Effect of ICTs on Youth Unemployment in Sub Saharan Africa: A Panel Data Analysis[1]

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Abstract

This study investigates the impact of Information and Communication Technologies (ICTs) on youth unemployment in the Sub-Saharan African (SSA) during the period 1995-2010. The study employs a dynamic panel data method for a sample of 30 SSA countries, measuring the ICT facilities by mobile cellular subscriptions and the number of internet users. The empirical results show that mobile subscriptions have a negative and significant effect on youth unemployment in SSA countries, implying that communications boom in the last decades has promoted the youth employment. The impact of internet is found to be negative but it is not significant, confirming the weakness of internet infrastructure in SSA. To improve the employability of young workers in SSA, the paper recommended that the ICT facilities should be utilized effectively to provide job opportunities for young people. In addition, private and foreign direct investment in ICTs should be expanded taking into account the needs of labour markets. Moreover, serious efforts need to be paid to ICT skills development aiming at enhancing the experiences of young people in order to facilitate their entering into the labour market.

Keywords: ICTs, Youth unemployment, Panel data, SSA countries
JEL Classification: C23, J21, J23.

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1. Introduction

The impact of Information and Communication Technologies (ICTs)[2] on employment has been regarded as one of the development issues that received a considerable debate in developed and developing countries. Advocates of ICTs argue that ICT innovations increase efficiency, provide access to new markets and services, create job opportunities, generate new activities and in turn improve employment (Smolny (1998) and Vivarelli and Pianta (2000)). On the other hand, a number of researchers claim that ICTs lead to jobs loss and increase in the unemployment rates (e.g. Brouwer et al., 1993; Machin et al., 1991).

In the last two decades, African countries have undergone a remarkable ICT revolution with intensive use of advanced technologies in all aspects of life. The recent statistics shows that tow thirds of adults in Sub-Saharan Africa (SSA) have mobile phones and about 16 adults per 100 people have access to the internet (ITU World Telecommunication/ICT Indicators database, 2014). In fact, most of the African countries experienced a widespread of technologies and communication equipments such as, computers, mobile phones and internet. ICTs are expected to help in solving the economic problems that face SSA countries like volatile economic growth, price instability and particularly youth unemployment. Indeed, SSA countries suffer from high rates of youth unemployment which is considered as one of the most challenges for development in the region. According to recent statistics, unemployment rate among the young people in SSA accounted for about 12% in 2012, which is approximately twice the average rate of adult unemployment in the region (ILO, 2013).

Based on the above the main questions of this study are: What is the impact of ICT innovations on the youth unemployment in SSA? To what extent advanced technologies in SSA can reduce the youth unemployment through offering more jobs for young people? To answer these questions, the study uses panel data methods employing annual data for a sample of 30 SSA countries over the period 1995-2010.

[2] ICT refers to any activity involves gathering, processing, storing and presenting information. While the common use of ICTs tends to refer to the modern technologies like mobile phone and internet, the term ICT is also include the more traditional communication media such as radio and television.

The contribution of this paper is to provide some policy recommendations that aim to improve the employability of young people in SSA. The paper also would contribute to the existing literature on the impact of ICTs on youth unemployment, as there is a dearth of the studies on this issue in developing regions in general and Africa in particular. Furthermore, the paper highlights the effect of the some economic, demographic and institutional variables on youth unemployment in SSA.

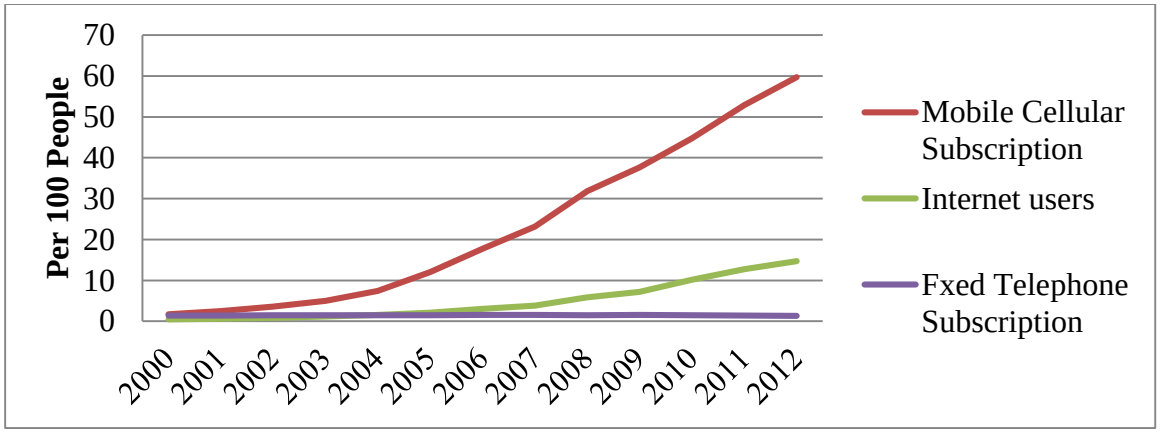
The remainder of this paper is organized as follows. The next section outlines some stylized facts about ICT development and youth unemployment in the SSA. Section three reviews the theoretical and empirical literature on the impact of ICTs on employment. Section four outlines methodology and data used in the study. While section five presents the empirical results, section six conclude with some policy implications.

2. ICT Development and Youth Unemployment in Sub-Saharan Africa: Some Stylized Facts

2.1. The trend of ICTs in SSA

Like other developing regions, Sub-Saharan Africa has witnessed a tremendous upsurge of ICTs in the last decades. All ICT equipments like mobile phones, fixed telephone lines and internet have increased remarkably, owing to the global revolution of ICT innovations. Figure 1 show a sharp increase in the trend of ICT facilities during the period 2000-2012.

