Digitalisation and Sectoral Employment Dynamics in ECOWAS: An Empirical Analysis

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Abstract
The digital transformation process presents an opportunity to create more stable and secure jobs in both the primary and tertiary sectors. Understanding how digitalisation can improve job availability in African households is essential for promoting equitable economic growth and reducing unemployment rates across the continent. Given this, the study investigates the influence of digitalisation on employment in the agricultural, industrial, and service sectors within the Economic Community of West African States (ECOWAS). A balanced panel dataset from 13 ECOWAS countries was considered; we applied three estimation techniques - pooled regression, fixed effects, and random effects models - to examine the impact of key digitalisation indicators (Mobile Cellular Subscriptions (MCS), Individuals Using the Internet, ICT Service Exports, and Fixed Broadband Subscriptions) on sectoral employment. The study results indicate that the digitalisation process has an industry-specific influence on employment. There is a negative relationship between growing internet usage in agriculture and employment, meaning that as internet usage increases, employment decreases. On the other hand, the export of ICT services and the number of broadband connections benefit agricultural employment. Within the industrial sector, the introduction of MCS hurts employment in all models, but implementing IUI demonstrates a direct effect. The service industry exhibits heterogeneous outcomes, where digitalisation has a favourable impact in certain circumstances but a negative impact in others, contingent upon the particular digitalisation metric and estimation approach. The study suggests that digitalisation can lead to increased employment in specific industries. However, it also emphasises the importance of taking a careful and detailed approach to preventing job losses in other sectors. This highlights the necessity of implementing customised policy measures to maximise the advantages of digital transformation in the ECOWAS region.

***Keywords**:* Digitalisation, Employment Outcomes, ECOWAS, Sectoral Employment, Fixed Effects Model, Pooled Regression, Random Effects Model

***JEL Classification**:* E24, E64, H31, J64, Q55

Introduction

Opportunities that possibly create more secure employment are introduced via digital transformation. The informal sector is identified as an important challenge to the fulfilment of the Sustainable Development Goals (SDGs) and the fourth goal of the African Union's Agenda 2063. Over 92.4% of total employment is in the informal sector. The distribution and the present state of work across sectors strongly support the prevalence of informality and instability. Common in the agriculture or service sectors is self-employment (Bonnet et al., 2019). A profound social and economic structural revolution driven by the rapid expansion of data storage, processing, and transmission capabilities enabled by digital technology is referred to as digitalisation. The growth of cyber-physical systems, the Internet of Things, artificial intelligence, smart robotics, and big data highlights the extensive nature of digitalisation, leading to a hefty transformation in both the composition and framework of labour (Schlögl, 2020). The change has redefined labour, comprising an extensive spectrum of activities varying from software engineering to market vending, all of which are termed 'digital labour'.

With each technological revolution, the employment market faces remarkable challenges, digitalisation being a case in point. Two important issues crop up: how technological changes affect overall employment, and which industries and jobs are most affected by these changes (Kovancı & Sapancalı, 2022). Digitalisation has a twofold impact on the labour market: it invents new opportunities in employment, while making certain jobs outdated, aggravating unemployment in some sectors. The swift rise of digital technologies requires a matching increase in skill, as employment blueprints across sectors, occupations and expertise sets continue to advance.

Presently, digitalisation drives the world economic change and is marked by its acceptance of digital technologies in many different spheres. Economic Community of West African States (ECOWAS), a regional bloc of 15 West African countries, faces significant employment challenges, with high unemployment rates and a labour market still heavily reliant on agriculture. Nevertheless, digitalisation has the capacity to reform employment structures by enhancing productivity, fostering new business paradigms, and facilitating access to markets and information (World Bank, 2019). Yet, the region's progress in digitalisation is lopsided, with many individuals still not having access to the necessary digital infrastructure and skills, leading to digital exclusion. The prospect of digitalisation to propel economic growth and job creation is considerable, specifically in regions like West Africa, states where the spreading out of broadband infrastructure and digital literacy could unravel ample economic opportunities. ICT investments have been shown to definitely impact job creation, real wages, GDP, and overall well-being. States like Benin, Togo and Côte d'Ivoire (CIO Mag, 2021), governments are giving Internet-driven advancement top priority. These countries have tenacious goals to provide fast Internet access to their entire populations. Although many nations are still in their initial phases of execution, most have crafted national digital policies. In spite of this, discrepancies in access to digital resources, predominantly in rural areas, and the uneven distribution of digital skills, remain major obstacles (Puttin, 2023).

The modification to a digital economy in West Africa is confounded by structural challenges, including rising unemployment owing to deindustrialisation and a swing away from agrarian economies. The region's gradual growth in digital transformation, as signified in its categorisation in the Digital Intelligence Index (DII), points out the urgent need for strategic interventions to enhance digital readiness. Through the next decade, an estimated 230 million jobs in Sub-Saharan Africa will require digital skills, presenting both opportunities and challenges for employment, particularly among the youth in Nigeria (Puttin, 2023).

