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Is ICT a Complement or Substitute? A Cross-Regional Study on the Impacts of ICT Access and Usage on Unemployment

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ABSTRACT

Information and communication technology (ICT) is fast becoming a key tool in driving sustainable development. Not only does it revolutionize the world economic structure, but ICT also promotes employment by paving the way for more and better jobs. However, the body of literature posits that ICT results in two conflicting impacts: compensation (positive) and substitution (negative). The fact that the unemployment level remained high even after the economic and financial turmoil of 2008 – 2009 triggers a global concern of whether ICT reshapes the labour market in a more positive or negative manner. Building on this problem, this study empirically estimates the impact of ICT access and usage on unemployment rate in five country groups, namely Africa, Americas, Middle East, Asia and Europe, over the 2006 to 2018 period. Using the dynamic panel data approach with Instrumental Variables (IV) and Blundell-Bond System Generalized Method of Moments (GMM) as the main estimators, this study found evidence consistent with the compensation theory where ICT reduces unemployment rate via several market mechanisms for all country groups except the Middle East.

INTRODUCTION

As information and communication technology (ICT) continues to pick up speed in its diffusion and adoption across borders, the structure of global economies will undergo tremendous

changes. The labour market, for instance, becomes more innovative and inclusive as ICT results in more and new job creation, as well as improves the job-search process. According to the Institute for the Future mentioned in International Telecommunication Union report (2012), there are six drivers most likely to shape the future workforce: longer life spans; increase in smart devices and systems; improvements in computational systems; new multimedia technology; the continuing development of social media; and a globally connected world. This goes to show that technological innovations have the potential to unlock new employment opportunities generated by both ICT-using and ICT-producing industries, which subsequently drives global economic growth.

Employment effects of ICT include both process innovations and product innovations: process innovation refers to the adoption of a new or improved production method, whereas a product innovation relates to the commercialization of new and improved products (Spiezia, Polder, & Presidente, 2016). While positive employment impacts are more evident in the case of product innovation, the impact of ICT on employment with regard to process innovation remains ambiguous. On one hand, ICT process innovations allow the production of goods and services with a lesser amount of labour force, especially when new technologies may take over some task causing certain jobs to be obsolete. This could lead to the possibility of labour, particularly the low-skilled workers, being displaced by technological innovation, thus leading to higher unemployment. On the other hand, process innovation can result in the reduction of production cost that translates to lower price. Lower price promotes greater demand for goods and services, which in turn generates more production and employment to cater to this increasing demand.

Several researchers have argued that ICT is either a substitute (Bresnahan, Brynjolfsson, & Hitt, 2002; Autor, Levy, & Murnane, 2003) or a complement (Kaiser, 2003; Gunnarsson, Mellander, & Savvidou, 2004) to human capital. Deployment of ICT may not be favoured as technologies replace routine tasks and eventually hollow out low- and medium-skilled jobs in developing economies. However, as discussed by Brynjolfsson and McAfee (2014), ICT does not necessarily reduce demand for labour; it simply reallocates the demand to different forms of work, including a new job. Building on these conflicting views, this study attempts to investigate the impact of two distinct dimensions of ICT – access and usage – on unemployment rate across several country groups, by using a more recent period of 2006 to 2018.

ICT AND UNEMPLOYMENT

Two dominant and competing views that reflect the potential employment impact of ICT are commonly associated with compensation and substitution theories. The compensation theory proposes that the initial effect of labour-saving or displacement of workers resulting from the adoption of ICT can be counterbalanced in the long-run by a few market compensation mechanisms. These mechanisms are related to job creation which can be a result of (i) producing new products, (ii) reduction of unit costs in production, as well as (iii) increase in consumption due to greater demand. On the other hand, the substitution theory proposes that the labour-saving impact of ICT can cause both positive and negative job displacement among labour of various skill levels. It could result in polarization of the labour market; whereby employment may branch off into both the low and high skills bracket, at the expense of middle-skill jobs (Goos & Manning, 2007). Additionally, the substitution theory also put forward an extreme view whereby the labour-saving impact of ICT could also potentially result in a jobless economy where human intelligence is replaced by computers in almost all jobs (Sabadash, 2013).

