Innovations

Effects of Digital Technology on Employment Growth in Sub-Saharan Africa: Evidence from One-Step Difference GMM

Elfenesh Muleta Beyene*[1], Amsalu Bedemo Beyene*[2], Atnafu Gebremeskel Sore *[3]

1. PhD candidate in Economics, Department of Economics, College of Business and economics, Wallaga University, Ethiopia.
2. School of Policy Studies, Ethiopian Civil service University Ethiopia.
3. College of Business and Economics, Addis Ababa University, Ethiopia.

* Corresponding author: **Elfenesh Muleta Beyene**

Abstract

This study examines the effects of digital technology on employment growth in Sub-Saharan African countries. The data were obtained from 27 Sub-Saharan African countries from 2010 to 2020 and the one step Difference GMM method of estimation was employed. The findings show that digital technology positively affect employment growth through overall digital technology index, digital technology usage index, and digital empowerment index whereas, government general consumption expenditure harms employment growth in the region. This undesirable result of government spending is due to allocating government spending in favor of Unproductive expenditures that arise because of uncertainties, the lack of a well-trained civil service, inadequate checks and balances in the political and budgetary process, and corruption. The result implies that there is a need for policy intervention in terms of investment in digital technology development, improving digital skills and creating awareness about digital technology, and empowering people to use digital technology and allocating government expenditure in favor of productive expenditure.

Keywords: 1.*Digital technology, 2.Employment Growth, 3.One-Step Difference GMM, 4.Sub-Saharan Africa*

1. Introduction

The digital revolution has transformed the economy and society since the late 1980s. It first came in terms of the development of a connected economy that characterized by mass take-up of the Internet and the roll-out of broadband networks. This was followed by the development of a digital economy via the increasing use of digital platforms as business models for the supply of goods and services. Now the movement is towards a digitalized economy whose production and consumption models are based on the incorporation of digital technologies in all economic, social and environmental dimensions((ECLAC, 2021).

The digital economy, also known as the Internet economy, new economy, or the Web economy, refers to the economy that is based in a large part on digital technologies, including digital communications networks (Internet, intranets, etc.), computers, software, and other related information technologies(Schilirò, 2021).It is characterized by the digitization of many products and services and by the use of the Internet and other networks to support the whole economic activities(Unold, 2003).This new economy like digital technology are generally seen as drivers of economic growth and development. However, there is a growing concern

about the effects of new digital technology on employment growth due to an increasing ability of digital technology to replace human labor in the market(Fossen & Sorgner, 2021).

Employment growth in developing countries like Sub –Saharan Africa is crucial issue that attracted worldwide attention. However, these problems are more complex than anticipated. The population has been growing rapidly for many years. For instance, UN estimated that, the total population of Sub Saharan Africa is about 1.0 billion and expected to reach about 1.7 billion in 2040 and the working age population (15-64 years) increases to 20 million people per year(United Nations, 2019). According to (Employment & Outlook, 2019) Sub Saharan Africa is characterized by low-level of employment rate. This employment in the area relies on traditional sector and employment growth rate in the region is only around 3.1 per cent per year which is unsatisfactory. According to (Journal & Scientific, 2020) occupying such a rapidly growing work force into a relatively weak economy can be an incredible task. Many workers continue to struggle with low wages and inhumane, hazardous jobs. Limited social security increases the vulnerability of workers in economic situations. The most urgent task for a region is determining how to quickly generate massive numbers of jobs and guarantee security for its residents with limited purchasing power and investment capital.

In order to solve this problem, the international organizations such as IMF,2018 recommended harnessing digital technology as one of the solution. However, there is a debate and controversies among scholars on the impact of digital technology on employment growth. The positivist view towards effect of digital technology on employment growth, found that, digital technology always fueled economic growth, improved standards of living, and opened up avenues to new and better kinds of work. For instance (Group, 2020), found that, digital technology changes the world of work and reshape the labor markets. It provides advantage of catch up in diversification, productivity, and complexity, and improving access to labour markets and ensuring decent work. As indicated by (Schulte & Howard, 2019), digital technology creates abundant opportunities for workers and boost economies. As technology advanced the way work is done and the number of jobs created has outstripped the number of jobs eliminated. Similarly, (Kravchenko et al., 2019) pointed out that technological waves, will increase the demand for labor in other sectors and create new jobs that did not exist in the past, and therefore lead to higher wages and improvements in the standards of living and they noted that technological advances have historically increased productivity, generated sustained increases in living standards and created more jobs than they have destroyed.