Figure 1: Trend of ICTs in Sub-Saharan Africa

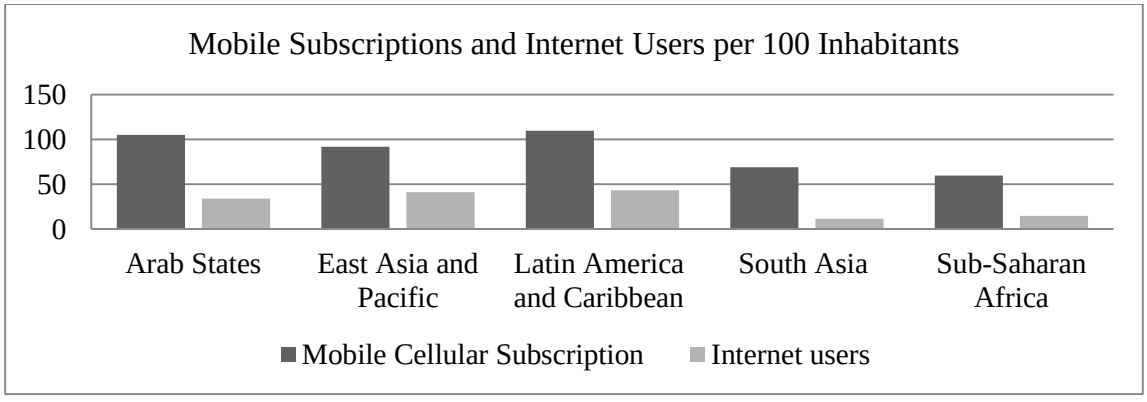


Source: ITU World Telecommunication/ICT Indicators database

Figure 1 show that the number of mobile cellular subscriptions in SSA has increased remarkably from about 3 in 2000 to more than 60 per 100 inhabitants in 2012. The number of internet users also has increased from less than one user in 2000 to about 15 users per 100 people in 2012. Regarding the fixed telephone lines, the Figure show its trend has been remained constant over such period and fluctuated around the average of 1.4 per 100 people. According to ITU World Communication Statistics (2014), among other regions of the World, Africa reported a lowest rate of fixed telephones lines, reflecting the weakness of ICTs infrastructure in the region.

Despite the rapid expansion of ICTs in SSA in the last decade, the region lags behind other developing regions in terms of using the ICT facilities. Figure 2 shows the distribution of mobile cellular subscriptions and internet users among the developing regions of the World. As indicated, SSA reported the lowest number of mobile subscribers compared to the other regions, estimated at about 60 subscribers per 100 people. Arab states and Latin America reported more than one hundred mobile subscribers per 100 inhabitants, implying that each individual has more than one mobile cellular in such regions. The number of mobile holders in SSA is lower than that in the other less developed regions like South Asia. Regarding the number of internet users, Figure 2 reveals that SSA has the second lowest number of internet users after South Asia. The Figure shows that in 2012, the numbers of internet users are 14.7 and 11.6 per 100 inhabitants in SSA and South Asia, respectively.

Figure 2: Mobile Subscriptions and Internet Users per 100 Inhabitants in SSA



Source: ITU World Telecommunication/ICT Indicators database

While the access to ICT facilities has significant impact on the economic prosperity of other developing region, African countries face many constraints regarding utilization of ICTs for the sake of economic growth and development. These constraints could be manifested in inadequate technical infrastructure, low ICT skills to use available networks and services and the relatively high cost of communications equipments (International Telecommunication Union, 2007). Therefore, access to ICTs such as computers, mobile phones and the Internet, especially broadband, remains a challenge for a large part of the population in Africa. All these reduce the scope for countries and communities to realize the potential of ICTs for growth and development.

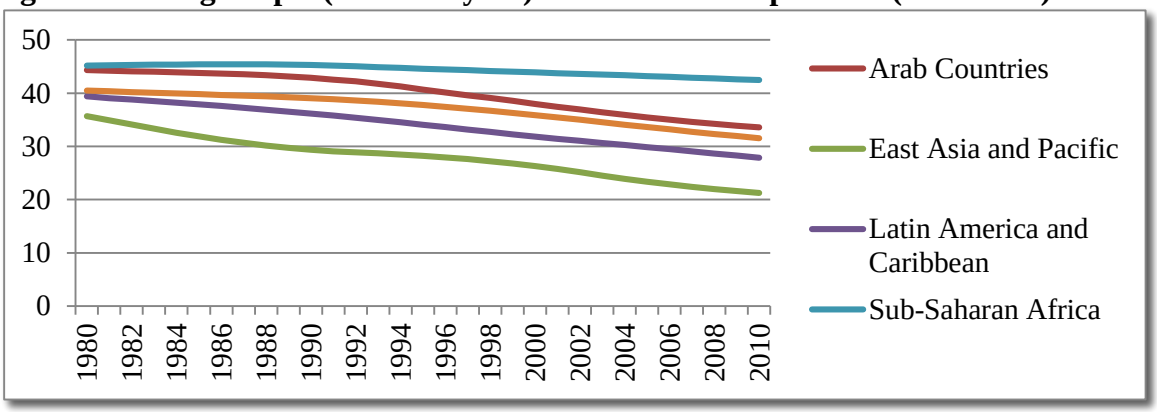
2.2. Youth Unemployment in the SSA: Some Stylized Facts

Before analysing the impact of ICT penetration on youth unemployment in SSA, it is useful to highlight the structure of population and unemployment in SSA region. In fact, during the last four decades, SSA countries have undergone remarkable demographic transformations, in terms of population growth, fertility rate, migration as well as the age structure of population (Ebaidalla, 2013). All these have had significant impact on labour markets and employment. Recent statistics show that SSA countries suffer from high and persistent unemployment rates (United Nations, World Population Prospects, 2010). Official estimates point out that about 27 million workers, or around 8 percent of the SSA labour force, were unemployed in 2012 (World Bank, 2013). Youth unemployment also is very high, estimated at 14% in 2013 (World Bank, 2013). This chronic problem of unemployment may be responsible for the unfavourable economic performance and low development outcomes as well as political instability in the SSA countries (Ebaidalla, 2013).