Beyond the services sector, there has been little investigation into how digitalisation impacts other ECOWAS employment sectors, leaving a void in the literature. While previous studies have looked at how digitisation impacts the economy as a whole and how many jobs it creates, less is known about how it influences particular industries like agriculture, manufacturing, and services in the ECOWAS area. it is necessary to undertake sector-specific research to understand the specific difficulties and possibilities that digitalisation brings.

With a specific focal point on sectoral employment dynamics in agriculture, industry and services, this paper explores the relationship between digitalisation and employment outcomes in ECOWAS. Utilising pooled regression, fixed effects, and random effects models, the analysis purposes to offer empirical insights into how digitalisation influences employment across different sectors.

Likewise, it reconnoitres the influence of government policies, digital literacy, and access to technology on employment patterns in West Africa.

Literature Review

Consequent on the implementation of digital technologies, the services industry sector has remarkably experienced substantial growth in Sub-Saharan Africa. Ndubuisi et al. (2021) finding supports the perception that digital infrastructure brings to bear a favourable influence on employment within the services sector. However, the effectiveness of this influence is dependent upon various yardsticks, including education, institutional quality, and macroeconomic stability. Their findings highlight the complex relationship between digitalisation and the wider socioeconomic context. The effects of ICT use in several sectors, including industry, government, and individuals, were classified within the framework of overall economic development (Solomon, 2020). Myovella et al. (2020) suggest that there is an important correlation between ICT service exports, mobile cellular subscriptions, and GDP per capita growth in Nigeria. Their study reveals that individual ICT usage, particularly social media and government ICT integration, supportively influences economic growth.

Beyond economic development, digitalisation has far-reaching consequences for labour markets and job arrangements. According to Olofin (2023), the digital economy correlates with institutional quality; although digitalisation and human capital have the potential to stimulate economic growth, deficient institutional quality can reduce the positive effects of these factors. Furthermore, Ahuru et al. (2023) stated that the adoption of ICT has a notable contrary influence on unemployment in the West Africa Monetary Zone (WAMZ). Nonetheless, the magnitude of this impact varies depending on the particular information and communication technology indicators considered.

At the micro level, household and labour survey evidence suggests ICT access shapes labour reallocation. Nsabimana and Funjika (2019), using Tanzanian panel survey data, found that mobile phone ownership reduced household members' farm work intensity while increasing hired farm labour, and also induced labour movements into non-farm sectors. Similarly, Bahia (2023) showed that 3G mobile broadband coverage raised household consumption and reduced poverty in Tanzania by boosting wage employment and non-farm self-employment, although benefits were uneven across age, gender, and skill groups.

Studies also highlight ICT's long-run externalities in agriculture. Oyelami et al. (2022) found that mobile subscriptions and internet use had significant positive effects on agricultural value addition and exports in SSA in the long run, though short-run effects were negligible. Ayim et al. (2022), in a systematic review, reported widespread adoption of mobile and radio-based ICT services in African agriculture, but stressed barriers such as poor infrastructure, weak policies, and low digital skills among farmers. Similarly, Aminu and Raifu (2019) showed through Nigerian input–output tables that ICT reforms generated strong inter-sectoral linkages, with services benefiting most through induced effects.

The literature also reflects the duality of ICT's impact across labour markets. Garcia-Murillo and Velez-Ospina (2017) found that while mobile phones reduced transaction costs and expanded informal sector activity, broadband access facilitated movement into formal employment. Nipo et al. (2018) further observed that ICT enhanced trade competitiveness in middle-income countries but not in low-income ones, illustrating the persistence of the digital divide. Outside Africa, similar heterogeneity is evident. Viete and Erdsiek (2020) demonstrated that mobile ICT adoption improved service firms' productivity in Germany only when paired with flexible work arrangements, while Stockinger (2019) showed broadband adoption had negative effects in manufacturing but positive effects in services. Ronen (2021) linked ICT service exports to high-skilled job creation in Israel, whereas Salsabila and Oktora (2022) found broadband expansion reduced unemployment in Indonesia. In South Africa, Gonese and Ngepah (2024) reported that while ICT usage and broadband boosted sectoral employment, ICT exports and high-tech imports displaced jobs, underscoring sector-specific divergences.

Two primary approaches have evolved to analyse the influence of digitalisation on employment within a wider theoretical framework. One viewpoint indicates that progress in digital technology may result in ample job displacement, making human labour progressively jobless and hence contributing to extreme levels of unemployment. On the other hand, the second standpoint holds that digitalisation can provide fresh employment possibilities by producing new occupational roles, industries, and demands for innovative goods and services. This perspective postulates that although technological advancements may result in the loss of certain occupations, these losses could be counterbalanced by the presence of fresh opportunities, thereby ushering in a new era of economic success (World Bank, 2016; Balliester & Elsheikhi, 2018; Frey & Osborne, 2013).