In general, studies investigating the link between technology and unemployment reach a comparable conclusion that renders ICT development as insignificant in causing job destruction or loss in employment. Take for example a firm-level study by Harrison, Jaumandreu, Mairesse and Peters (2008) that analysed whether the process and product innovations have any impact on the growth of employment. Their study found no indication of job displacement impacts linked to product innovation in the manufacturing sector, and similar evidence is also observed in the case of process innovation in the services sectors. These findings correspond rather well with the body of literature supporting the strong positive employment impact of ICT through product innovation, as well as the fragile employment impact of process innovation (Peters, 2004). In another effort to determine whether ICT replaces and lowers the demand for labour, Pantea, Biagi and Sabadash (2014) in their study also did not discover any significant and negative correlation between the intensity of ICT usage and employment growth.

Although some studies indicated either neutral (Hall, Lotti & Mairesse, 2008; Giuliodori & Stucchi, 2012) or positive (Lachenmaier & Rottmann, 2011) employment impacts of ICT, several other studies, however, found the opposite results. A study by Michaels, Natraj, and Van Reenen (2010) for instance, found evidence in line with the ICT-based polarization premise, thereby supporting the substitution theory hypothesis. Using industry-level data of the United States, Japan, as well as nine European countries for the period of 1980 to 2004, their results showed that industries that underwent faster ICT growth would not only see an increasing relative demand for highly educated workers at a faster rate, but it is also accompanied by a higher fall in relative demand for middle educated workers. Such evidence is consistent with studies by Heydari and Kiani (2015) as well as by Rasoulinezhad and Nouri (2009), where findings from both studies indicated that ICT is negatively associated with the employment of unskilled labour. Moreover, Evangelista, Guerrieri, and Meliciani (2014) highlighted that the displacement impact of ICT is likely to be more pronounced in industries characterised by a high share of human labour and routine jobs such as the services sector. While it was found that relationship between technological change and employment differs across industries, a study by Ju (2014) revealed that ICT has a significant and negative effect on employment growth especially for middle-low skilled workers in the manufacturing industry.

Majority of the previous studies (Marquez-Ramos & Martínez-Zarzoso, 2010; Mattes, Meinen, & Pavel, 2012; Evangelista et al., 2014) employed the use of a composite index such as ICT Access Index and ICT Use Index as a proxy to measure the level of ICT development of a country. When these indices are tested for their relationship with economic indicators, it is not established which component of the indices bears more significance. Therefore in this study, two proxies of ICT access (fixed broadband subscriptions and mobile phone subscriptions) and one proxy of ICT usage (Internet users) are used as ICT variables, whereby each of these variables is individually estimated to determine which of these different forms of technology gives a significant influence on the unemployment rate.

METHODOLOGY

An econometric analysis for testing the relationship between ICT and unemployment involved a panel dataset comprising of 136 countries across the globe over a 13-year period (2006 to 2018). Subject to data availability, the sample countries are further classified into 5 country groups: Africa, Americas, Middle East, Asia and Europe. The dependent variable is the unemployment rate (%) while the independent variables comprise of several ICT variables and control variable.

Regression Model

Building upon the standard endogenous growth theory, this study adopted the dynamic panel regression model proposed by Andrianaivo and Kpodar (2011) as follows:

$$y_{it} = \alpha_i + \sum_{m=1}^{M} \beta_m y_{i,t-m} + \sum_{m=0}^{M} \gamma_m MOB_{i,t-m} + \sum_{m=0}^{M} \delta_m X_{i,t-m} + \varphi_i + \mu_{it} \quad (1.0)$$

where *y* is the logarithm of real GDP per capita; MOB refers to mobile phone development; and *X* is a set of determinants of economic growth which consists of rate of primary school enrolment, inflation, government consumption and institutional development. For this study, the aforementioned model (1.0) is improvised by (i) substituting GDP with unemployment as the primary economic indicator to be tested against the independent variables, (ii) adding additional proxies of ICT apart from mobile phone, and (iii) considering a different set of control variables consistent with the endogenous growth model as shown below:

$$UNE_{it} = \alpha_i + \sum_{m=0}^{M} \beta_m UNE_{i,t-m} + \sum_{m=0}^{M} \gamma_m LAB_{i,t-m} + \sum_{m=0}^{M} \gamma_m CAP_{i,t-m} + \sum_{m=0}^{M} \gamma_m ICT_{i,t-m} + \sum_{m=0}^{M} \delta_m Z_{i,t-m} + \varphi_t + \mu_{it} \quad (1.1)$$

where UNE is unemployment rate; LAB and CAP denote total labour force and gross fixed capital formation respectively; ICT represents proxies of technological development as separately measured by fixed broadband subscriptions (FBB), mobile phone subscriptions (MOB) and Internet users (INTR); and Z refers to control variables comprising of inflation rate (INF), gross secondary enrolment ratio (EDU) and health expenditure (HLT). Since the model may be plagued with problems of heteroskedasticity and endogeneity, this study employs the Instrumental Variables (IV) estimator and the Blundell-Bond system Generalised Method of Moments (GMM) estimators to produce reliable parameter estimates.