As indicated in (International Labour Organization, 2018),even though the effect of technological changes is likely to be context-specific, differing among countries, sectors and occupations, it expected to improve the functioning of the labour market and improve recruitment processes and to enhance labour market efficiency. (Xue, 2022) found that digital economy increases a number of jobs, though quality of jobs needs to be further improved. It is a double-edged sword indicates, with the rapid expansion of the digital economy, there are new requirements for employment, which harms the traditional, low skilled labor and lead them to unemployment. In another side, digital platforms, such as LinkedIn and Monster.com, the online shopping, e-commerce are connecting individuals with work opportunities in both traditional and digital workplaces which affect employment growth positively.

As mentioned by (Svetlana V & Tetiana K., 2020), the influence of digital technology on employment has two side; on the one hand, it expands the opportunities for youth employment growth, and on the other hand, digitalization leads to a reduction in traditional employment. Young people as the most dynamic and mobile segment of the employed population are the most adaptable one to new working conditions and requirements of new business development patterns. Similarly (McGuinness et al., 2021) found that ,digital technology in terms of automation and technological change have the potential to destroy jobs, as well as to

enhance and improve existing jobs by creating new tasks and roles that did not exist in the past and the positive effects of technological change is highlights it is negative impact.

Pessimists' views on the effect of digital technology on employment and labor productivity quarreled that, technology is not without challenges and also it brings risks. According to (States et al., 2018), increasing in use of digital technology in the form of artificial intelligence (AI) and automation may reduce relative cost of production in emerging economies, decreasing the comparative advantage of low-cost labour in those countries and cause unemployment. Even though digital technology bring economic growth, prosperity, and welfare, it can creates technological unemployment and job polarization erosion of employment,(Zee, 2016 and Carlaw & Lipsey, 2003). Studies by (BBVA, 2015 and WTO, 2017) also revealed that, digital technology causing mass unemployment, due to machines replacing human labour.

This inconsistence in the findings of empirical literatures on effects of digital technology on employment growth require further investigation to find how digital technology influence employment growth. Hence this Study tried to fill this gap by examining the effects of digital technology on employment growth in Sub-Saharan Africa through the help of one step difference GMM method of estimation.

2. Literature Review

There is international debate on digital technology and its potential effect on employment growth. There are two opposite and divergent views on the effects of digitalization on employment growth which named as positivists' view and Pessimists' views. The positivists' view towards digital economy argued that, technology has always fueled economic growth, improved standards of living, and opened up avenues to new and better kinds of work. It changing the world of work and reshaping labor markets(Group, 2020; Schulte & Howard, 2019;Kravchenko et al., 2019).There are many opportunities from digital jobs and the wider use of digital tools in governments, businesses, and individuals can benefit today from new digital jobs and from the use of this digital tools. Digital technologies provide advantage of catch up in diversification, productivity, and complexity, and to leapfrog into advanced technologies and industries for developing countries. Technologies present for improving access to labour markets and ensuring decent work (Group, 2020). As indicated by (Schulte & Howard, 2019) and other positivist views', technological change create abundant opportunities for workers and boost economies. As technology advanced the way work is done and the number of jobs created has outstripped the number of jobs eliminated.

(No et al., 2019) also explains impact of technology on productivity and employment by using two effects that named as, displacement effect and reinstatement effect. As to him technology enable capital to replace labor and reduce labor demand and share of labor in value added which called as displacement effect. The effect of technology is counterbalanced by the creation of new tasks in which labor has comparative advantage. Introduction of new task changes content of production in favor of labor because of reinstatement effect and always raises the labor share and labor demand. Here labor reduced by displacement effect offset by reinstatement effect, labor which mean digital technology has positive effect of employment and labor productivity growth.