Nevertheless, the features of employment are anticipated to experience significant transformation, complemented by a change in the required competencies within the workforce. This change poses both difficulties and opportunities, requiring the implementation of policies that promote skill upgrading and workforce adaptation to prevent the deepening of inequalities. The findings of Anderton et al. (2020) and Banga & Willem te Velde (2018) confirm that digitalisation enhances productivity and competitiveness, but its benefits hinge on parallel improvements in workforce skills.

Within ECOWAS, empirical evidence confirms the sector- and skill-specific nature of digitalisation's employment effects. Ejemeyovwi et al. (2019) found that internet usage and innovation significantly improved human development across ECOWAS countries, though results varied by country. Avom et al. (2021) reported that ICT adoption in WAEMU countries yielded net job creation, displacing some low- and medium-skill jobs while generating high-skill employment. Faton and Chabossou (2024) showed that internet usage alone negatively affected ECOWAS employment, but when combined with IT skills among secondary school graduates, its effect became positive.

Ultimately, digitalisation has both positive and adverse implications for job dynamics in ECOWAS and Sub-Saharan Africa. Although it has substantial potential for economic expansion and employment generation, these prospects are contingent upon the wider socioeconomic context, encompassing factors such as education, institutional quality, and macroeconomic stability. The challenge lies in effectively managing the transition to a digital economy in ways that optimise benefits while minimising risks, particularly regarding employment and social equity. Addressing these gaps can foster a deeper understanding of how digitalisation influences labour markets and economic outcomes in ECOWAS, thereby enabling more focused and effective policy responses

Research Methodology

The theoretical framework review reflects on the Technology Acceptance Model (TAM) and Schumpeterian Growth Theory (SGT). Building on these frames, the study provides a balanced view for comprehending the means through which digitalisation impacts sectoral employment dynamics in the ECOWAS region. Following are the stepwise derivation from Schumpeterian Growth Theory and the Technology Acceptance Model, the explanatory variables are selected to reproduce both the adoption and diffusion of digital technologies.

In the Schumpeterian Growth Theory (SGT), growth and employment patterns depend on the rate of technological innovation. When digitalisation accelerates At sectors adjust employment through creative destruction (job losses in some areas, new job creation in others). At its core, SGT formalises the process of innovation-driven growth via creative destruction

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}, \quad \frac{\dot{A}}{A} = \phi(I_t) \qquad (1)$$

Where $Y_t -$ aggregate output; $A_t -$ technology/knowledge stock; $K_t -$ capital input; $L_t -$ labour input; $\phi(I_t) -$ innovation intensity as a function of R&D, digitalisation, or ICT. TAM operates at the micro-level, explaining adoption behaviour defined as:

$$Usage_i = f(PU_i, PEOU_i) \qquad (2)$$

Where PU – Perceived usefulness; $PEOU -$ perceived ease of use; $Usage_i -$ individual or firm-level adoption of digital technology. Integrating SGT and TAM results in Macro–Micro Link. TAM explained adoption (Usage) is defined as:

$$D_{it} = \delta_0 + \delta_1 MCS_{it} + \delta_2 IUI_{it} + \delta_3 ISEX_{it} + \delta_4 FBS_{it} + \delta_5 GEE_{it} + u_{it} \qquad (3)$$

$D_{it} -$ digitalisation intensity (country i, time t). SGT explains how innovation/ digitalisation affects growth and employment:

$$EMP_{it}^{s} = \beta_0 + \beta_1 D_{it} + \beta_2 Z_{it} + \mu_i + \lambda_t + \varepsilon_{it} \qquad (4)$$

EMP_{it}^{s} – employment in sector sss (agriculture, industry, services); $D_{it} -$ digitalisation (from TAM model above); $Z_{it} -$ control variables (trade openness, FDI, macro conditions, etc.); $\mu_i, \lambda_t -$ country and time effects; β_0 - Intercept; β_1 … β_5 - Coefficients; MCS - Mobile cellular subscriptions; IUI - Individuals using the Internet; ISX - ICT service exports; FSB - Fixed broadband subscriptions; GEE - as well as the broader institutional and structural supports for digital transformation captured by Government expenditure on education; EMPA -

Employment in agriculture; EMPI - Employment in industry; EMPS - Employment in services.