According to ILO report (2013), the SSA hosts the fastest-growing and most youthful population in the world. Recent statistics show that more than 20 percent of SSA's population are between the ages of 15 and 24 and over 40 percent under 15 (World Bank, 2013). Thus, the size of the youth population represents a potential human resource for the present and future development of the region. The high youth rate makes the situation of unemployment in general even more critical and difficult as such a population structure has prompted the need to restructure the labour market in order to

create more jobs and is expected to pose more pressure in the future, as demand for jobs in the SSA countries will continue to rise (Ebaidalla, 2013). Figure 1 below presents data on the population under 15 in the developing regions.

Figure 3: Young People (under 15 year) as % of Total Population (1980-2010)

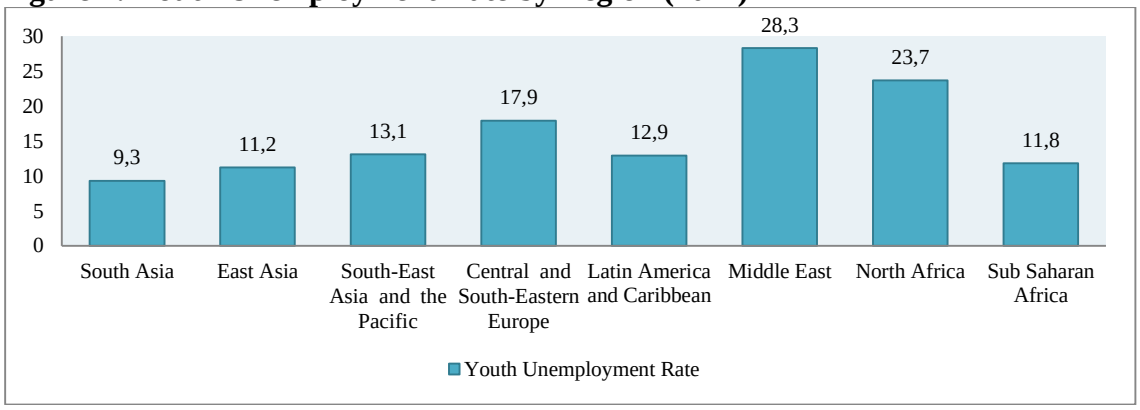


Source: World Bank's Development Indicators

Figure 3 shows that SSA has the highest rate of youth under 15 year. The figure also show that for most developing regions of the World, the trend of youth population has declined remarkably between 1980 and 2010, while the trend of SSA has declined slightly. This implies a persistence of the problem of youth unemployment in the next decades. However, the high youth population ratio in SSA implies a high share of youth in the total labour force, which causes SSA to face high rate of youth unemployment .

Figure 4 shows the position of youth unemployment in the most developing regions of the world. As indicated the rates of youth unemployment is high, estimated to be about 12% in 2012. The rate of youth unemployment in SSA exceeds the rates in the populous regions like East and South Asia.

Figure 4: Youth Unemployment Rate by Region (2012)



Source: ILO (2013): Global Employment Trends for Youth

Having, SSA countries witness a huge boom of ICTs with considerable numbers of young people, it is necessary to understand the effect of ICT facilities on youth unemployment. This would guide an appropriate strategy that helps in utilizing the ICTs to improve the employability of the youth people in SSA countries.

3. ICT Innovations and Employment: A Literature Review

Motivated by the rapid and remarkable diffusion of ICTs in the last decades, a huge body of literature has grown to investigate the impact of ICT on economic prosperity in developing and developed countries. However, most of the empirical studies have focused on the effect of ICTs on economic growth and development, but the unemployment impact of ICT has received a little attention. Therefore, in this section I briefly review the theoretical and empirical literature on the relationship between ICT innovations and employment.

In the literature there is no clear cut view on the effect of ICTs on employment. Some empirical studies revealed a positive effect of ICT on employment (e.g. Entorf and Pohlmeier, 1990; Smolny, 1998) while others found evidence of negative effect for ICTs (e.g. Brouwer et al., 1993; Machin et al., 1991). This disagreement can be attributed to the difference in measurement of ICT innovations, model specifications and the type of economic sector that used in the analysis. However, the debate on the positive and negative effects of technological change on employment has a long history in economics (see Vivarelli (2012) and Vivarelli and Pianta (2000)).