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Studies by (BBVA, 2015 and WTO, 2017) also reveal that, digital technology causing mass unemployment, due to machines replacing human labour. Throughout history, technological change has often been a source of anxiety for many workers. (McAfee, 2014) have also claimed that such disruptive technologies reduce the demand for labour and put workers at a permanent disadvantage.

3. Methodology

To analyze the effect of digital technology on employment growth in Sub-Sahara African countries, the study employed a quantitative research approach through the help of Dynamic panel-data estimation which is a one-step difference GMM. One-step difference GMM was used to examine the effect of digital technology development on employment growth of 27 sample countries in Sub-Saharan Africa for the time 2010- 2020 based on data availability and model suitability.

3.1. Data sources and description

A secondary source of data was employed. Standardized secondary data on required components were taken from reputable data sources, such as the World development indicators (WDI), the World Economic Forum, African Development Indicators (ADI), and the World Labor Organization (WLO).

This study aims to examine the effect of digital technology on employment growth. Thus, to achieve the required objective, the annual data on employment growth rate, digital technology, and other control variables are needed and obtained from different sources for Sub-Saharan African countries. But due to the unavailability of a complete set of data for all countries, the study has made a limited choice of only 27 Sub-Saharan African countries (for which there is a complete dataset).
The dependent variable, Employment growth, is measured by the rate of growth of employment. Because of the limited data span in developing countries on digital technology, only the period from 2010 to 2020 was considered. Moreover, due to the scarcity of complete data on digital technology indicators for some countries under investigation, a few missing years were estimated using linear interpolation techniques.
The digital technology Index is one of the explanatory variables of interest in this research. Digital technology has no established aggregate indicator that can be used as a measure of digital technology but most studies either use proxies or compute digital index (Schelenz &Schopp 2018). Data on indicators of digital technology was obtained from the World Bank open database and the International Telecommunication Union. The Digital technology index was computed by using the principal component analysis (PCA). In this study, the digital technology index was constructed from different technological indicators and categorized into the overall digital technology index, and its three pillars named as; the digital infrastructure index, the digital usage index, and the digital empowerment index.

The digital technology indicators as defined by(Evangelista et al., 2014) and applied by different scholars under different contexts are summarized as the digital infrastructure index captures, the number of telephone lines (per 100 people), the number of internet users (per 100 people), the number of broadband internet subscribers (per 100 people), and the number of mobile cell subscribers (per 100 people). Individual digital usage index contains the intensity and quality of the use of internet services as well as skills implied in use of these services. It includes individuals using the Internet, fixed (wired)-broadband per 100 inhabitants and Active mobile broad band subscription per 100 inhabitants. The third digital technology pillar is the digital empowerment index which captures internet takes up in various spheres (education, labor, health). The personal and social empowerment of digitalization in key socio-economic areas: Education, Labour, Health, Government, Economy, Culture and Communication. Besides, the overall digital technology index was estimated from all indicators by using PCA and included in the estimation.

3.2. Econometric model specification

Digital technology has an impact on employment growth. The directions of the impacts are different from scholar to scholar. For some of them, digital technology has a positive effect on employment growth and others revealed that digital technology harms employment growth. For instance, Studies by (BBVA, 2015; WTO, 2017 and De Groen et al., 2017) revealed that digital technology causes mass unemployment, due to machines replacing human labour. Other scholars are advocating the positive effect of digital technology and they conclude that technological change creates abundant opportunities for workers and boosts economies. As technological advances, the way work is done and the number of jobs created has outstripped the number of jobs eliminated (Schulte & Howard, 2019).Hence there is no agreement on the effect of digital technology, and this study tried to find the effect of digital technology on employment growth by employing the dynamic panel GMM model that reflected in the following equation:

$$EMP_{it} = \delta_0 + \delta_1 LC_{it} + \delta_2 DEM_{it} + \delta_3 POP_{it} + \delta_4 INFRA_{it} + \delta_5 USAG_{it} + \delta_6 EMP_{it} + \delta 6 ggcfx_{it} + \delta_6 Inf_{it} + \varepsilon_{it} \quad (1)$$