Given the panel nature of the data across ECOWAS countries and sectors, fixed and random effects estimations are employed to explain the unobserved heterogeneity. The fixed effects specification controls for country-specific unobservable characteristics, while the random effects model assumes independence between the regressors and country effects, improving efficiency when valid. Following the precedent of Faton and Chabossou (2024), Ejemeyovwi et al. (2019), and Avom (2021), three econometric models are thus specified to capture the effects of digitalisation on sectoral employment outcomes, as presented below.

Each of the sectors served as a dependent variable in each specified model, respectively. Model I captures the effect of digitalisation on employment output in the agricultural sector, with Model II, the effect of digitalisation on employment output in the industrial sector, and the last Model III tends to explain the role of digitalisation on employment output in the service sector. The three models (Model I, II, III) are specified as follows:

$$empa_{it} = f(msc, iui, isex, fbs, gee) \quad (5)$$

The fixed effect and Random effects model (random intercepts) are defined as:

$$empa_{it} = \beta_0 + \lambda_i + \beta_1 msc_{it} + \beta_2 iui_{it} + \beta_3 isex_{it} + \beta_4 fbs_{it} + \beta_5 gee_{it} + \varepsilon_{it} \quad (6)$$

$$empa_{it} = \beta_0 + \beta_1 msc_{it} + \beta_2 iui_{it} + \beta_3 isex_{it} + \beta_4 fbs_{it} + \beta_5 gee_{it} + v_{it} + \varepsilon_{it} \quad (7)$$

$$empi_{it} = f(msc, iui, isex, fbs, gee) \quad (8)$$

The fixed effect and Random effects model (random intercepts) are defined as:

$$empi_{it} = \beta_0 + \lambda_i + \beta_1 msc_{it} + \beta_2 iui_{it} + \beta_3 isex_{it} + \beta_4 fbs_{it} + \beta_5 gee_{it} + \varepsilon_{it} \quad (9)$$

$$empi_{it} = \beta_0 + \beta_1 msc_{it} + \beta_2 iui_{it} + \beta_3 isex_{it} + \beta_4 fbs_{it} + \beta_5 gee_{it} + v_{it} + \varepsilon_{it} \quad (10)$$

$$emps_{it} = f(msc, iui, isex, fbs, gee) \quad (11)$$

The fixed effect and Random effects model (random intercepts) are defined as:

$$emps_{it} = \beta_0 + \lambda_i + \beta_1 msc_{it} + \beta_2 iui_{it} + \beta_3 isex_{it} + \beta_4 fbs_{it} + \beta_5 gee_{it} + \varepsilon_{it} \quad (12)$$

$$emps_{it} = \beta_0 + \beta_1 msc_{it} + \beta_2 iui_{it} + \beta_3 isex_{it} + \beta_4 fbs_{it} + \beta_5 gee_{it} + v_{it} + \varepsilon_{it} \quad (13)$$

Sample Data Source and Technique of Estimation

The indicator of digitalisation is mostly evident through the surge in computer and internet utilisation. Various variables that specify digitisation have been utilised in studies examining the digitalisation process. However, it is not feasible to effectively and systematically get a significant portion of the data of these indicators for the panel analysis (countries, time-series cross-sectional data) deployed in this study. Hence, Mobile cellular subscriptions (MCS), Individuals using the Internet (IUI), ICT service exports (ISEX), and Fixed broadband subscriptions (FBS) are used as a proxy for digitalisation. Sectoral employment in agriculture (EMPA), industry (EMPI) and services (EMPS), which are in percentage of total employment, and the modelled International Labour Organisation estimate (ILO) are the three categories considered accordingly within this context.

The data on the indicators of digitalisation, mobile cellular subscriptions, individuals using the Internet, ICT service exports, and fixed broadband subscriptions are obtained from the World Development Indicators (WDI) and data on sectoral employment were collected for the International Labour Organisation. The study gathered data from 2010 to 2022 for 13 countries of the 15 countries in ECOWAS Namely, Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, Ghana, Guinea, Guinea-Bissau, The Gambia, Mali, Nigeria, Niger, Togo and Senegal were carefully chosen out of the 15 countries based on the availability of data. Liberia and Sierra Leone were not included in the countries analysed for this study. These countries are selected using a purposive sampling technique for trade liberalisation and market expansion within the Economic Community of West African States (ECOWAS). The panel data used covers 2010 to 2022.

Although the Hausman test indicated that the random effects model provides the most consistent estimates, we report results from pooled OLS and fixed effects models as robustness checks. This comparative approach highlights the consistency of key findings across different estimation techniques while accounting for model-specific assumptions. The random and fixed effect models, known as panel data models, take into account the multiple measurement points of countries measured in panel data. These models consider the structure and occasions of nested countries within the data.

Although the pooled ordinary least squares violate the assumption of independence but the OLS regression model is fit into the panel data. Hence, its estimates are still presented in each of the table analysis of results, basically for comparison of other models' estimated parameters. The fixed effect model controls for all stable unobserved variables, including variables that have not, or cannot, be measured. All time-invariant differences between individuals are contained in the fixed effect, and time-varying differences can be estimated in the model (captured by the term λ_i in the fixed effect model specified below) (Kevin, 2024).