The argument of the positive effect of ICT innovations on employment is based on the classical theory of compensation that developed by Karl Marx (1961). This theory assumes many market compensation mechanisms that are triggered by technological change itself and which can counterbalance the negative effect emerged from labor-saving impact of technological innovations (Vivarelli, 1995 and 2007). First, technology innovation may create additional employment in the capital goods sector. That is, while the technologies which displace workers in the user industries, create new jobs in the capital sectors where the new machines are produced (Vivarelli, 2007). Second, the compensation mechanism may channel via a decrease in prices, meaning that

technologies lead to a decrease in the unit costs of production, and in a competitive market this effect is channeled into decreasing prices; in turn, decreasing prices create a new demand for products and so additional production and employment. Third, new technologies provide opportunities for unemployed workers via creating new investments. That is, in a competitive world, it is observed that during the gap between the decrease in costs due to technological progress and the consequent fall in prices, extra profits may be accumulated by the innovative entrepreneurs. These profits are invested and so new productions and new jobs would be created. Four, the direct effect of labor-saving technologies may be compensated within the labor market through a decrease in wage. According to the neoclassical framework with free competition and full substitutability between labor and capital, a decrease in wages leads to an increase in the demand for labor. Finally, the loss of jobs due the process of new technology may be compensated by new products. This indicates that technical change and ICT innovation can create new products which develop new economic branches and create additional jobs (Vivarelli, 2007).

Based on the above arguments several empirical studies confirmed the compensation theory, and argued that technology innovations exert positive impact on employment since they allow for the development of entire new goods or increase productivity of existing one (e.g. Freeman et al,1982; Freeman and Soete, 1987 and 1994; Vivarelli and Pianta, 2000). For example, Whitley and Wilson (1982) used a multi-sectoral dynamic model to investigate the employment impact of technological change based on the compensation framework. They estimated the employment levels in 1990 for most sectors of British economy and found that technology innovation promotes the employment level and compensates the initial job losses due to adoption of innovation. Among the compensatory forces, the mechanism via decrease in prices is found to be the more effective, accounting for more than 50% of compensation of the initial labour displacement.

In the same vein, Meyer-Krahmer (1992) examined the employment effect of technology using a sample of 51 German sectors covering the entire economy in the ‘80s, the author measured technology innovation by research and development (R&D) spending and purchase of R&D knowledge. His results support the view that

technological progress implies overall labour-saving effects; yet important sectoral differences emerge: while purchased R&D involves job losses in industries like textile, clothing and electronic equipment, in house R&D stimulates the demand for labour in sectors like chemicals and computer industries.

Sinclair (1981), employing a macro IS/LM framework examined the effect of technology innovation on employment in USA. He argued that a positive employment compensation can occur if the demand elasticity and the elasticity of factor substitution are sufficiently high. Using macroeconomic data from US economy, the author found a strong evidence supporting the mechanism via decrease in wages but not the mechanisms via decrease in prices.

Simonetti et al, (2000) employed a simultaneous equations macroeconomic model to investigate the direct labour-saving effect of innovation process. They applied different compensation mechanisms to examine the job-creating impact of product innovation. Using data for four countries namely, USA, Italy, France and Japan over the period 1965-1993, the authors pointed out that the more effective compensation mechanisms were that "via decrease in prices" and that “via increase in incomes”, especially in European countries till the mid 1980s.

Nevertheless, the theory of compensation has been criticized in explaining the counterbalancing of initial labour-saving effect of process innovation. Most of the critiques emphasized on the inefficient role of the main mechanisms of compensation, among them are: First, the mechanism "via decrease in prices" does not hold in the reality since decreasing prices reduce demand and has to more than counterbalance the initial decrease in the aggregate purchasing power. Also, this mechanism relies on Say's law and does not take into account that demand constraints might occur. In addition, the effectiveness of the mechanism "via decrease in prices" depends on the hypothesis of perfect competition; thus, if an oligopolistic regime is dominant, the whole compensation would not hold (Viverelli, 2012). Second, the compensation mechanism "via new investments" based on the Say's law which assumes that the accumulated profits due to innovation are entirely and immediately translated into additional investments. However, based on Keynesian view about Say's law, there is a doubt on full effectiveness of this compensation mechanism. Moreover, the intrinsic nature of the new investments does

matter; if these are capital-intensive, compensation can only be partial. Finally, the mechanism "via decrease in wages" contrasts with the Keynesian theory of effective demand. On the one hand, a decrease in wages can induce firms to hire additional workers, but - on the other hand - the decreased aggregate demand lower employers' business expectations and so they tend to hire less workers (Vivarelli, 2007).

Empirically, a few studies have found evidence of negative relationship between ICT innovations and employment. For example, Brouwer et al. (1993) examined the influence of innovation on growth rates of employment in 859 Dutch manufacturing firms during the period 1983–1988. They found that employing advanced innovation has a slight negative impact on employment. Likewise, Machin et al. (1991) using the 1984 British Workplace Industrial Relations Survey, find a negative relationship between ICTs adoption and employment. Moreover, Zimmermann (1991) found similar results using microdata from 16 German industries, concluding that technological change was one of the determinants of the employment decrease in Germany during the 1980s.

The above discussion reveals that the literature on the impact of technology and innovations on employment is intensive and diverse and most of the empirical evidence confirms the view that technologies and innovations exert positive impact on employment. On the other hand, a few of studies reveal negative effect on employment. However, Most of the empirical studies have focused on the advanced countries and there is a little research attention given to this issue in the developing regions, particularly Africa. Unlike the previous studies that used sectoral and micro data, this study uses a cross-country data. Furthermore, although most of the previous studies focused on technology and product innovation using many proxies, including spending of R&D and firm innovation; this study uses advanced measures of technology like mobile subscriptions and number of internet users. Indeed, in the recent decade, ICT facilities have been an important measure for technological progress and development of regions and countries.

