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INFORMATION AND COMMUNICATION TECHNOLOGIES AND EMPLOYMENT: COMPLEMENTS OR SUBSTITUTES?

Ngouwouo Younchawou[a] ✉
Eric Mouchili Moumie[b]

[a,b]*University of Dschang, Dschang, Cameroon.*

✉ yngouwouo@gmail.com *(Corresponding author)*

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ABSTRACT

Information and communication technologies have changed the way in which a very large number of professions are exercised. As a result, digital technology can therefore contribute to the reduction or destruction of jobs and consequently to the rise in unemployment. Hence the fear of workers regarding the substitution of labor by machinery. Nevertheless, Schumpeterian theory maintains that technical progress generates opportunities for profit, and therefore investment opportunities, which when seized by companies are transformed into jobs. It is in the light of this controversy that the purpose of this paper is to analyze the effect of information and communication technologies on employment in Cameroon. By applying the OLS method to data covering the period 1980-2016, the results reveal that ICT promotes job creation in Cameroon. Thus, we suggest to the Cameroonian government to create more favorable conditions for the development of ICTs which will have the positive externality of job creation.

Contribution/Originality: This work contributes to the debate on the relationship between ICT and employment by focusing on the case of Cameroon. So far, this country has not attracted the attention of researchers on this subject and however it's one of the developing countries where the expansion of ICT is very rapid.

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1. INTRODUCTION

Nowadays, it becomes almost impossible to talk about the evolution of the world without associated information and communication technologies. These are found in virtually every industry. If we consider the evolution of the number of mobile phone and internet users, we can notice that in the world there has been a remarkable evolution. For instance in Cameroon, according to statistics of the Telecoms Regulatory Agency (TRA), the telephone sector had 16.8 million subscribers (out of a population of 22 million) at the end of September 2015, compared to 16.6 million in 2014. And with regard to internet use in Cameroon, the number of internet users increased from 2000 in 2005 to 3 million internet users in 2015. In order to increase its capacities, Cameroon has launched the construction of a new optical fiber linking Kribi to the city of Fortaleza in Brazil, which will boost the digital sector, thus making digital capacity 400 times faster. The rapid growth of ICTs in Cameroon is explained by factors such as the purchase and sale of goods and services online, online transactions, rapid connectivity and increased purchasing power (World Bank, 2017). It appears that ICT in the world, and in particular in Cameroon, are becoming more and more important. Despite the current context marked by the intensive use of information in many activities, the contribution of ICT in the development of Cameroon as in Africa is still disputed. These tools are considered by their detractors as an unproductive luxury with regard to traditional development priorities (like food, drinking water, public health and roads). Moreover, new technologies effectively eliminate many jobs. In this sense, they continue the secular movement of labor reallocation