FINDINGS

Tables 1, 2 and 3 report empirical results obtained from dynamic panel data analysis for all country groups sampled for this study. In what follows, overall findings from this study mainly refers to results generated by the system GMM estimator as it is regarded as a more efficient estimator compared to IV when dealing with regression models with heteroskedastic errors (Baum, Schaffer, & Stillman, 2003). In addition, to ensure the reliability of results produced by system GMM estimator, the Arellano-Bond (AR) tests are carried out to detect for both first-order autocorrelation, AR(1) and second-order autocorrelation, AR(2). Generally, first-order correlation is expected due to the inclusion of a lagged dependent variable as part of the independent variables in the regression model (Habimana, 2017). Therefore, performing the subsequent AR(2) test is required to verify that the error terms are free from any serial correlation. Moreover, the Sargan test is another important test to be carried out in this study as it not only helps to verify the validity of instruments used but to also confirm that such instruments are independent of error terms. Based on the result of the AR(2) test as well as the Sargan test, large p-values generated by both tests (as presented in their corresponding brackets in Tables 1, 2 and 3) do not reject their respective null hypotheses which therefore indicated absence of serial correlation between the error terms and validity of instruments used.

Referring to the empirical results produced by the system GMM estimator, it is revealed that only a few ICT variables emerged significantly in influencing rate of unemployment for all 5 country groups – Africa, Americas, Middle East, Asia and Europe. In the case of Middle East countries, all ICT

variables are found statistically insignificant as shown in Table 2. This could be due to the level of ICT penetration in the Middle East is relatively lower as compared to other regions and therefore, is not sufficient to produce any evidence of significance. Other findings obtained from the dynamic panel data model analysis point to the relative importance of certain ICT variables in certain groups of countries. Fixed broadband subscriptions for instance, appeared to have a significant reducing impact on the unemployment rate especially for country groups Africa, Asia and Europe. It is surprising to observe that fixed broadband emerged as a significant form of ICT in influencing employment growth in Africa, alongside the relatively more technologically advanced country groups like Asia and Europe. The coefficient value of fixed broadband subscription in Africa suggests that a 10 percentage point increase in fixed broadband subscriptions is associated with a 0.379 percentage point decrease in Africa's unemployment rate. From this analysis, evidence of the importance of having access to ICT especially in the form of fixed broadband in helping to bring down the unemployment rate agrees well with findings from a study done by Katz (2009). His study showed that broadband penetration can promote employment by the creation of more jobs resulting from the development of broadband infrastructure, via businesses or suppliers that provide inputs to entities involved in building and developing the said broadband infrastructure, as well as through the induced effects in other economic areas.

Table 1 Empirical results of dynamic panel data analysis on the impact of ICT on unemployment for Africa and the Americas