Where

EMP_{it}: denotes the rate of growth of employment (or the employment rate) of country i at time t

LC_{it}:is the rate of growth of labour costs (measured as total remuneration per employee in Constant prices)

DEM_{it}:is the rate of growth of demand (measured as the rate of growth of GDP at constant prices)

POP_{it}:The rate of growth of the total population

When identifying the impact of digital technology on the employment growth rate, human capital, the rate of growth of demand, and the rate of growth of population are taken as control variables

$INFRA_{it}$: Digital technology infrastructure index

$USAG_{it}$: Digital technology USAGE index

EMP_{it}: Digital technology empowerment index

$ggcfx_{it}$=General government final consumption expenditure, percentage of GDP

Inf_{it}=inflation rate, expressed as the annual average change

Regarding diagnostic tests, the Kaiser-Meyer-Olkin (KMO) test, was used to test the validity of principal component analysis to construct a digital technology index as justified by (Creel, Hubert, & Labondance 2014), and Im-Pesaranm and Shin(1997 and 2003), (IPS) was employed to test panel unit root test. Model specification tests which are Hansen, 1982, J test, and Sargen, 1985 test were used to check the instrumental validity and over-identification problem respectively(Baum et al., 2003). The Second order serial autocorrelation problem was tested by using AR (2) statistics.

4. Findings and discussion

4.1. Descriptive Statistics

In this section of the study, the quantitative data gathered from secondary data sources were analyzed using descriptive statistical methods like mean, standard deviation, minimum, and maximum. As indicated in table 1, the employment growth rate has a mean value of 63.26 and a standard deviation of 14.49, while its lag has a mean value of 63.45 and a standard deviation of 14.47. Foreign direct investment is the second explanatory variable, which appeared in the model with a mean of 3.657 and a standard deviation of 4.93. The mean and standard deviation of the rate of growth in labor cost are 15.65 and 15.61, respectively. The mean and standard deviation of the population growth rate are 2.469 and .812, respectively. Another important explanatory variable is the general government's final consumption expenditure which has 84.243 and

15.011 mean and standard deviations respectively. Inflation has a 7.235 mean with 34.355 standard deviations. The rate of growth of demand appears in the model with 3.89 and 4.179 mean and standard deviation respectively. Regarding descriptive statistics results for interest variables which are the overall digital technology index and its three sub-indices; the digital usage index has a mean of -0.4972 with 1.158 standard deviations. The digital empowerment index exists in the model with 1.030 and 0.556 mean and standard deviation respectively. The digital infrastructure index has a mean of .004527 and a standard deviation equal to 0.779. Finally over digital technology index appears in the model with 0.473 means and a 0.617standard deviation

Table 1: Descriptive Statistics

Variable	Mean	SD	Min	Max
Employment rate	63.26	14.49	35.779	86.031
Lag of employment rate	63.45	14.478	39.315-	86.031
Foreign direct investment	3.657	4.93	11.198	39.456
The rate of growth of labor costs	15.65	15.61	0	83.86891
General government finalconsum.exp.	84.243	15.011	31.717	134.55
The rate of growth of the total population	2.469	.812	17.112	37.634
The rate of growth of demand	3.89	4.179	.002	3.907
Digital infrastructure index*	.004527	.77940	-17.004	19.67
Digital usage index*	-.4972	1.158	-6.234	2.464
Digital empowerment index*	1.030	.556	-2.83065	-2.830296
Overall digital technology index*	.473	.617	-1.139-	2.445
Inflation rate	7.235	34.355	78.562	557.201

Source, prepared by the author, 2022

4.2. Empirical Findings and Discussion

In this paper to estimate the effects of digital technology on employment growth, the digital technology index was computed from its indicators by using principal component analysis. Here overall digital technology index and digital technology sub-indices such as the digital infrastructural index, digital usage index, and digital empowerment index were taken as interest variables with other control variables in the model. To avoid the multicollinearity problem, regression was done two times which is once with the overall digital technology index and the second with digital technology sub-indices as shown in table 2.

