understand information and communication technology enabled socio-economic development at community level in Bangladesh. *Information Technology & People*, *30*(4), 736–752. https://doi.org/10.1108/ITP-03-2016-0067

Boamah, N. A. (2017). The relevance of global sector influence in African sector portfolios. *African Journal of Economic and Management Studies*, *8*(2), 205–220.

Calderon, C., Loayaza, N., & Schmidt-Hebbel, K. (2004). External conditions and growth performance. *Working Papers Central Bank of Chile*, *292*, 1–31.

Chang, R., Kaltani, L., & Loayza, N. (2009). Openness can be Good for growth: The role of policy complementarities. *Journal of Development Economics*, *90*(1), 33–49. https://doi.org/10.1016/j.jdeveco.2008.06.011

Chavula, H. K. (2013). Telecommunications development and economic growth in Africa. *Information Technology for Development*, *19*(1), 5–23. https://doi.org/10.1080/02681102.2012.694794

Chowdhury, S. (2006). Investments in ICT-capital and economic performance of small and medium scale enterprises in East Africa. *Journal of International Development*, *18*(4), 533–552. https://doi.org/10.1002/jid.1250

Dollar, D., & Kraay, A. (2004). Trade, growth and poverty. *The Economic Journal*, *114*(1), F22–F49. https://doi.org/10.1111/j.0013-0133.2004.00186.x

Donou-Adonsou, F. (2019). Technology, education, and economic growth in Sub-Saharan Africa. *Telecommunications Policy*, *43*(4), 353–360. https://doi.org/10.1016/j.telpol.2018.08.005

Dunne, J. P., & Masiyandima, N. (2017). Bilateral FDI from South Africa and income Convergence in SADC. *African Development Review*, *29*(3), 403–415. https://doi.org/10.1111/1467-8268.12277

Ejemeyovwi, J. O., & Osabuohien, E. S. (2018). Investigating the Relevance of mobile technology adoption on inclusive growth in West Africa. *Contemporary Social Science*, 1–16. https://doi.org/10.1080/21582041.2018.1503320

Eriş, M. N., & Ulaşan, B. (2013). Trade openness and economic growth: Bayesian model Averaging estimate of cross-country growth regressions. *Economic Modelling*, *33*, 867–883. https://doi.org/10.1016/j.econmod.2013.05.014

Fanta, A. B., & Makina, D. (2017). Equity, bonds, institutional debt and economic growth: Evidence from South Africa. *South African Journal of Economics*, *85*(1), 86–97. https://doi.org/10.1111/saje.12122

Fetahi-Vehapi, M., Sadiku, L., & Petkovski, M. (2016). Empirical analysis of the effects of trade openness on economic growth: An evidence for South East European countries. *Procedia Economics and Finance*, *19*, 17–26. https://doi.org/10.1016/S2212-5671(15)00004-0

Frankel, A., & Romer, D. (1999). Does trade cause growth? *American Economic Review*, *89*(3), 379–399. https://doi.org/10.1257/aer.89.3.379

Freund, C., & Bolaky, B. (2008). Trade, regulations, and income. *Journal of Development Economics*, *87*(2), 309–321. https://doi.org/10.1016/j.jdeveco.2007.11.003

Ghosh, S. (2016). Does mobile telephony spur growth? Evidence from Indian States. *Telecommunications Policy*, *40*(10-11), 1020–1031. https://doi.org/10.1016/j.telpol.2016.05.009

Gosavi, A. (2018). Can mobile money help firms mitigate the problem of access to finance in Eastern Sub-Saharan Africa? *Journal of African Business*, *19*(3), 343–360. https://doi.org/10.1080/15228916.2017.1396791

Gruber, H., & Koutroumpis, P. (2011). Mobile telecommunications and the impact on economic development. *Economic Policy: A European Forum*, *26*(67), 387–426. https://doi.org/10.1111/j.1468-0327.2011.00266.x