There are two components to the error distribution in the random effects framework, which is the reason why the random effects model is also called the error components model. The first is the often-included error term as ε_{it} in the random effect model below, and the second component is the country parameter that summarises the overall distribution of the country's differences, shown as v_i in the random effect model. Given the assumption that unobserved characteristics must not be correlated with the variables that are observed in the model. The random effects estimate may be biased if there is a correlation between the observed and unobserved variables (Kevin, 2024).

Presentation and Analysis of Results

The summary statistics of mean, standard deviation, minimum and maximum of the variables used are displayed in Table 1 below.

Table 1: Summary Statistics

Variable		Mean	Std.Dev.	Min	Max	Observations
EMPA	overall	48.018	17.946	10.136	79.106	N = 169
	between	18.323	14.581	76.433		n = 13
	within	3.211	39.960	57.992		T= 13
EMPI	overall	12.774	5.737	5.737	22.626	N = 169
	between	5.856	6.403	20.913		n = 13
	within	1.037	9.790	15.799		T = 13
EMPS	overall	39.208	13.130	15.020	67.895	N = 169
	between	13.355	17.130	64.506		n = 13
	within	2.601	31.499	46.334		T =13
MCS	overall	88.052	27.890	22.037	174.025	N = 164
	between	21.194	40.619	117.620		n = 13
	within	19.426	30.739	144.458		T = 12.615
IUI	overall	20.278	16.567	.83	69.762	N = 156
	between	11.479	7.515	48.253		n = 13
	within	12.367	-2.186	58.214		T = 13
ISEX	overall	15.925	15.118	0.118	61.451	N = 157
	between	12.464	1.524	39.248		n = 13
	within	9.200	-11.543	52.164		T = 12.077
FBS	overall	50161.570	66671.190	350	379978	N = 160
	between	55111.610	932.500	1.81e+05		n = 13
	within	41728.210	-8.43e+04	2.49e+05		T = 12.308
GEE	overall	16.867	4.612	5.493	30.634	N = 157
	between	3.949	8.428	22.199		n = 13
	within	2.619	9.191	27.658		T = 12.077

Source: Authors' computation (Stata 16)

The statistics in Table 1 show no missing values for any variables, indicating a balanced panel. For the thirteen countries, the overall mean employment in agriculture, services, and industry (EMPI) is 48.02%, 39.2%, and 12.8%, respectively. The highest employment in services (EMPS) was 67.9%, recorded in Cabo Verde in 2022. The maximum employment in industry (22.6%) was also recorded in 2022, in Senegal. The highest employment in agriculture (EMPA), 79.1%, occurred in Burkina Faso in 2010. The overall averages for the digitalisation proxies—Mobile Cellular Subscriptions (MCS), Individuals Using the Internet (IUI), ICT Service Exports (ISEX), and Fixed Broadband Subscriptions (FBS)—are 88.1%, 20.3%, 15.9, and 50,161.6, respectively. Government Expenditure on Education (GEE) averaged 16.9%. To assess the impact of digitalisation on employment across agriculture, industry, and services, pooled, fixed-effect, and random-effect regression estimates were used.

Table 2: EMPA Analysis Results

	Pooled Regression		Cluster regression		Fixed effect		Random effect (RE)	
EMPA	**Coef.**	**p-value**	**Coef.**	**p-value**	**Coef.**	**p-value**	**Coef.**	**p-value**
MCS	.141	.017**	.141	.319	-.021	.174	-.02	.194
IUI	-.681	0.00***	-.681	.005***	-.211	0***	-.214	0.00***
ISEX	.419	0***	.419	.01***	.004	.834	.007	.739
FBS	0	.377	0	.618	0	0***	0	0***
GEE	-.888	.002***	-.888	.103	.119	.209	.109	.248
Constant	59.46	0***	59.46	.001***	51.222	0***	51.756	0***
Hauman Test	Prob > chi2 = 0.1296						RE is the preferred model	
R-squared	0.523		0.523		0.550		0.290	
F-test	27.844		10.676		28.100		140.690	

**** p<.01, ** p<.05, * p<.1*

Source: Authors' computation (Stata 16)

To assess the magnitude of variables indicating the impact of digitisation on agriculture, industry and service employment, the Hausman test is used to determine the appropriate technique between fixed and random effect regression estimates. To show that the findings are not purely an artifact of one estimation method and to see the sensitivity of the results, the pooled OLS, fixed effects or, random effects (base on the outcome of the Hausman test), and even clustered estimates are presented.