As revealed in table 2, Hansen's statistics (0.721) reflected that there is instrumental validity. Second-order serial autocorrelation was checked by using AR (2) statistics which is equal to 0.326 indicating that there is no second-order serial autocorrelation problem in the model, hence, the diagnostics test revealed that, there is no evidence of second-order auto-correlation and over-identifying restrictions. The overall significance of the model was also checked by using F- statistics, F (16, 26) which is highly significant and shows the joint

significance of regressors in explaining the dependent variable. Finally, the model contains 27 groups with 25 instruments which indicates the number of an instrument are less than the number of groups and it is possible to run a one-step Difference GMM estimation model**.** After the model validity test, the results of the one-step difference GMM are presented as follows:

Table 2: One-Step Difference GMM Estimation results

Dependent: Employment rate		
Variable	Coefficient	Std. Err
Lag of employment rate	0.524*	0.264
Digital Technology index	0.527***	0.157
Digital technology empowerment index	0.107*	0.062
Digital technology infrastructure index	0.257	0.179
Digital technology Usage Index	0.201*	0.108
General government final consumption expenditure	-0.016**	0.008
The rate of growth of labor costs	-0.001	0.003
The rate of growth of the total population	0.660	0.806
The rate of growth of demand	0.002	0.018
Foreign direct investment	0.012	0.021
Year dummies		yes
Observations		243
Number of groups		27
AR(1)		0.695
AR(2)		0.326
Hansen		0.721
Sargen		0.107
Number of instruments		25

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

As reflected in table 2, the effects lag of employment growth on current employment growth (0.524) indicate that a unit change in a Lag of employment growth rate is associated with a 0.524 increase in the current year employment growth rate at a 10% significance level on average ceteris paribus in Sub-Saharan African countries. Over all digital technology index has a positive effect (0.527) on employment growth that is a unit increase in the digital technology index leads to a 0.527 increase in employment growth in the region at a 1% significance level when other predictors remain constant. The third explanatory variable is the digital technology usage index that positively predicts (0.201) employment growth, meaning that a unit increase in the digital technology usage index coupled with a 0.201 increase in employment growth in the study area at a 10% significance level. The digital technology empowerment index also positively influences (0.107)

employment growth, as a unit increase in the digital empowerment index leads to a 0.107 change in employment growth in Sub –Saharan Africa at a 10% significance level.

The general government final consumption expenditure harms employment growth (-0.016) meaning that a one-unit increase in general government final consumption expenditure is associated with a 0.016 decline in employment growth at a 5% significance level when other predictors are constant in the study area. The finding of this study show unwanted result of general government expenditure on employment growth. This finding is supported by (Heitger, 2001) who found that general government final consumption expenditures on public goods have a positive effect on the whole economy, but this growth effect tends to decline or even reverse when the government is overdoing it.This unwanted result of general government expenditure is justified differently by different scholars. For instance (Iwegbunam, 2017) found that excessive public capital expenditure might bring the unwanted outcome of government general consumption expenditure. (T. T. Chu et al., 2020) pointed out that general government expenditure harms the economy due to allocating government spending in favor of non-productive expenditure. Similarly (K. Chu, 1995) concludes that undesirable result of government spending is due to Unproductive expenditures that arise because of uncertainties, the lack of a well-trained civil service, inadequate checks and balances in the political and budgetary process, and corruption. From this one can conclude that to have the positive effect of general government final consumption expenditure on employment growth, government spending and allocation should favor towards productive expenditure.