Gui-Diby, S. L. (2014). Impact of foreign direct investments on economic growth in Africa: Evidence from three decades of panel ddata analyses. *Research in Economics*, *68*(3), 248–256. https://doi.org/10.1016/j.rie.2014.04.003
Hartmann, D., & Hidalgo, C. (2017). Linking economic complexity, and income inequality. *World Development*, *93*, 75–93. https://doi.org/10.1016/j.worlddev.2016.12.020
Imbert, C., & Papp, J. (2015). Labor market effect of social programs: Evidence from India's employment guarantee. *American Economic Journal: Applied Economics*, *7*(2), 233–263. https://doi.org/10.1257/app.20130401
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), 302–322. https://doi.org/10.1080/15228916.2017.1416215
Jacobs, C., Rivett, U., & Chemisto, M. (2019). Developing capacity through Cco-design: The case of two municipalities in Rural South Africa. *Information Technology for Development*, *25*(2), 204–226. https://doi.org/10.1080/02681102.2018.1470488
Jawaid, T., & Waheed, A. (2017). Contribution of international trade in human development of Pakistan. *Global Business Review*, *18*(5), 1155–1177. https://doi.org/10.1177/0972150917710345
Johnson, O. D. (2016). *Information and communication technologies adoption and inclusive growth: The ICT-inclusive growth pyramid approach*. Department of Economics and Development Studies. Covenant University.
Keho, Y. (2017). The impact of trade openness on economic growth: The case of cote d'Ivoire. *Cogent Economics & Finance*, *5*(1), 1332820. https://doi.org/10.1080/23322039.2017.1332820
Kong, Q., Peng, D., Ni, Y., Jiang, X., & Wang, Z. (2020). Trade openness and economic growth quality of China: Empirical analysis using ARDL model. *Finance Research Letters*, 101488. https://doi.org/10.1016/j.frl.2020.101488
Kowal, J., Keplinger, A., & Mäkiö, J. (2019). Organizational citizenship behavior of IT professionals: Lessons from poland and germany. *Information Technology for Development*, *25*(2), 227–249. https://doi.org/10.1080/02681102.2018.1508402
Kpomblekou, E., & Wonyra, K. (2020). Spatial diffusion of international trade in West African Economic and Monetary Union (WAEMU). *Scientific African*, *7*, e00295. https://doi.org/10.1016/j.sciaf.2020.e00295
Lach, L. (2010). Fixed capital and long-run economic growth: Evidence from Poland. *Systems Science*, *36*(4), 33–50. https://mpra.ub.uni-muenchen.de/52280/
Lech, P. (2019). Enterprise system implementations in transition and developed economies: Differences in project contracting and governance. *Information Technology for Development*, *25*(2), 357–380. https://doi.org/10.1080/02681102.2018.1564726
Lee, G., Shao, B., & Vinzé, A. (2018). The role of ICT as a double-edged sword in fostering societal transformations. *Journal of the Association for Information Systems*, *19*(3), 209–246. https://doi.org/10.17705/1jais.00490
Madon, S. (2000). The internet and socio-economic development: Exploring the interaction. *Information Technology & People*, *13*(2), 85–101. https://doi.org/10.1108/09593840010339835
Mahmood, M., Weerakkody, V., & Chen, W. (2019). The influence of transformed government on citizen trust: Insights from Bahrain. *Information Technology for Development*, *25*(2), 275–303. https://doi.org/10.1080/02681102.2018.1451980
Manwa, F., Wijeweera, A., & Kortt, M. A. (2019). Trade and growth in SACU countries: A panel data analysis. *Economic Analysis and Policy*, *63*, 107–118. https://doi.org/10.1016/j.eap.2019.05.003
Melitz, M.J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, *71*(6), 1695–1725. https://doi.org/10.1111/1468-0262.00467
Mengesha, G. H., & Garfield, M. J. (2019). A contextualized IT adoption and use model for telemedicine in Ethiopia. *Information Technology for Development*, *25*(2), 184–203. https://doi.org/10.1080/02681102.2018.1461057
Milanovic, B., & Squire, L. (2005). Does tariff liberalization increase wage inequality? Some empirical evidence. *NBER Working Paper No. W11046*.
Minkoua Nzie, J. R., Bidogeza, J. C., & Azinwi Ngum, N. (2018). Mobile phone use, transaction costs, and price: evidence from rural vegetable farmers in Cameroon. *Journal of African Business*, *19*(3), 323–342. https://doi.org/10.1080/15228916.2017.1405704
Myovella, G., Karacuka, M., & Haucap, J. (2020). Digitalization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies. *Telecommunications Policy*, *44*(2), 101856. https://doi.org/10.1016/j.telpol.2019.101856
Niebel, T. (2014, August 24–30). *ICT and economic growth - comparing developing, emerging and developed countries* [Paper presented] IARIW 33rd General Conference, Rotterdam, the Netherlands.
Nourzad, F., & Powell, J. J. (2003). Openness, growth, and development: Evidence from a panel of developingcountries. *Scientific Journal of Administrative Development*, *1*(1), 72–94.
Ongo, E. N., & Vukenkeng, A. W. (2014). Does gross capital formation matter for economic growth in the CEMAC Subregion? *EuroEconomica*, *2*(33), 79–88.
Osabuohien, E. S. (2008). ICT and Nigerian Banks' reforms: Analysis of anticipated impacts in Selected Banks. *Global Journal of Business Research*, *2*(2), 67–76. https://ssrn.com/abstract=1543523
Palvia, P., Baqir, N., & Nemati, H. (2018). ICT for socio-economic development: A citizens' perspective. *Information & Management*, *55*(2), 160–176. https://doi.org/10.1016/j.im.2017.05.003

Razmi, M. J., & Yavari, Z. (2012). Reviewing the effect of trade openness on human development. *Interdisciplinary Journal of Contemporary Research in Business*, *4*(6), 970–978.