Table 2 presents the results for EMPA as the dependent variable. The different estimation techniques yield varying results, with some estimates reaching statistical significance at the 5% level. The random effect is the preferred model based on the Hausman test. The pooled regression shows MCS as the only statistically significant variable (P-value 0.017). The IUI estimates are significant and negative across all models, implying that as the percentage of individuals using the internet increases, agricultural employment decreases. The ISEX estimate is significant and positive only in the pooled regression, indicating that a one-unit increase in ICT service exports leads to a 0.42% increase in EMPA. The coefficient of FBS is positive and highly significant in both the fixed and random-effect models, suggesting that an increase in fixed broadband subscriptions results in a 2.3 x 10^{-5} increase in agricultural employment.

Table 3: EMPI Analysis Results

	Pooled Regression		Cluster regressio		Fixed effect		Random effect	
EMPI	**Coef.**	**p-value**	**Coef.**	**p-value**	**Coef.**	**p-value**	**Coef.**	**p-value**
MCS	-.09	0***	-.09	.055*	-.014	.001***	-.015	.001***
IUI	.223	0***	.223	0***	.075	0***	.076	0***
ISEX	-.114	0***	-.114	.029**	-.007	.22	-.008	.188
FBS	0	.12	0	.405	0	.108	0	.131
GEE	.618	0***	.618	.001***	.014	.589	.019	.486
Constant	6.751	.001***	6.751	.101	12.329	0***	12.372	0***
Hauman Test	Prob > chi2 = 0.51						RE is the preferred model	
R-squared		0.519		0.519		0.545		0.266
F-test		27.382		23.394		27.535		135.906

**** p<.01, ** p<.05, * p<.1*

Source: Authors' computation (Stata 16)

Table 3 presents the regression results for the relationship between industry employment and digitalisation in ECOWAS. In Table 3, Hausman test result revealed that the random effect model is appropriate. The MCS estimate is negative and statistically significant across all models. The IUI coefficient is positive with a high level of significance (P-value 0.01) in all models. ISEX, FBS, and GEE are not statistically significant in the fixed and random regressions but are significant in the pooled regression.

Table 4: EMPS Analysis Results

	Pooled Regression		Cluster regression		Fixed effect		Random effect	
EMPS	**Coef.**	**p-value**	**Coef.**	**p-value**	**Coef.**	**p-value**	**Coef.**	**p-value**
MCS	-.051	.242	-.051	.608	.035	.012**	-.035	.012**
IUI	.458	0***	.458	.016**	.136	0***	-.138	0***
ISEX	-.305	0***	-.305	.011**	.003	.876	.00034	.986
FBS	0	.601	0	.765	-.000021	0***	-.000021	0***
GEE	.27	.203	.27	.49	-.133	.119	-.127	.133
Constant	33.789	0***	33.789	.003***	36.449	0***	35.864	0***
Hauman Test	Prob > chi2 = 0.234						RE is the preferred model	
R-squared	0.512		0.512		0.459		0.299	
F-test	26.619		9.026		19.498		99.298	

**** p<.01, ** p<.05, * p<.1*

Source: Authors' computation (Stata 16)

Table 4 shows the regression results for employment in services and digitalisation. The random effect model is deemed fit based on the Hausman test. The MCS coefficient is statistically significant and positive in the fixed-effects model but negative in the random-effects regression. The elasticity of IUI is highly significant in all models, positive in the fixed-effect and pooled regressions, and negative in the random-effects regression. The elasticity of FBS is negative and highly significant in the fixed and random-effects regressions.

The findings in the current study align with various earlier works that examine the role of digitalisation on agricultural employment (EMPA) and broader labour market outcomes in the sector. The results show that mobile cellular subscriptions (MCS) and fixed broadband subscriptions (FBS) positively impact agricultural employment, resounding Nsabimana and Funjika's (2019) observation that mobile phone ownership increases agricultural output by 40%, particularly in male-headed households. Similarly, Bahia et al. (2023) note the positive effects of mobile broadband on household consumption and poverty reduction, primarily driven by increased labour-force participation and a transition away from farm employment, suggesting that the decline in agricultural employment due to higher internet use (IUI) observed in our study may reflect labour shifts to other sectors.

While our study highlights the significant role of ICT service exports (ISEX) and broadband subscriptions (FBS) in bolstering agricultural employment, Oyelami et al. (2022) observe a more nuanced impact. Their findings suggest that mobile subscriptions do not affect agricultural output in the short run but have a positive impact in the long run, aligning with the long-term positive impacts of ICT we observe. However, their findings on the underutilization of the Internet in agriculture due to low awareness may explain why the Internet users' variable (IUI) has a consistently negative effect on EMPA in our models, signalling a need for increased education on Internet applications for agricultural productivity. Aminu and Raifu (2019) ascertain that changes in the ICT sector generate job increases across all sectors, particularly in services, which corresponds with the favourable impacts of ISEX on agricultural employment in this research. This highlights the inter-sectoral connections between agriculture and ICT-driven service exports. Furthermore, Ayim et al. (2022) and Matthew et al. (2023) highlight the persistent hurdles in adopting ICT in rural agricultural settings, including inadequate infrastructure and insufficient user proficiency. The obstacles likely add to the adverse effects of internet usage on agricultural employment in the models, indicating that although the digital economy presents job prospects, its advantages depend on overcoming basic obstacles to ICT adoption in agriculture.