made possible by technical progress. At the same time, they are also changing the way in which a very large number of professions are exercised, without creating millions of "technologist" jobs. New job opportunities in ICT are important because all countries seek to create more quality jobs with positive economic and social benefits for workers and communities. The impact of ICT on employment also depends on the sector of activity because the particular effect of ICT on employment in the service sector, in particular in services and professions hitherto largely "protected" from automation or "computerization". To the extent that these "sheltered" service jobs have previously acted as the main absorber of job cuts in industry and agriculture, there is an obvious concern as to whether the new services will indeed be able to provide enough new job opportunities. As highlighted above, this news crucially depends on an appropriate regulatory framework. More specifically, the emergence of new markets for information services requires not only a more competitive framework, deregulation and open access; it also requires new institutions that set the rules of these new markets, so to speak, including those governing property rights, security, privacy, etc. At the same time, as the case of the internet has shown, the speed of change can often exceed - pace the old process of "controlled" liberalization pursued in many large continental European countries and in Japan. In some areas, such as finance and other intermediation services (utilities) can sometimes involve a more dramatic process of "creative destruction", with a completely new communications pricing structure. Particularly in Europe and Japan, there are concerns that regulatory reform is too slow and that the development of new services lags behind their development in other parts of the world (Soete, 2001). Reflections on the impact of the evolution of the digital economy on employment lead to contradictory results from researchers. On the one hand, some present the digital economy as an asset to economic development through the creation of jobs and the transformation of the economic structures of the countries (Hamid & Hossein, 2013). On the other hand, several authors have presented the digital economy as an evil to development (Bresnahan, Brynjolfsson, & Hitt, 1999; Chennells & Van, 1999). They developed the theory of creation destruction to indicate that the development of digital technology creates a few jobs to the detriment of a large mass of labor generally in routine activities and predicts that the arrival of a new technology induces the uselessness of all the jobs related to the old technology and in this case, digital technology can therefore contribute to the reduction or destruction of jobs and consequently to the increase an unemployment. The latter mainly fear the substitution of labor by machinery. Current studies emphasize the destabilizing nature of technological change, and the large number of jobs it risks destroying (ILO (International Labor Office), 2017). Estimates of the extent of disruptions in labor markets vary widely, from less than 10 percent to more than 60 percent of total employment. According to Frey and Osborne (2017) 47 percent of existing jobs in the United States could be replaced due to new technologies. However, these assessments tend to overstate the potential impact of automation as they only consider the technical feasibility of substituting capital for labor. In doing so, they ignore aspects related to economic feasibility, i.e. the relative profitability of investing in new technologies compared to other labour-intensive options (Kucera, 2017). The impact of technology on employment is a question that is attracting growing interest. Countries with higher ICT penetration are more likely to experience labor disruption more quickly than those with lower penetration. Anderson and Harris (1989) has examined the impact of ICT on employment in the United States and they concluded that technological trends would not drastically affect employment until the year 2000. At the time, analysis indicated that the full employment effects might not have been noticeable because many companies had not yet begun to exploit the full potential of automation tools and software broadband communication networks. Thus, at the time, ICT was seen to create new jobs requiring higher skill levels, while low-skilled, low-paying jobs were declining in industries that relied heavily on communications.The evolution of ICT and the employment rate is shown in Figure 1. It's question for us of giving the factors which have contributed to the variation of these variables from 1980 to 2016. From a general point of view, the evolution of information and communication technologies and the employment rate in Cameroon from 1980 to 2016 has two main phases: the first going from 1980 to 2000 and the second covering the period 2000-2016. During the first period, there was a certain stability in the labor market because the employment rate fluctuated around 64% during this period. However, information and communication technology (measured in this paper by the number of people having a mobile phone per hundred inhabitants) was first recorded in 1994 with a rate of one percent of people having a mobile phone. The second phase is materialized by a greater expansion of mobile phone users. Thus, the number of mobile phone users reached the threshold of 68.11% in 2016, surpassing the rate of 41.88% in 2010. The employment rate increased considerably during this period. It should be noted that this increase is not noticeable due to the demographic explosion. In general, Figure 1 shows that ICT took off in Cameroon from 1994. Its evolution is extremely fast and it did not encounter major disruptions during its second phase, it looks like a product that is in its expansion phase. As for the evolution of the employment rate, it has increased by 5.09% in 36 years. This situation sufficiently demonstrates the failure of the employment policies put in place by the Cameroonian government to resolve the thorny issue of unemployment.

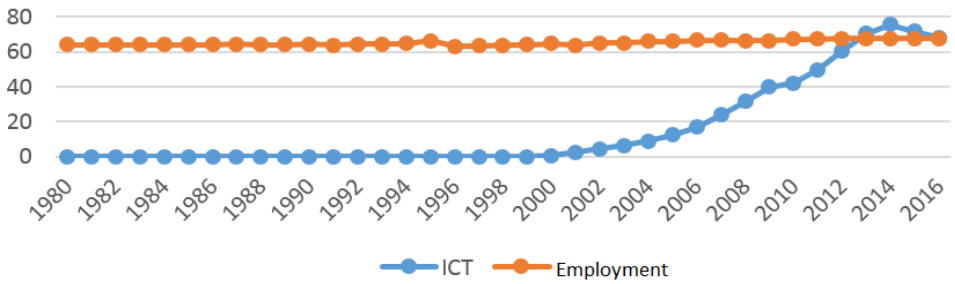

Figure 1. Evolution of ICT and the employment rate in Cameroon from 1980 to 2016.

2. LITERATURE REVIEW

This literature review will be structured on two axes : The theoretical and the empirical literature.