REGION	AFRICA						AMERICAS					
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
VARIABLES	lnune	lnune	lnune	lnune	lnune	lnune	lnune	lnune	lnune	lnune	lnune	lnune
L.lnune	0.237***	−0.0923	0.261***	0.261*	0.253***	−0.286**	0.371***	0.487***	0.347***	0.0472	0.366***	0.346***
	(0.0663)	(0.374)	(0.0633)	(0.157)	(0.0633)	(0.123)	(0.0691)	(0.153)	(0.0701)	(0.176)	(0.0673)	(0.121)
lnfbb	−0.0319*	−0.0379*					−0.0412	0.00494				
	(0.0179)	(0.0225)					(0.0439)	(0.0442)				
lnmob			−0.0907	0.0227					0.239**	−0.654*		
			(0.0625)	(0.0562)					(0.0963)	(0.361)		
lnintr					−0.0310	−0.0945					−0.00660	0.136
					(0.0392)	(0.107)					(0.102)	(0.129)
lnlab	0.334	0.293	0.419	0.0477	0.213	0.502	0.169	−0.0909	−0.296	−1.302	0.106	0.0293
	(0.241)	(0.332)	(0.316)	(0.284)	(0.287)	(0.760)	(0.456)	(0.100)	(0.411)	(1.174)	(0.530)	(0.750)
lncap	−0.0485	0.0104	−0.0310	−0.0351	−0.0338	0.0246	−0.123*	−0.0801***	−0.188***	−0.324**	−0.157**	−0.161*
	(0.0350)	(0.0562)	(0.0304)	(0.0542)	(0.0305)	(0.0325)	(0.0643)	(0.0272)	(0.0620)	(0.144)	(0.0630)	(0.0830)
lninf	−0.00483	0.000467	−0.00228	0.00121	−0.00101	0.000649	−0.0505***	−0.0538***	−0.0359**	−0.0268**	−0.0453***	−0.0373***
	(0.0117)	(0.00274)	(0.0107)	(0.00369)	(0.0107)	(0.00476)	(0.0174)	(0.0183)	(0.0174)	(0.0134)	(0.0167)	(0.0139)
lnedu	−0.0518	0.0209	−0.0447	−0.125	−0.0646	0.0679	0.278	0.954	0.501	1.145**	0.301	2.116***
	(0.201)	(0.115)	(0.190)	(0.219)	(0.192)	(0.273)	(0.472)	(0.602)	(0.485)	(0.535)	(0.475)	(0.662)
lnhlt	0.105	0.0298	0.0717	−0.0194	0.0701	0.0267	0.128	0.821**	0.0937	0.451**	0.0920	0.586***
	(0.0653)	(0.0550)	(0.0576)	(0.0502)	(0.0577)	(0.0555)	(0.125)	(0.371)	(0.128)	(0.180)	(0.123)	(0.225)
Constant	−0.933	−1.192	−1.545	1.019	−0.229	−2.505	0.280	−1.002	1.691	5.408	0.816	−3.435
	(1.508)	(1.771)	(2.026)	(2.044)	(1.900)	(5.230)	(3.227)	(1.048)	(2.730)	(7.108)	(3.517)	(5.150)
R-squared	0.1192		0.1080		0.1052		0.4190		0.3734		0.4161	
AR(1)	−0.5568 [0.5777]		−1.2306 [0.2185]		−0.1930 [0.8470]		−1.7933 [0.0729]		−0.1723 [0.8632]		−1.6826 [0.0925]	
AR(2)	0.1372 [0.8908]		0.9261 [0.3544]		−1.477 [0.1397]		−0.7157 [0.4742]		−1.2829 [0.1995]		−0.8616 [0.3889]	
Sargan Test	19.1723 [0.3813]		30.4378 [0.2498]		18.2042 [0.4423]		7.5995 [0.9998]		15.1204 [0.2349]		15.3709 [0.2218]	
No. of countries	33		36		36		19		20		20	

Notes: Values in parentheses are robust standard errors, whereby ***, ** and * indicate significance at 1%, 5% and 10% levels, respectively. Columns denoted by (1) and (2) represent Instrumental Variable estimator and Blundell-Bond System GMM estimator, respectively. T-statistics for first and second-order correlation are indicated by AR(1) and AR(2), with their corresponding p-values presented in brackets.

Table 2 Empirical results of dynamic panel data analysis on the impact of ICT on unemployment for the Middle East and Asia