Several empirical studies support the findings of this study on the effects of digitalisation on employment outcomes in services within ECOWAS, examining the relationship between ICT and labour markets. Between Mobile Cellular Subscriptions (MCS) and employment in the service sector, findings unveil a significantly positive relationship given the fixed-effects model. Comparable outcome in the findings of Mercado et al. (2021), suggests that MCS directly affects service sector employment, rather than ICT being a substitute; its function is as a complement to labour in the services sector. Given the result from Latin American Countries by Garcia-Murillo and Velez-Ospina (2017), which aligns with the findings observed in the random-effects model, the adverse relationship between MCS and employment in the service sector. Consequently, mobile cellular technology impacts differently across economic structures and states.

As shown by the pooled and fixed-effects regressions result, the significant decisive effect of Individuals Using the Internet (IUI) on service employment supports the findings of Viete and Erdsiek (2020). Their study points out that internet usage, combined with high elasticity in work arrangements, enhances firm productivity, which possibly steers greater employment prospects. In the same way, internet access significantly influences employment in upper-middle-income countries according to Nipo et al. (2018), thereby buttressing the affirmative influence of internet implementation on service sector productivity and employment in the ECOWAS region.

On the contrary, the negative effect of Fixed Broadband Subscriptions (FBS) on service sector employment in this research outcome line up with Stockinger's (2019) conclusions, which reveal that while broadband extension noticeably has some bearing on job creation in firms that intensely utilise broadband, it may adversely influence sectors where broadband adoption leads to diminished labour demand owing to automation or efficiency developments.

Moreover, Ronen (2021) findings agree with the significant impact of ICT service exports (ISEX) on employment. In his study, ICT services exports enhance labour demand, particularly for female workers in high-income nations. This correlation underscores the significance of ICT in propelling employment, implying that public policies, incorporating funding for ICT research and education, could enhance this impact. Finally, the adverse effects of broadband subscriptions found in both fixed and random effects models draw attention to the intricate effects of digitalisation: although broadband access enables a decline in unemployment by improving access to information and encouraging innovation (Salsabila & Oktora, 2022), it may at the same time result in job losses in specific sectors due to technological shift or efficiency step up.

Concerning the influences of digitalisation on employment in the service sector with ECOWAS, the outcome of this study is in line with the considerable existing literature on digital infrastructure and employment findings. The results point out that Mobile Cellular Subscriptions (MCS) and internet usage (IUI) have a certain influence on service sector employment in the short term, supporting Gonese and Ngepah's (2024) assertion that technologies associated with the Fourth Industrial Revolution produce wide-ranging but by and large beneficial effects on employment across sectors. They underscore the mediating functions of education, institutional quality, and macroeconomic steadiness, revealing that the differing effects of digitalisation in this study's models may be associated with similar conditions in ECOWAS countries.

Conclusion and Policy Recommendations

This article makes available empirical substantiation on the impact of digitalisation on employment outcomes in the ECOWAS region, emphasising significant sectoral differences. The outcome shows that digitalisation, as proxied by mobile cellular subscriptions, internet usage, and fixed broadband subscriptions, has differing impacts on employment across agriculture, industry, and services. In agriculture, increased internet usage correlates with reduced employment, while ICT service exports and broadband subscriptions positively influence agricultural employment. In the industrial sector, digitalisation measure indicates an adverse impact on employment, notably mobile cellular subscriptions, which is consistently significant across models. Contrarily, internet usage positively sways industrial employment. The service sector reveals mixed results, with digitalisation contributing positively in some settings but negatively in other contexts, contingent on the identifiable digitalisation proxy and estimation technique used.

These results suggest that while digitalisation holds the possibility to transform employment situations in ECOWAS, its effects are graded and sector-specific. Policymakers should reflect custom-made tactics that leverage digitalisation to boost employment in sectors where it has an optimistic influence, while addressing conceivable displacement impacts in others. This study underlines the importance of a balanced approach to digital transformation, ensuring that the benefits of digitalisation are equitably distributed across different sectors of the economy.