2.1. Theoretical Literature

On the theoretical level, the relationship between technological innovation and employment has been analyzed in the literature by the theory of compensation. This theory breaks down the different compensation mechanisms that are triggered by technological change and that can balance the destructive effect of process innovation. Our choice is explained by the fact that the economists in favor of this theory are those who have made this question one of the main elements of their reflection, they are: Smith, Ricardo and Schumpeter.

Adam Smith (1723-1790) can be considered as the first to have developed an argument that could be linked to a first theory of compensation. Its originality is to give paramount importance to the division of labor. By giving the example of pin-making, he shows that the division of labor makes it possible to increase enormously the quantity of goods produced. Adam Smith also maintains that the appearance of a particular branch of industry devoted to machine production does not only create jobs for inventors, but also many jobs for workers.

According to Ricardo (1821) the introduction of a machine built by part of the workers does not affect employment during the first year, but he shows that, for the following year, the total capital increases by the amount of the profit, but that the distribution of fixed capital/circulating capital has changed in such a way that the means for employing labor have been reduced. In this example, Ricardo shows that the total capital does not vary but its composition is modified: there is now more technical capital and less wage capital because the latter is reduced by the value of the machine. It is this reasoning that Ricardo adopts in his chapter on "machines" in his work "On the Principles of Political Economy and Taxation" (published in 1821).

Schumpeterian theory marks in many respects a turning point in the analysis of the relationship between technical progress and employment. Schumpeter (1883-1950) will indeed analyze the problem from an entirely different angle. Classical economists have adopted macroeconomic reasoning with a central question: do compensation mechanisms eliminate job losses linked to the substitution of capital for labour? The compensation mechanism is thus inscribed in Schumpeterian vision, although it is presented differently. It is a process of creative destruction.Technical progress generates opportunities for profit, therefore investment opportunities, which when seized by companies, turn into jobs. Admittedly, the new investments devalue the pre-existing equipment and the related jobs, on the other hand they create them nearby. Innovation does not necessarily create jobs where it is carried out. But we can implicitly consider that innovation creates jobs through the economic dynamics it generates.

2.2. Empirical Literature

In this review, there is no clear vision of the effect of ICT on employment. Some empirical studies have found a positive effect of ICT on employment while others have found evidence of negative or neutral effects on ICT on employment.

2.2.1. Proponents of the Positive Effect of ICT on Employment

The argument for the positive effect of ICT innovations on employment is based on the classic compensation theory developed by Marx (1961). This theory assumes many market compensation mechanisms that are triggered by technological change itself and that can offset the negative effect arising from the economic impact of technological innovations (Vivarelli, 2007). Meyer-Krahmer (1992) examines the effect of technology on a sample of 51 German sectors spanning the entire economy in the 1980s and measured technological innovation by expenditure on research and development (R&D) and the purchase of the (R & D). His results support the view that technological progress involves aggregate labor-saving effects. That is, as technologies displace workers in user industries new jobs are created in the sectors of capital where new machines are produced (Vivarelli, 2007).

Using a CES (constant elasticity of substitution) type production function (Sepehrdoust & Khodaee, 2012) presented a study providing an overview of the effective ways in which ICTs help create more employment opportunities in selected economies of Organization of the Islamic Conference (OIC). For this purpose, an econometric panel data model is run to analyze the relationship between ICT and employment rate of OIC countries for the period 2000 to 2009 and the results found that the introduction of technology has led to structural changes in the economy of OIC member countries and there is also a positive and significant effect of ICT on the employment rate but the effects are diversified.

Benavente and Lauterbach (2008) using Chilean companies for the period 1998-2001 to study the impact of innovation on employment, find that innovation has a positive and significant effect on employment at different levels of skills. Piva and Vivarelli (2005) also did a similar study to the previous one by studying the same relationship between innovation and employment on data from 575 industrial firms in Italy during the period 1992-1997. And the results that reflect everything likewise a positive relationship between innovation and employment in the company. Vivarelli and Pianta (2000) argued that technological innovations have a positive impact on employment since they allow the development of new goods or increase the productivity of existing goods.