Romer, P. M. (1986). Increasing returns and long-Run growth. *Journal of Political Economy*, *94*(5), 1002–1037. https://doi.org/10.1086/261420

Rondović, B., Kašćelan, L., Lazović, V., & Đuričković, T. (2019). Discovering the Determinants and Predicting the degree of e-business diffusion using the Decision Tree method: Evidence from Montenegro. *Information Technology for Development*, *25*(2), 304–333. https://doi.org/10.1080/02681102.2017.1415863

Roztocki, N., Soja, P., & Weistroffer, H. R. (2017). Enterprise Systems in Transition economies: Research Landscape and framework for Socioeconomic development. *Information Technology for Development*, *26*(1), 1–37. https://doi.org/10.1080/02681102.2017.1377148

Roztocki, N., Soja, P., & Weistroffer, H. R. (2019). The role of information and communication Technologies in Socioeconomic development: Towards a multi-dimensional framework. *Information Technology for Development*, *25*(2), 171–183. https://doi.org/10.1080/02681102.2019.1596654

Roztocki, N., & Weistroffer, H. R. (2016). Conceptualizing and Researching the adoption of ICT and the impact on Socioeconomic development. *Information Technology for Development*, *22*(4), 541–549. https://doi.org/10.1080/02681102.2016.1196097

Sachs, J. D., & Warner, A. (1995). Economic reform and the process of global integration. *Brookings Papers on Economic Activity*, *26*(1), 1–118. https://doi.org/10.2307/2534573

Salahuddin, M., & Gow, J. (2016). The efects of internet usage, financial development and trade openness on economic growth in South Africa: A time series analysis. *Telematics and Informatics*, *33*(4), 1141–1154. https://doi.org/10.1016/j.tele.2015.11.006

Sein, M. K., Thapa, D., Hatakka, M., & Sæbø, Ø. (2018). A holistic perspective on the theoretical foundations for ICT4D research. *Information Technology for Development*, https://doi.org/10.1080/02681102.2018.1503589

Solow, R. M. (1956). A contribution to the theory of economic growth. *The Quarterly Journal of Economics*, *70*(1), 65–94. https://doi.org/10.2307/1884513

Stal, J., & Paliwoda-Pękosz, G. (2019). Fostering development of soft skills in ICT curricula: A case of a transition economy. *Information Technology for Development*, *25*(2), 250–274. https://doi.org/10.1080/02681102.2018.1454879

Steinmueller, W. E. (2001). ICTs and possibilities for leapfrogging by developing countries. *International Labour Review*, *140*(2), 1–18. https://doi.org/10.1111/j.1564-913X.2001.tb00220.x

Tallon, P. P., & Kraemer, K. L. (2000). Information technology and economic development: Ireland's coming of age with lessons for developing countries. *Journal of Global Information Technology Management*, *3*(2), 4–23. https://doi.org/10.1080/1097198X.2000.10856275

UNDP. (2019). Human development index. http://hdr.undp.org/sites/default/files/hdr2019_technical_notes.pdf

Ward, M. R., & Zheng, S. (2016). Mobile telecommunications service and economic growth: Evidence from China. *Telecommunications Policy*, *40*(2-3), 89–101. –81. https://doi.org/10.1016/j.telpol.2015.06.005

Were, M. (2015). Differential effects of trade on economic growth and investment: A cross-country empirical investigation. *Journal of African Trade*, *2*(1-2), 71–85. https://doi.org/10.1016/j.joat.2015.08.002

World Bank. (2019). World development indicators. https://data.worldbank.org/data-catalog/world-development-indicators

Zahonogo, P. (2016). Trade and economic growth in developing countries: Evidence from Sub-Saharan Africa. *Journal of African Trade*, *3*(1-2), 41–56. https://doi.org/10.1016/j.joat.2017.02.001

Appendix

Table A1. List of countries.