4. Methodology and Data

4.1. Model Specification

To analyze the impact of ICTs penetration on youth unemployment in Sub-Saharan Africa, the paper uses econometric approach, employing a dynamic panel data method. The specification of unemployment model used in this study follows most of empirical studies on unemployment such as Feldmann (2009). However, the model is augmented by ICT variables to capture the effect of ICT on the youth employment. Thus, the model to be employed in the analysis could be specified as follows:

$$YU_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 INF_{it} + \beta_3 TRD_{it} + \beta_4 ED_{it} + \beta_5 FER_{it} + \beta_6 BUR_{it} + \beta_7 MOB_{it} + \beta_8 INT_{it} + \mu_{it} \quad \ldots\ldots (1)$$

Where the subscripts i and t represent the country and time period, respectively. The variable YU_{it} is the dependent variable capture the youth unemployment. This model relates youth unemployment to a set of control variables beside ICT proxies. The control variables are all variables that hypothesized to influence youth unemployment which include economic, demographic and institutional factors. GDP is the growth of gross domestic product, INF is the inflation rate, TRD is the trade openness variable, ED is education, FER is the fertility rate, BUR is the bureaucracy quality. The bureaucracy quality variable is used to capture the impact of institutional quality, since efficient institutions are conducive to labour productivity and growth (Acemoglu et al., 2004). MOB is the mobile cellular subscriptions and INT is number of internet users; these variables are used to capture ICT development. Finally, $\boldsymbol{\mu}$ is the error term with a zero mean and constant variance. The definition and sources of the variables are presented in Appendix I. All the variables are expressed in the natural logarithm except GDP growth because it bears negative values for some countries.

According to theoretical and empirical literature, the impact of GDP growth is expected to be negative, as an increase in country's income will reduces the employment level. This also supported by the Okun's Law (1962) which is confirmed by many empirical studies[3]. The inflation rate would be negative as expected, since there is

[3] Economist Arthur Okun (1962) who first started studying the relationship between unemployment and economic growth, and his research on the subject since then has become known as Okun's law. Okun law indicates a positive association between employment and output.

negative association between the unemployment rate and inflation, as suggested by Philips (1958). The coefficients of trade openness and education are expected to be positive. The effect of fertility rate also is expected to be positive, because an increase of fertility level rises the numbers of young people, and hence their unemployment rates. The coefficient of bureaucracy quality is expected be negative, since a country with bad institution tend to suffer from unfavorable labour conditions and hence, high rate of youth unemployment. This is also supported by several studies on economic growth which assumed that good institutions are necessary for labor and human capital progress (e.g. Acemoglu et al., 2004). Finally, the expected signs of ICT variables are inconclusive, as there is no consensus in the literature on the impact of ICT innovations on unemployment.

4.2. Estimation Methodology

To examine the link between ICTs and youth unemployment in Sub-Saharan Africa, the study uses a panel data method. Therefore, the error term μ_{it} in equation 1 is a composite disturbance term that includes an unobserved country-specific effect η_i, a time-specific effect λ_t, and a error term ε_{it}. The composite error could be specified as follows:

$$\mu_{it} = \eta_i + \lambda_t + \varepsilon_{it} \qquad (2)$$

The possible endogeneity of unemployment as well as the correlation of the unobserved country fixed effects with the error term implies that the orthogonality condition is not likely to be met for Fixed Effects (FE) or random effects (RE) estimator to produce consistent estimates. To account for endogeneity of regressors the appropriate method is to use an instrumental variables (IV) estimator. Therefore, this study uses the dynamic panel models based on the Generalized Method of Moments (GMM), developed by Arellano and Bond (1991)

The GMM dynamic method has many advantages over the conventional static panel data methods of fixed effects and random effects models. First, GMM model takes into account the time series dimension of the data and, hence it considers the short run effect. Second, it includes the non observable country specific. Finally, this method treats

all the explanatory variables as endogenous variables, hence it consider the problem of endogenity that may result from the correlation between the error term and the lagged dependent variable.

Empirically, there are two types of GMM models that have been widely used in estimating panel regressions: the first-difference GMM estimator, developed by Arellano and Bond (1991) and the system GMM estimator, developed by Arellano and Bover (1995) and Blundell and Bond (1998). However, the recent literature has shown that there are some possible statistical problems associated with the use of first-difference GMM estimator (Bond et al., 2001). That is, when the regressors are highly persistent, the instrumental variables used in difference GMM, such as, lagged levels of the dependent variable and of the explanatory variables might be weak instruments. In this situation, the first-differenced GMM model potentially suffers from a downward bias, especially when the time periods (T) is small (Blundell and Bond, 1998). On the other hand, the system GMM estimator overcomes the weak instruments problem by allowing the use of the lagged differences and lagged levels of the explanatory variables or other variables as instruments. Therefore, the analysis in this paper relies solely on the system GMM technique.

The System GMM estimators are derived from the estimation of a system of two simultaneous equations, one in levels (with lagged first differences as instruments) and the other in first differences (with lagged levels as instruments). However, one possible problem that might be arising when adopting the system GMM is the invalidity of the lagged differences of the explanatory variables as instruments. Therefore, we examine the validity of the instruments by two tests: Sargan test of over-identifying restrictions and Arellano and Bond (AB) test of serial correlation. Furthermore, the study tests the endogeneity problem applying Durbin (1954), Wu (1974) and Hausman (1978) endogeneity test.

4.3. Data Sources

The study used annual data for a sample of 30 Sub-Saharan African countries over the period 1995-2010. The data on employment, macroeconomic and demographic variables are gathered from several sources including World Bank's development indicators and

IMF Financial Statistics (IFS). Data on institutional quality (bureaucracy quality) is collected from the International Country Risk Guide (ICRG) statistics[4]. Finally, data on mobile subscriptions and internet users are obtained from ITU World Telecommunication/ICT Indicators database.