For most sectors of the UK economy, Whitley and Wilson (1982) estimated employment levels in 1990 and found that technological innovation promotes employment levels and compensates for initial job losses due to adoption of innovation. Sinclair (1981) employing a macro-IS/LM framework, examined the effect of technological innovation on employment in the United States. He argued that a positive employment offset can occur if the elasticity of demand and the elasticity of factor substitution are high enough. Using macroeconomic data from the US economy, the author found strong evidence supporting the wage-decreasing mechanism but not the price-decreasing mechanism.

The UNCTAD (2011) studied the effects of information and communication technologies on development and found that ICTs play a role in job creation and job opportunities. Impacts can be direct, through the growth of the ICT sector using industries, and indirect through multiplier effects. In increasingly ICT-dependent economies, individuals will benefit from the required ICT skills, which will increase their opportunities. Entorf and Pohlmeier (1990) using simultaneous equations (linking innovation, exports and employment) show that product innovations have a positive effect on employment. Van (2011) for his part, studied through the estimation of a CES-type production function (constant elasticity of substitution) the impact of innovations on employment for the period (1976-1982). It shows that the innovations of past years stimulate the creation of new jobs. In other words, through the technique of lagged variables, Van (2011) finds that product innovations play an important role in the evolution of employment. Ebaidalla (2014) examines the impact of information and communication technologies (ICT) on youth unemployment in sub-Saharan Africa (SSA) during the period 1995-2010. The study uses a dynamic panel data method for a sample of 30 countries in sub-Saharan Africa and measuring ICT by the installation of mobile subscriptions and the number of Internet users. Empirical results show that mobile subscriptions have a negative and significant effect on youth unemployment in Sub-Saharan African countries, implying that the communications boom in recent decades has promoted youth employment.

Previous studies seem to show that ICTs have a positive impact on employment. However, some authors have not come to this conclusion. However, others authors have found the negative impact of ICT on employment.

2.2.2. Proponents of the Negative Effect of ICT on Employment

We address this part by Leontief and Duchin (1986) who, using one of the input-output accounting matrices, tested the impact of automation on employment by assuming four different scenarios (characterized by different rates of technological change). The authors carried out their simulations by considering the future evolution of demand as exogenous. While for all the other four the simulations led to an upward trend in employment, the study revealed an obvious technological bias: in fact, faster technological progress led to lower growth rates of employment. Moreover, David (2017) assessed employment vulnerability from a technical perspective by considering the differential endowment of jobs with soft skills in Japan. Using the machine learning technique, the author found evidence that around 55% of jobs are likely to be IT capital driven in the next few years. In addition, the author also shows that there is no significant difference according to gender. On the contrary, atypical jobs (those involving temporary and part-time workers) are more vulnerable to the spread of IT than others. These results, based on a technical context, shed light on the extent of potential capital/labour substitution, but this dynamic will also depend on economic and social factors.

2.2.3. Proponents of the Neutral Effect of ICT on Employment

Biagi and Falk (2017) analyzed the impact of information and communication technologies on employment in Europe. The data is based on new and unique data for 10 European countries for the period 2002-2010. A key feature of the empirical analysis is the use of several types of advanced ICT activities, such as enterprise resource planning (ERP) systems, mobile Internet access, and e-commerce practices. The main result of the study is that the increase in ICT/e-commerce activities over time has not led to a decline in employment. This applies to both manufacturing industries and services, as well as to SMEs (Small and Means Entreprises) and large companies. For ERP systems and websites, there is evidence of positive effects. These results do not support the hypothesis that ICT use leads to overall labor substitution. In fact, ICT activities seem rather neutral for employment. The results are robust not only to the specification of the model, but also to the estimation method applied. Postuła, Chmielewski, Puczyński, and Cieślik (2021) analyzed the impact of information and communication technologies (ICT) on energy poverty and unemployment in selected European Union countries.The research results described were obtained through a comparative factor analysis based on secondary data. The analysis showed that over the period 2009-2019, the use of ICT had a limited impact on the unemployment rate in the EU.