REGION	MIDDLE EAST						ASIA					
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
VARIABLES	lnune	lnune	lnune	lnune	lnune	lnune	lnune	lnune	lnune	lnune	lnune	lnune
L.lnune	0.463***	0.902***	0.447***	0.787**	0.459***	0.878**	0.601***	0.955***	0.611***	1.063***	0.610***	1.113***
	(0.0875)	(0.347)	(0.0870)	(0.376)	(0.0879)	(0.435)	(0.0512)	(0.164)	(0.0505)	(0.0611)	(0.0503)	(0.0618)
lnfbb	0.0502	0.00960					0.0277	−0.00249*				
	(0.0257)	(0.0674)					(0.0194)	(0.0251)				
lnmob			0.105	0.00845					0.0663	−0.0235		
			(0.0426)	(0.0878)					(0.0424)	(0.0403)		
lnintr					0.103	0.0489					0.0483	−0.00133*
					(0.0586)	(0.103)					(0.0309)	(0.0210)
lnlab	−0.110	0.125	−0.0810	0.165	−0.144	−0.0264	0.191	0.0110	0.201*	0.0232	0.175	−0.00132
	(0.147)	(0.140)	(0.126)	(0.556)	(0.170)	(0.106)	(0.124)	(0.0514)	(0.120)	(0.0402)	(0.126)	(0.0450)
lncap	−0.00415	−0.154	−0.0544	−0.0393	−0.0490	−0.0181	−0.150***	−0.000710	−0.152***	0.0109	−0.156***	0.0114
	(0.0395)	(0.292)	(0.0418)	(0.190)	(0.0437)	(0.160)	(0.0398)	(0.0298)	(0.0394)	(0.0233)	(0.0407)	(0.0186)
lninf	0.000618	0.0116	−0.00526	2.64e-05	−0.00811	−0.00274	−0.00621	−0.0121	−0.00836	−0.0108	−0.00802	−0.0135
	(0.0166)	(0.0325)	(0.0165)	(0.0499)	(0.0172)	(0.0255)	(0.00976)	(0.0146)	(0.00965)	(0.0112)	(0.00960)	(0.0106)
lnedu	−0.176	0.821	−0.204	−0.453	−0.423	−0.265	−0.325	−0.0793	−0.338	−0.0836	−0.322	0.129
	(0.318)	(1.637)	(0.307)	(1.111)	(0.309)	(0.783)	(0.227)	(0.419)	(0.228)	(0.202)	(0.225)	(0.194)
lnhlt	-0.000575	0.0624	0.0384	0.0960	0.0717	0.0112	0.0928	0.113*	0.0712	0.0873	0.0811	0.00389
	(0.0933)	(0.138)	(0.0821)	(0.525)	(0.0810)	(0.432)	(0.0755)	(0.0652)	(0.0759)	(0.0688)	(0.0750)	(0.0791)
Constant	1.474*	−0.999	1.427*	0.479	2.843**	1.036	1.306	0.0891	0.974	−0.0293	1.576	−0.503
	(0.817)	(2.163)	(0.782)	(1.369)	(1.352)	(2.004)	(0.979)	(0.955)	(0.830)	(0.470)	(1.057)	(0.518)
R-squared	0.3547		0.3679		0.3505		0.5980		0.5967		0.6010	
AR(1)	−1.6743 [0.0941]		−1.466 [0.1426]		−1.4493 [0.1473]		−2.2703 [0.0232]		−2.5864 [0.0097]		−2.5701 [0.0102]	
AR(2)	1.5268 [0.1268]		1.0813 [0.2796]		1.1658 [0.2437]		−1.1482 [0.2509]		−1.1516 [0.2495]		−1.1152 [0.2648]	
Sargan Test	5.2821 [1.0000]		6.5132 [1.0000]		6.2519 [1.0000]		24.8259 [0.8130]		25.5974 [0.4854]		24.4398 [0.5508]	
No. of countries	12		12		12		31		31		31	

Notes: Values in parentheses are robust standard errors, whereby ***, ** and * indicate significance at 1%, 5% and 10% levels, respectively. Columns denoted by (1) and (2) represent Instrumental Variable estimator and Blundell-Bond System GMM estimator, respectively. T-statistics for first and second-order correlation are indicated by AR(1) and AR(2), with their corresponding p-values presented in brackets.

Table 3 Empirical results of dynamic panel data analysis on the impact of ICT on unemployment for Europe

REGION	EUROPE					
	(1)	(2)	(1)	(2)	(1)	(2)
VARIABLES	lnune	lnune	lnune	lnune	lnune	lnune
L.lnune	0.424***	0.388***	0.499***	0.748	0.465***	0.422***
	(0.0375)	(0.0570)	(0.0385)	(0.741)	(0.0384)	(0.0409)
lnfbb	−0.251***	−0.121**				
	(0.0433)	(0.0554)				
lnmob			−0.272*	−0.309		
			(0.161)	(6.879)		
lnintr					−0.219***	−0.170
					(0.0617)	(0.110)
lnlab	0.368	0.971	−0.0943	−0.384	0.240	0.957**
	(0.671)	(0.819)	(0.469)	(5.998)	(0.445)	(0.483)
lncap	−0.412***	−0.716***	−0.459***	−0.0476	−0.494***	−0.713***
	(0.0551)	(0.141)	(0.0555)	(0.737)	(0.0529)	(0.112)
lninf	0.00138	−0.00299	−0.00699	−0.0252	−0.00115	−0.00610
	(0.00875)	(0.00879)	(0.00866)	(0.150)	(0.00862)	(0.00749)
lnedu	−0.235	0.237	−0.355	0.824	−0.335	0.116
	(0.379)	(0.450)	(0.357)	(21.40)	(0.337)	(0.380)
lnhlt	0.646***	1.216***	0.765***	0.995	0.699***	1.196***
	(0.124)	(0.292)	(0.168)	(3.170)	(0.165)	(0.216)
Constant	4.189	−0.419	4.396	−1.670	4.120	0.395
	(3.293)	(5.303)	(2.876)	(46.85)	(2.795)	(3.707)
R-squared	0.7326		0.6964		0.7125	
AR(1)	−1.1648 [0.2441]		−0.2929 [0.7696]		−1.071 [0.2842]	
AR(2)	−1.5369 [0.1243]		−1.3839 [0.1664]		−1.2839 [0.1992]	
Sargan Test	25.7251 [0.1062]		35.0815 [0.7994]		31.1943 [0.3563]	
No. of countries	37		37		37	