The summary statistics of the variables used in the study are presented in Table 1 below. It is clear that the inflation rate, trade openness and education vary greatly across countries. The result of descriptive statistics also shows the average of growth of per capita income is relatively low, implies that the per capita income in the Sub-Saharan African countries grow slowly and unequally distributed. Interestingly, the standard deviation of internet users is small, indicating a low disparity in the access to internet among SSA countries.

Table 1. Summary statistics of sample data

Variable	Mean	Std. Dev	Minimum	Maximum
Youth unemployment	26.805	12.102	14.2	49.1
GDP Growth	4.7992	7.059	-32.832	26.234
Inflation	102.925	1158.807	-3.0303	24411.03
Trade openness	71.014	28.328	14.772	179.120
Education	34.848	20.567	5.1594	95.699
Fertility	5.112	1.339	1.47	7.706
Bureaucracy	1.285	0.776	0	3.5
Mobile subscriptions	13.781	21.300	1.31	120
Internet users	2.010	3.383	1.67	24

5. Empirical Results and Discussion

The estimation results of equation (1) using GMM method are presented in Table 2 below. Column 2 through 4 presents the results of GMM model with three specifications regarding the ICT variables to ensure the robustness of the analysis. Column five contains the results of fixed effect estimates which presented for the purpose of comparison.

[4] The International Country Risk Guide (ICRG)' political stability indicators comprises 12 institutional measures - government stability, socioeconomic conditions, investment profile, internal conflict, external conflict, corruption, military in politics, religious tensions, law and order, ethnic tensions, democratic accountability, and bureaucracy quality.

Table 2: The Results of GMM- system estimation (1995-2010)

Dependent Variable: Youth Unemployment				
Variable	Model 1	Model 2	Model 3	Model 4
	GMM	GMM	GMM	Fixed effect
Constant	1.581	3.260	1.315	63.879***
	(0.683)	(1.387)	(0.561)	(17.542)
Youth unemployment (-1)	0.924***	0.980	0.9167***	
	(20.442)	(32.132)	(29.064)	
GDP Growth	-0 .022*	0.019	-0.021*	0.025
	(-1.938)	(1.603)	(-1.873)	(1.244)
Inflation	-0.001**	-0.001**	-0.001**	-0.006***
	(-2.181)	(-2.264)	(-2.035)	(-5.266)
Trade openness	-0.023	-0.015**	-0.025	-0.001
	(-1.334)	(-2.135)	(-0.600)	(-0.161)
Education	-0.018	-0.018	-0.041**	-0.102***
	(-1.206)	(-1.176)	(-2.251)	(-3.734)
Fertility	0.590*	0.390	0.668**	-1.393**
	(1.828)	(1.181)	(2.045)	(-2.503)
Bureaucracy	-0.241	-0.395*	-0.293	0.083
	(-1.134)	(-1.792)	(-1.362)	(0.256)
Mobile subscriptions	-0.714***		-0.085***	-0.381
	-(5.676)		-(4.079)	(-1.153)
Internet users		-0.001	-0.078	0.088
		(-0.06)	-(1.202)	(1.458)
Observations	480	480	480	480
Sargan Over-identification Test	2.561	1.878	2.265	
	(0.324)	(0.657)	(0.435)	
Durbin–Wu–Hausman Test	0.945	0.065	1.234	
	(0.032)	(0.016)	(0.023)	
AB- test for AR(1)	4.345	5.234	3.873	
	(0.000)	(0.000)	(0.001)	
AB- test for AR(2)	0.939	1.156	1.003	
	(0.567)	(0.432)	(0.512)	

Notes: Figures in Parentheses are t-statistics

***, ** and * denotes significance at the 1, 5 and 10 percent level

The estimation is two steps System GMM, instruments used in the analysis are the first lagged difference and the second lagged level of dependent and explanatory variables.

Durbin–Wu–Hausman and Sargan tests are asymptotically chi-sq distributed, with p values reported in brackets.

The results show that the Sargan and Arellano and Bond tests indicate that all the regressions does not suffer from any problems with the instruments, and there are no

second order serial correlation problems in the estimated models. The Durbin–Wu–Hausman test statistic also rejects the null hypothesis that all regressors are exogenous at any reasonable degree of confidence. Thus, we conclude that all the variables are endogenous and this constitutes a suitable justification for using GMM method.

Focusing on the results of GMM model in column 4, we find that all the estimated coefficients bear the expected sings and in line with the theory. The results show that GDP growth has negative and significant impact on youth unemployment, implying that improving economic situation encourage youth employment. This result confirms the validity of Okun's Law for SSA countries. The coefficient of inflation is also negative, indicating that Philips Curve' hypothesis holds in the Sub-Saharan African countries. The trade openness is found to have negative impact on youth unemployment as expected, implying that a country with high degree of trade openness tends to witness low rate of youth unemployment. Therefore, we conclude that economic environment plays a significant role in explaining youth employment in SSA countries. This also implies that the demand side of labour market has an important role in influencing youth unemployment in SSA countries.

The coefficient of education is negative and significant as expected, suggesting inverse relationship between education level and youth unemployment in SSA countries. This result supports the evidence of some empirical studies such as Kabaklarli, et al (2011). This finding also implies that SSA does not suffer from the problem of skills mismatch which is a major phenomenon in other regions like East Asia and Arab states. This result could be attributed to the low education attainment in SSA countries compared to other regions. Moreover, the results of GMM model indicate that the impact of fertility is positive and significant, suggesting that high fertility rate increases the opportunity of youth people to confront unemployment. This result also indicates that a country with high level of fertility tends to suffer from high rate of youth unemployment. Furthermore, the results reveal that bureaucracy quality has a negative effect on youth unemployment, but it is not significant[5]. This finding implies that good institutions reduce the youth employment.