From the above, we find that the literature on the relationship between ICT and employment is ambiguous and inconclusive. This is proof that the debate on the relationship is not closed and that there are always contributions that can enrich the debate. It is for this reason that the objective of this work aims to analyze the relationship between information and communication technologies and employment in Cameroon. We have chosen this country because it has not yet drawn the attention of researchers to this subject. However, this country is part of the developing countries where the expansion of ICT is very rapid.

This paper is structured in five sections. Besides the introduction, section two is dedicated to the literature review. The section three is devoted to the methodology. The presentation of the results is provided by the section four and section five concludes.

3. METHODOLOGY

The data used in this work are from secondary sources. The work takes into account the data of each variable of the study for the period 1980-2016. These Data come from the World Development Indicators (WDI) and the Perspective Monde newspaper of the University of Sherbrooke. The dependent variable for this work is employment. Persons employed within the meaning of the ILO are those who have worked for any length of time, even just one hour, during a so-called reference week. This concept is different from that of employment in the sense of the population census, which concerns people who declared that they had a job in the census form. According to the International Labor Office, it is expressed by the ratio between the number of active people in a profession, and the total population of this profession in a country. Information and communication technologies represent the independent variable of this

work. The acronym ICT can be defined as the integration of telecommunications, computer and multimedia technologies. More than one proxy makes it possible to capture and (or measure) the technological variable of information and communication such as the number of telephone lines, the number of secure servers, the number of mobile phones, the number of Internet users and the number of air passengers transported. In this work, we will use the number of mobile phones per 100 inhabitants as a proxy for the ICT variable because it is the most widely used in the literature. The correlation between the dependent variable and the independent variable of interest is given by Figure 2.

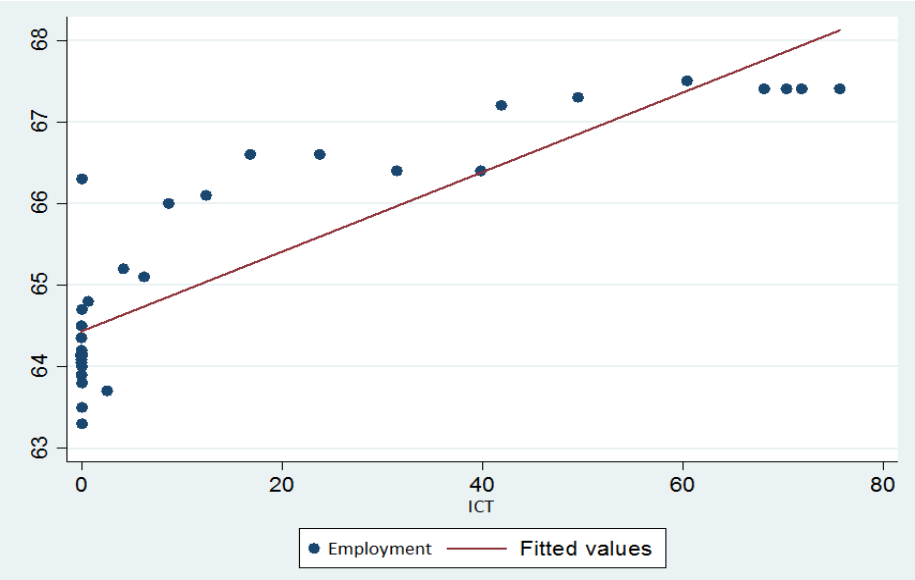

Figure 2. ICT and employment.

In order to analyze the effect of ICT on employment in Cameroon, our econometric model is inpired from the work of Matteucci and Sterlacchini (2003) as follow :

$$EMPL_t = \alpha_0 + \alpha_1 Trade_t + \alpha_2 ICT_t + \alpha_3 INF_t + \alpha_4 FDI_t + \alpha_5 ODA_t + \varepsilon_t \quad \forall t = 1, \ldots, 37 \qquad (1)$$

Where EMPL, TRADE, ICT, INF, FDI and ODA represent employment, foreign trade, information and communication technology, inflation, foreign direct investment and official development assistance respectively. In the absence of autocorrelation, heteroscedasticity of errors, the OLS method gives BLUE estimators in time series. This method, which is a basic method, will be used in this work to make regressions. Indeed, it makes it possible to find the explanatory factors of employment. Due to its simplicity, it has already been used by several authors such as Beck, Demirgüç-Kunt, and Maksimovic (2005); Svejnar and Commander (2007); Hinh, Dimitris, and Hoa (2010) as well as Bah and Cooper (2012). Table 2 simultaneously presents the descriptive statistics as well as the result of the VIF test.