Notes: Values in parentheses are robust standard errors, whereby ***, ** and * indicate significance at 1%, 5% and 10% levels, respectively. Columns denoted by (1) and (2) represent Instrumental Variable estimator and Blundell-Bond System GMM estimator, respectively. T-statistics for first and second-order correlation are indicated by AR(1) and AR(2), with their corresponding p-values presented in brackets.

In Asia, apart from fixed-broadband subscriptions, the only proxy of ICT usage in this study which is Internet users is another ICT variable that emerged significantly in reducing the unemployment rate. This finding is consistent with that of Barber (2006) who revealed that the Internet has served as a medium between job seekers and potential employers by facilitating information exchange pertaining to job search and recruitment processes. Meanwhile, for country group Americas, mobile phone subscriptions are the only proxy measuring ICT access that has a significant influence on the unemployment rate. Its corresponding coefficient value suggests that a greater number of mobile phone subscriptions leads to a lower unemployment rate in the Americas by 0.654.

CONCLUSION AND RECOMMENDATION

This study presents empirical evidence regarding the impact of ICT access and usage on the unemployment rate across five world regions: Africa, Americas, Middle East, Asia and Europe over the period of 2006 to 2018. A key feature of this study is the inclusion of non-conventional forms of ICT such as the fixed broadband, mobile phone and the Internet. Using the Instrumental Variable and Blundell-Bond system GMM estimators, empirical findings revealed that having access and usage to ICT has a negative impact on the unemployment rate. This holds true for all regions, with the exception of Middle East countries, as none of the four ICT appeared statistically insignificant. Fixed broadband subscriptions have a significant reducing effect on unemployment rate particularly in Asia, Europe and even Africa, implying that raising the amount of access to this modern form of technology can bring down the number of unemployed in the said regions. Additionally in Asia, increasing the intensity of Internet usage among the population would also lead to a lower unemployment rate. As for Americas on the other hand, mobile phone subscriptions in the only ICT variable out of the three to emerge with a significant and negative correlation with the unemployment rate, indicating the importance of mobile telecommunication network in promoting employment in the region.

In sum, although the degree of impact varies across regions, the overall result of this study is consistent with existing literature whereby ICT does not always reduce the demand for labour, instead, it acts as a complement to the human job. ICT also lowers the unemployment rate as evidenced by their significant and negative relationship found in this study. Overall findings of this study, therefore, support the compensation theory which suggests that the displacement of workers due to ICT adoption can be offset in the long-run by a few market compensation mechanisms. These mechanisms are related to job creation resulting from (i) producing new products, (ii) reduction of unit costs in production, as well as (iii) increase in consumption.

It is recommended that governments or policymakers design appropriate ICT-related initiatives and strategies to increase the penetration of technology into the countries. To have greater ICT access, cost and price of acquiring ICT hardware and software should be further driven down through stimulated competition. As this study observes that ICT usage has relatively smaller significance than ICT access, governments should also further intensify usage of ICT by making significant investments in integrating ICT into important economic sectors such as education and healthcare. For future research, it is recommended to look into the impact of ICT particularly on youth unemployment, which peaked at an all-time high during the global financial crisis and continued to be at high levels after the crisis. As youth presents profound potential development of human capital which nations cannot afford to overlook, it is thus important to investigate whether ICT can too become an effective tool to tackle the problem of youth unemployment across the globe.

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