[5] Bureaucracy quality index is scaled from zero to six. Higher scores indicate more bureaucracy quality.

Interestingly, the coefficient of mobile phone subscriptions is negative and statistically different from zero, indicating that an expansion of mobile networks results in negative and significant effect on youth unemployment in SSA. This result indicates that the diffusion of communications in SSA during the last decades has played a significant role in reducing youth unemployment via providing more jobs for your young people. Indeed, the communications sector in Africa offers several jobs for youth including mobile maintenance and distribution and internet services. In addition, mobile phones provide the exchange of information in labour markets, matching between demand and supply of labour, and in turn help in reducing unemployment. On the other hand, the effect of internet is found to be negative but it is not significant. This could be explained by the fact that Africa exhibits a low number of internet users among other World's regions. This situation also confirms the situation that African countries lack an appropriate ICTs infrastructure, particularly internet and broadband services.

Overall, the negative coefficients of ICT variables indicate that technological process reduces the youth unemployment, since new technologies may increase productivity and generate new activities that absorb the unemployed workers. This finding also suggests that the boom of information and communications in Africa could contribute effectively in the growth and development via solving the problem of youth unemployment in the continent.

6. Conclusion and Policy Implications

Motivated by the tremendous diffusion of ICTs and high rates of youth unemployment in Africa, this study examines the effect of ICTs on youth unemployment. The study applied a dynamic panel data based on GMM method using a sample of 30 SSA countries over the period 1995-2010. The empirical results show that real GDP growth, inflation rate, trade openness, education and institutional quality exerts negative impact on youth employment. The results also show that fertility rate has positive and significant effect on youth unemployment in SSA countries. Interestingly, the coefficients of ICT variables are negative, indicating that ICTs penetration in Africa reduces the rate of youth unemployment. The impact of mobile subscriptions is found to be positive and significant, indicating that communications in Africa increase the employability of young

people. Moreover, the results revealed that the impact of internet is negative but it is not significant, suggesting the inefficient role of internet in reducing youth unemployment in SSA.

Based on above findings, many policy implications can be drawn aiming at utilizing the potential of ICTs to improve the employability of young people in SSA. Since about half of population of SSA is youth, serious efforts need to be exerted to promote the access of young people to ICT facilities and innovations. First and foremost, access of youth to ICTs in terms of internet and broadband should be at the top agenda of development in all SSA countries. Beside, technical education and developing ICT skills should paid a great attention from policy makers in the way that easing the entering of young into the labour market. In addition, sound economic policies such as liberalizations and privatization should be adopted to attract private and foreign capital flow into investment in the ICT and innovations products. Moreover, foreign direct investment should be directed to ICT infrastructures that provide significant jobs opportunities for young people. Furthermore, Innovation legislation also should be revised to encourage participation of young people in the production of innovations and ICT industries. Finally, SSA countries endowed with a huge amount of natural resources, therefore, using ICT facilitates in the economic sectors like agriculture and mining may develop new products and increase the employability of young people.

References

Acemoglu, D., Johnson, S. and Robinson, J. (2004). *Institutions as the Fundamental Cause of Long-Run Growth: Handbook of Economic Growth*, North Holland.

Arellano, M. and Bover, O. (1995) 'Another look at the instrumental variables estimation of error components models', *Journal of Econometrics*, Vol. 68, No. 1, pp. 29–51.

Arellano, M., and Bond, S. (1991) 'Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations', *Review of Economic Studies*, Vol. 58, No. 2, pp. 277-297.

Blundell, R. and Bond, S. (1998) 'Initial conditions and moment restrictions in dynamic panel data models', *Journal of Econometrics*, Vol. 87, No. 1, PP. 115–143.

Bond, S., Hoeffler, A., and Temple, J. (2001) 'GMM Estimation of Empirical Growth Models', CEPR Discussion Paper Series, No. 3048. Centre for Economic Policy Research (CEPR), London.

Brouwer, E; Kleinknecht, A and Reijnen, J. (1993). "Employment growth and innovation at the firm level", *Journal of Evolutionary Economics*, Vol. 3, No. 2, pp 153-159.

Durbin, J. (1954). "Errors in variables" *Review of International Statistical Institute*, Vol. 22, No. 1, pp. 23–32.

Ebaidalla, E. (2013). 'Analysis of Youth Unemployment in Sub Saharan Africa'. Presented at International Conference on "Beyond Rio + 20: Emerging Challenges and Opportunities", 20th – 22 November, 2013, ASSER, University of Ghana, Accra, Ghana.

Entorf, H., and Pohlmeier, W. (1990). Employment, Innovation and Export Activities. In J.P. Florens, M. Ivaldi, J.J. Laffont and F. Laisney (eds), *Microeconometrics: Surveys and Applications*. London: Basil Blackwell.

Feldmann, H. (2009). "The Unemployment Effects of Labor Regulation around the World", *Journal of Comparative Economics*, Vol. 37, No. 1, pp. 76–90.

Freeman, C., and Soete, L. (eds). (1987). *Technical Change and Full Employment*. Oxford: Basil Blackwell.

Hausman, J. (1978). "Specification tests in econometrics", *Econometrica*, Vol. 46, No. 6, pp. 1251-1271.

ILO (2013): Global Employment Trends for Youth.

ITU World Telecommunication/ICT Indicators database (2014), accessed 12, September, 2014. Available at: http://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx

International Telecommunication Union (2007). Telecommunication/ICT Markets and Trends In Africa. Report, International Telecommunication Union, Geneva, Switzerland.