5. Conclusions

Numerous conclusions and policy implications can be drawn from the findings. First, the study concludes that digital technology positively influences employment growth In sub-Saharan Africa. That is overall digital technology, digital technology usage, and digital empowerment indices positively affect employment growth in the region. The result has an important policy implication: to increase the contribution of digital technology on employment growth, there should be an investment in digital technology development, improving digital skills and creating awareness about digital technology, and empowering people to use digital technology in some main sectors such educational sector, health sector, and other social and cultural areas.

Second, the result revealed that general government final consumption expenditure has a significant negative effect on employment growth of the region. The undesirable result of government spending on employment growth is due to unproductive expenditures that arise because of uncertainties, the lack of a well-trained civil service, inadequate checks and balances in the political and budgetary process, and corruption. The result has a policy implication that to have the positive effect of general government final consumption expenditure on employment growth in the region, government spending and budget allocation should favor towards productive expenditure.

Acknowledgement: We are very thankful to Wallaga University, Department of economics for their both material and technical support

Competing interests: The author declare that they have no competing interests

Funding: Not applicable

Availability of data and material: All data used in this study are provided by World development indicators (WDI). This data can be found here: databank.worldbank.org

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*Corresponding email: **elfeneshmb@gmail.com***

Appendices

Appendix 1: The Kaiser-Meyer-Olkin (KMO) index and Eigenvectors, for digital indices that constructed by PCA

Variables		value		
	Over all Digital Technology index	Digital infrastructure index	Digital usage index	Digital empowerment index
PCA eigenvectors (highest)	3.94	2.285	2.653	1.35
Proportion explained	0.737	0.57	0.53	0.45
Kaiser-Meyer-Olkin	0.6358	0.5913	0.7348	0.5520

Appendix 2: Dynamic panel-data estimation, one-step difference GMM

Group variable: cry_id Number of obs = 243

Time variable : year Number of groups = 27

Number of instruments = 27 Obs per group: min = 9

F(17, 26) = 11.84 avg = 9.00

Prob > F = 0.000 max = 9

| Robust

EMp | Coef. Std. Err. t P>|t| [95% Conf. Interval]

---+---

EMplag | .5438627 .2667347 2.04 0.052 -.0044183 1.092144

Lc | -.0016039 .0020637 -0.78 0.444 -.0058458 .002638

POP | .7447991 .7602827 0.98 0.336 -.8179844 2.307583

DEm | .0044865 .0132365 0.34 0.737 -.0227215 .0316945

Fcexp | -.015313 .0086883 -1.76 0.090 -.0331721 .0025462

Fdi | -.0001653 .0117541 -0.01 0.989 -.0243262 .0239957

INFIlag | .1454388 .2369041 0.61 0.545 -.3415245 .6324022

USAI | .1852886 .0928464 2.00 0.057 -.00556 .3761372

Empilag | .0996345 .0533734 1.87 0.073 -.0100761 .2093451

yr2 | 2.295237 .3408531 6.73 0.000 1.594604 2.995871

yr3 | 2.134217 .2985269 7.15 0.000 1.520586 2.747848

yr4 | 2.189637 .298819 7.33 0.000 1.575406 2.803869

yr5 | 1.975477 .2849494 6.93 0.000 1.389755 2.561199

```
       yr6 |   1.916403   .2717027     7.05   0.000     1.35791    2.474896
       yr7 |   1.778274   .2003273     8.88   0.000    1.366496    2.190053
       yr8 |   1.742028   .2129867     8.18   0.000    1.304227    2.179828
       yr9 |   1.659993   .2116463     7.84   0.000    1.224948    2.095039
      yr10 |   1.594817   .1965149     8.12   0.000    1.190875    1.998759
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(Lc POP DEm Invlag Fcexp Fdi INFIlag USAI Empilag yr1 yr2 yr3 yr4 yr5
    yr6 yr7 yr8 yr9 yr10 yr11)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/.).EMplag collapsed
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -0.16  Pr > z =  0.869
Arellano-Bond test for AR(2) in first differences: z =  -0.71  Pr > z =  0.475
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(8)    =  17.26  Prob > chi2 =  0.028
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(8)    =   7.38  Prob > chi2 =  0.496
  (Robust, but weakened by many instruments.)
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