S/No.	Country	Region	S/No.	Country	Region
1	Algeria	NA	28	Libya	NA
2	Angola	CA	29	Madagascar	SA
3	Benin	WA	30	Malawi	SA
4	Botswana	SA	31	Mali	WA
5	Burkina Faso	WA	32	Mauritania	NA
6	Burundi	EA	33	Mauritius	SA
7	Cabo Verde	WA	34	Morocco	NA
8	Cameroon	CA	35	Mozambique	SA
9	Central African Republic	CA	36	Namibia	SA
10	Chad	CA	37	Niger	WA
11	Comoros	EA	38	Nigeria	WA
12	Congo, Dem. Rep.	EA	39	Rwanda	EA
13	Congo, Rep.	EA	40	Sao Tome and Principe	CA
14	Cote d'Ivoire	WA	41	Senegal	WA
15	Djibouti	EA	42	Seychelles	EA
16	Egypt, Arab Rep.	NA	43	Sierra Leone	WA
17	Equatorial Guinea	CA			
18	Eritrea	CA	44	South Africa	SA
19	Ethiopia	CA	45	South Sudan	EA
20	Gabon	CA	46	Sudan	NA
21	The Gambia, The	WA	47	Swaziland	SA
22	Ghana	WA	48	Tanzania	EA
23	Guinea	WA	49	Togo	WA
24	Guinea-Bissau	WA	50	Tunisia	NA
25	Kenya	EA	51	Uganda	EA
26	Lesotho	SA	52	Zambia	EA
27	Liberia	WA	53	Zimbabwe	EA

Source: Authors' Compilation.

Table A2. Africa and the Rest of the World – GDP and HDI.

Region	GDP	HDI
Central Africa	**2.19E+10**	**0.485**
East Africa	**1.38E+10**	**0.501**
East Asia and the Pacific	1.71E+13	0.688
Europe and Central Asia	2.12E+13	0.737
Latin America and the Caribbean	5.35E+12	0.732
The Middle East and North Africa	2.77E+12	
North Africa	**9.39E+10**	**0.632**
North America	1.69E+13	
OECD		0.872
South Asia	2.08E+12	0.585
Southern Africa	**4.40E+10**	**0.551**
Sub-Saharan Africa	1.39E+12	0.498
West Africa	**2.96E+10**	**0.449**
World		0.697

Note: 2.19E+10 = 21,900,000,000.00.
Source: Authors' Computations.

Table A3. Bootstrap Least Squares Dummy Variables Results for Sub-Regions (Mobile Phones) – Robustness.

	GDP, log					*HDI*				
Variables	*Central Afr.*	*East Afr.*	*North Afr.*	*Southern Afr.*	*West Afr.*	*Central Afr.*	*East Afr.*	*North Afr.*	*Southern Afr.*	*West Afr.*
Constant	314.5319***	380.9308***	151.1559*	357.2430***	448.2200***	28.0707***	1.6291	1.0342	20.2641**	5.7041
	(2.97)	(10.31)	(1.74)	(6.07)	(12.18)	(2.67)	(0.47)	(0.09)	(2.13)	(1.64)
GFCF, log	0.1874	0.1733	−0.6671***	0.7039***	0.1161*	0.0123	0.0172**	−0.1381***	0.1314***	−0.0079
	(0.55)	(1.16)	(−2.72)	(4.75)	(1.74)	(0.44)	(2.14)	(−3.55)	(4.53)	(−1.16)
LABOUR, log	1.9080***	−0.4515	0.9167	−1.0214**	−0.9188***	−0.2129***	−0.0549**	−0.2636	0.3058***	0.0301
	(3.41)	(−1.31)	(0.70)	(−2.42)	(−3.47)	(−4.41)	(−2.02)	(−1.05)	(4.49)	(1.26)
INFLATION	−0.0066	0.0000	−0.0053	−0.0111	0.0032	0.0004	−0.0000	0.0014	−0.0004	0.0010
	(−0.56)	(0.00)	(−0.34)	(−1.23)	(0.47)	(0.29)	(−0.00)	(0.56)	(−0.22)	(0.98)
TRADE, log	0.4127	0.1742	−9.6569***	−1.2725	1.4357	0.3164	−0.0926	−0.0513	0.9103	0.0609
	(0.12)	(0.20)	(−3.55)	(−0.56)	(1.59)	(0.95)	(−0.76)	(−0.10)	(1.34)	(0.68)
INTERNET, log	0.3661***	0.1307***	−0.2194	0.4274***	0.0856	0.0897***	0.0401***	−0.0122	0.1390***	0.0504***
	(3.77)	(4.40)	(−1.39)	(5.89)	(1.55)	(8.05)	(13.54)	(−0.43)	(11.50)	(12.36)
MOBILE, log	0.3627	0.7886***	−1.3815**	0.6825	1.5130***	0.0694	−0.0381	0.0058	0.2891	0.0000
	(0.39)	(3.32)	(−2.01)	(1.02)	(6.22)	(0.76)	(−1.20)	(0.04)	(1.47)	(0.00)
TRADE*MOBILE, log	0.0812	0.0139	0.5906***	−0.0010	−0.1247**	−0.0183	0.0094	0.0181	−0.0728	−0.0007
	(0.36)	(0.24)	(3.51)	(−0.01)	(−2.16)	(−0.83)	(1.20)	(0.55)	(−1.55)	(−0.11)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Observations	69	102	66	87	156	69	102	66	87	156
Bootstrap Replications	46	45	48	44	49	45	42	42	47	47