International Labor Organization's (ILO) statistics of 2011

Kabaklarli, E., Hazel Er, P. and Bulus, A. (2011) "Economic Determinants of Turkish Youth Unemployment Problem: Co Integration Analysis" Presented at the International Conference On Applied Economics, 2011. Held in Dubai, May 16-18, 2005.

Machin, S., and Van Reenen, J. (1998). "Technology and Changes in Skill Structure: Evidence from Seven OECD Countries." *Quarterly Journal of Economics*, Vol. 113, No. 4, pp. 1215–44.

Marx, K. (1961). *Capital*. Moscow: Foreign Languages Publishing House. First edition.

Meyer-Krahmer, F. (1992). "The Effects of New Technologies on Employment", *Economics of Innovation and New Technology*, Vol. 2, pp. 131-49.

Okun, A. (1962) "Potential GNP: Its Measurement and Significance'' Proceedings of the Business and Economics Section of the American Statistical Association. American Statistical Association, pp. 98-104.

Phillips, A. (1958). "The Relation between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957," *Economica*, Vol. 25, No. 100, pp. 283-299.

Population Reference Bureau (2013). The world's Youth Data Sheet. PRB. Washington. DC. http://www.prb.org/pdf13/youth-data-sheet-2013.pdf

Simonetti, R. - Taylor, K. - Vivarelli, M. (2000). Modelling the Employment Impact of Innovation: Do Compensation Mechanisms Work?, in Vivarelli, M. - Pianta, M. (eds.), *The Employment Impact of Innovation: Evidence and Policy*, Routledge, London, 26- 43.

Sinclair, P.(1981). "When will Technical Progress Destroy Jobs?" *Oxford Economic Papers*, Vol. 31, No. 1, pp. 1–18.

Smolny, W. 1998. "Innovations, Prices and Employment: A Theoretical Model and an Empirical Application for West German Manufacturing Firms." *Journal of Industrial Economics*, Vol. 46, No. 3, pp. 359–81.

United Nations, World Population Prospects: The 2004 Revision (New York: UN, 2005).

United Nations, World Population Prospects: The 2010 Revision (New York: UN, 2010).

Vivarelli, M. (2007). "Innovation and Employment: A Survey". IZA Discussion paper No. 2621, University of Bonn, Germany.

Vivarelli, M. (2012). "Innovation, Employment and Skills in Advanced and Developing Countries: A Survey of the Literature". IZA Discussion paper No. 2691, University of Bonn, Germany.

Vivarelli, M. (1995). *The Economics of Technology and Employment: Theory and Empirical Evidence*. Aldershot: Elgar.

Vivarelli, M., and Pianta, M. (2000). *The Employment Impact of Innovation: Evidence and Policy*. London: Routledge.

Whitley, J. and Wilson, R. (1982). Quantifying the Employment Effects of Micro electronics, *Futures*, Vol. 14, No. 6, pp. 486-495.

World Bank (2013), World Bank's Development Indicators. Accessed 10, September, 2014. Available at:

Wu, D. (1974). "Alternative tests of independence between stochastic regressors and disturbances: finite sample results", *Econometrica*, Vol. 42, No. 3, pp. 529-546.

Zimmermann, K. 1991. "The Employment Consequences of Technological Advance: Demand and Labor Costs in 16 German Industries." *Empirical Economics*, Vol. 16, No. 2, pp. 253– 66.

Appendices

Appendix I: Description and Sources of Variables used in the Regression Analysis

Variable	Definition	Source
Youth unemployment	Measured as residual of Employment to Population Ratio, Ages 15-24 Total (%)*.	World Bank's World Development Indicators
Real GDP growth	Growth of gross domestic product	World Bank's World Development Indicators
Inflation Rate	Annual inflation rate measured by the change in consumer price index.	IMF Financial Statistics and World Bank's World Development Indicators
Trade Openness	Measured by the ratio of (Exports +Imports) to GDP	IMF Financial Statistics and World Bank's World Development Indicators
Fertility Rate	Measured by births per woman	United Nations, World Population Prospects and World Bank's World Development Indicators.
Education	Measured by ratio of total secondary enrolment to the population	World Bank's World Development Indicators
Bureaucracy Quality	Bureaucracy quality, measures autonomy from political pressure and strength and expertise to govern without drastic changes in policy or interruption in government services. (scale from zero to six)	International Country Risk Guide (ICRG), (2010)
Mobile subscriptions	Mobile cellular subscriptions per 100 people	World Telecommunication/ICT Indicators database (2014)
Internet Users	Internet users per 100 people	World Telecommunication/ICT Indicators database (2014)

Note: All the variables are expressed in the natural logarithm, except GDP growth.

* Due to the lack of systematic labour surveys in SSA countries the data on unemployment of total youth as % of total labor force ages 15-24 is not available.

Appendix II: List of Countries Considered for the Study

No	Country Name	No	Country Name
1	Angola	16	Madagascar
2	Botswana	17	Malawi
3	Burkina Faso	18	Mali
4	Cameroon	19	Mozambique
5	Congo, Dem. Rep.	20	Namibia
6	Congo, Rep.	21	Niger
7	Cote d'Ivoire	22	Nigeria
8	Ethiopia	23	Senegal
9	Gabon	24	Sierra Leone
10	Gambia	25	South Africa
11	Ghana	26	Sudan
12	Guinea	27	Tanzania
13	Guinea-Bissau	28	Togo
14	Kenya	29	Uganda
15	Liberia	30	Zambia