Table 1. Descriptive statistics and multicollinearity test.

Variables	Obs.	Mean	Std. Dev.	Min.	Max.	VIF
EMPL	37	65.199	1.398	63.300	67.500	-
TRADE	37	44.808	8.540	31.750	65.020	1.430
ICT	37	15.800	25.178	0	75.690	1.33
FDI	37	1.252	1.349	-1.011	4.622	1.30
INF	37	5.105	6.770	-3.210	35.090	1.270
ODA	37	4.114	2.100	1.672	9.710	1.18

4. RESULTS

The presentation of the results is structured in two subsections: the statistical presentation of the results and the economic interpretation of the results.

4.1. Presentation of Statistical Results

The table above gives the descriptive statistics of the variables of our econometric model on the one hand and on the other hand, the result of the test of the Variance Inflation Factor (VIF). This result shows that the VIF of each explanatory variable is less than 5, which means the absence of the multicollinearity problem. The results of model (1) are recorded in Table 2.

The estimate of the employment equation shows the R^2 equals 80.24% and an adjusted R^2 77.06%. The Fisher statistic equals 25 with a probability of 0. This means that this model is globally significant. We find that the coefficients of the ICT and ODA variables are respectively significant at 1% and 5% and have the expected signs while the a variables such as inflation, FDI and TRADE are not significant. We find that the residuals are homoscedastic through the Breusch-Pagan heteroscedasticity test. In other words, p-value = 0.7366 > 5%. We accept the null hypothesis which is the assumption of homoscedasticity of errors. With regard to the Breusch-Godfrey autocorrelation test, we

can conclude that there is no serial correlation of the residuals (i.e. the residuals are independent) because the p-value = 0.1075 > 5 %. Thus, we accept the null hypothesis of no serial correlation of the residuals.

Table 2. Results of the estimation of the employment model through OLS.

Variables	Coefficients	Ecart-type	t-statistiques	Probabilités
ICT	0.051***	0.005	10.013	0.000
TRADE	-0.006	0.015	-0.393	0.697
INF	0.001	0.018	0.080	0.936
FDI	0.034	0.094	0.370	0.713
ODA	0.119**	0.057	2.061	0.047
C	64.121***	0.752	85.19718	0.000
Heteroskedasticity (Breusch-Pagan):		Prob(Chi2)	= 0.736	
Autocorrelation (Breusch- Godfrey) :		Prob(Chi2)	= 0.107	
R-squared = 0.802		F-statistic	= 25.189	
Adjusted R-squared	= 0.770	Prob (F-statistic) = 0.000		

Note: ***, **représentent respectivement la significativité à 1% et 5%.

4.2. Economic Interpretation

Information and communication technologies have a positive and significant effect on employment in Cameroon. Thus, an increase in ICT by one unit leads to an increase in the employment rate of 5.12%. This result is compatible with the work of: Benavente and Lauterbach (2008) and Vivarelli (2007). This result can be explained by the fact that an increase in information and communication technologies leads to the creation of jobs not only in the ICT sectors, but also in the ICT user sectors (industries). This result materializes the fact that ICTs lead to more job creation than job destruction.

Concerning Official Development Assistance (ODA), it has a positive and significant effect on employment in Cameroon. Thus, an increase in public aid for the development of a unit leads to an increase in the employment rate of 11.92%. This result can be explained by the fact that official development assistance is at the origin of certain investments, which create jobs.

5. CONCLUSION

In conclusion, this work aimed to analyze the effect of information and communication technologies on employment during the period 1980-2016. To achieve this objective, we used the method of Ordinary Least Squares (OLS). It appears that information and communication technologies have a positive and significant effect on employment in Cameroon. This result can be explained by the fact that an increase in information and communication technologies leads to the creation of jobs not only in the ICT sectors, but also in the ICT user sectors (Industries). This result materializes the fact that ICTs lead to more job creation than job destruction.

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