Notes**:** ***, **, *are statistical significance at the 1%, 5% and 10% levels respectively; *t*-statistics in () are based on bootstrapped standard errors from 50 replications; GFCF = Gross fixed capital formation.

Source: Authors' Computations.

Table A4. Bootstrap Least Squares Dummy Variables Results for Sub-Regions (Fixed Telephone) – Robustness.

	GDP, log					*HDI*				
Variables	*Central Afr.*	*East Afr.*	*North Afr.*	*Southern Afr.*	*West Afr.*	*Central Afr.*	*East Afr.*	*North Afr.*	*Southern Afr.*	*West Afr.*
Constant	−37.8338	−180.0576	−170.8687**	−41.1029	−307.3696***	32.6200***	−1.0003	−34.0583***	24.5653***	7.3957**
	(−0.48)	(−1.62)	(−2.04)	(−0.63)	(−5.92)	(5.17)	(−0.31)	(−2.86)	(3.75)	(2.45)
GFCF, log	0.0030	0.2885	0.0617	0.3652	−0.6863***	−0.0033	0.0041	−0.0933***	0.0574**	−0.0030
	(0.01)	(0.97)	(0.44)	(1.32)	(−7.37)	(−0.17)	(0.32)	(−3.51)	(2.16)	(−0.37)
LABOUR, log	0.5467*	3.1624***	0.2489	1.6806***	−1.9211***	−0.1875***	−0.0182	−0.2138	0.0382	0.0129
	(1.70)	(3.88)	(0.20)	(2.99)	(−4.36)	(−4.82)	(−0.69)	(−1.27)	(0.76)	(0.55)
INFLATION	−0.0005	−0.0000	−0.0258**	0.0049	0.0433***	0.0004	−0.0000	0.0006	0.0018	0.0011
	(−0.05)	(−0.00)	(−2.03)	(0.28)	(5.27)	(0.34)	(−0.01)	(0.29)	(0.92)	(1.02)
TRADE, log	−1.4229	10.6372***	−6.3034***	14.5490***	4.3599***	0.3820***	0.2448***	−0.4797*	−1.1139***	−0.0559
	(−1.30)	(3.79)	(−3.44)	(5.53)	(6.21)	(2.90)	(2.89)	(−1.85)	(−5.12)	(−1.02)
INTERNET, log	0.1785**	−0.0384	−0.2372	0.4163***	−0.1651***	0.0944***	0.0406***	−0.0440**	0.0789***	0.0475***
	(2.09)	(−0.24)	(−1.35)	(3.39)	(−2.93)	(8.18)	(10.40)	(−2.07)	(7.15)	(10.19)
FIXED TEL, log	−0.5003	4.5079***	−0.9725*	6.1822***	2.9189***	0.1190**	0.0752**	−0.1488*	−0.3836***	−0.0441*
	(−1.22)	(4.12)	(−1.75)	(7.13)	(9.59)	(2.53)	(2.19)	(−1.81)	(−5.24)	(−1.88)
TRADE*TEL, log	0.2481**	−0.9335***	0.3938***	−1.2886***	−0.4583***	−0.0298**	−0.0191**	0.0497**	0.0971***	0.0109**
	(2.40)	(−3.53)	(2.87)	(−6.52)	(−6.49)	(−2.46)	(−2.39)	(2.46)	(5.62)	(2.11)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Observations	66	101	66	87	149	66	101	66	87	149
Bootstrap Replications	38	47	43	44	48	38	44	46	47	47

Notes: ***, **, *are statistical significance at the 1%, 5% and 10% levels respectively; *t*-statistics in () are based on bootstrapped standard errors from 50 replications; GFCF = Gross fixed capital formation.
Source: Authors' Computations.