Remarkably, in rural and underserved regions, policymakers must give precedence to investments in mobile cellular infrastructure and digital literacy programs. The encouraging impact of Mobile Cellular Subscriptions (MCS) and Internet Usage (IUI) on service sector employment brings to light the potential of digital technologies to expand labour market participation. To fully realise these benefits, targeted interventions are crucial to improve access to reasonably priced mobile services and to raise awareness of the economic opportunities offered by digital platforms. Addressing the physical obstacles that hamper the effective utilisation of broadband subscriptions is vital. Fixed Broadband Subscriptions (FBS) demonstrate a dual influence on employment; while specific sectors face job losses ascribed to technological displacement, the overall increase in broadband adoption may advance innovation and boost employment opportunities within knowledge-intensive industries. Strategies that urge firms to integrate broadband technologies in a way that improves rather than replaces labour may lessen negative employment influence while promoting productivity gains.

Governments and regional bodies should expand provision for ICT service exports (ISEX), as they are a vital driver of employment. Implementing ICT-centred educational programs and research initiatives, combined with financial incentives for companies participating in ICT services, can encourage more all-encompassing and bearable employment prospects within the ECOWAS service sector. Broader institutional reforms are important to advance the quality of education and governance in ECOWAS countries. The findings indicate that education and institutional quality mediate the effects of digitalisation, suggesting that enhancing human capital and improving the regulatory environment are fundamental for fully leveraging digital technologies to encourage employment. Policymakers must prioritise the establishment of stable macroeconomic conditions and the implementation of governance reforms to cultivate an environment conducive to the development of digital infrastructure. Tackling these areas will assist ECOWAS countries to efficiently utilise digitalisation for sustainable employment growth and to reduce the threats linked to technological change.

References

Adeleye, N., & Eboagu, C. (2019). Evaluation of ICT development and economic growth in Africa. *NETNOMICS: Economic research and electronic networking*, *20*, 31-53.

Ahuru, R. R., Osabohien, R., Al‐Faryan, M. A. S., & Sowemimo, E. J. (2023). Information and communication technology adoption and unemployment in West Africa Monetary Zone. *Managerial and Decision Economics*, *44*(1), 388-398.

Aminu, A., & Raifu, I. A. (2019). ICT sector, output and employment generation in Nigeria: Input-output approach. Online at https://mpra.ub.uni-muenchen.de/92917/ MPRA Paper No. 92917.

Andrews, D., Criscuolo, C., & Gal, P. N. (2018). The best versus the rest: The global productivity slowdown, divergence across firms, and the role of public policy. *OECD Productivity Working Papers*, No. 5, OECD Publishing.

Ayim, C., Kassahun, A., Addison, C., & Tekinerdogan, B. (2022). Adoption of ICT innovations in the agriculture sector in Africa: a review of the literature. *Agriculture & Food Security*, *11*(1), 22.

Bahia, K., Castells, P., Cruz, G., Masaki, T., Rodríguez-Castelán, C., & Sanfelice, V. (2023). Mobile broadband, poverty, and labour outcomes in Tanzania. The World Bank Economic Review, 37(2), 235-256.

Bayar, Y., Ozen, A., Sasmaz, M. U., & Danilina, M. (2024). ICT penetration and life expectancy in emerging market economies: panel evidence from asymmetric causality analysis. *BMC Public Health*, *24*(1), 897.

Bogoslov, I. A., Stoica, E. A., & Georgescu, M. R. (2022), The Labor Market in Relation to Digitalization — Perspectives on the European Union. In: Ciurea, C., Boja, C., Pocatilu, P., Bonnet, F., Vanek, J., & Chen, M. (2019). Women and men in the informal economy: A statistical brief. *International Labour Office, Geneva*, *20*, 22.

Brodny, J., & Tutak, M. (2022). Analyzing the level of digitalization among the enterprises of the European Union member states and their impact on economic growth. Journal of Open Innovation: Technology, Market, and Complexity, 8(2), 70.

Chiplunkar, G., & Goldberg, P. K. (2022). The employment effects of mobile internet in developing countries (No. w30741). National Bureau of Economic Research.

Digital skills and jobs. (2023). Shaping Europe's Digital Future. Retrieved 7 May 2024, from https://digital-strategy.ec.europa.eu/en/policies/digital-skills-and-jobs

Doinea, M. (eds), Education, research and business technologies. *Smart Innovation, Systems and Technologies*, 276. Springer, Singapore. https://doi.org/10.1007/978-981-16-8866-9_16.

Ejemeyovwi, J. O., & Osabuohien, E. S. (2020). Investigating the relevance of mobile technology adoption on inclusive growth in West Africa. Contemporary Social Science.

Emiru, T., & Wajebo, T. (2023). The Impact of Digitization on Economic Activity in Sub-Saharan Africa.

Fahlevi, M., Asdullah, M. A., Raza, F. A., Watto, W. A., Aljuaid, M., & Aziz, A. L. (2024). The influence of information and communication technology on trade in developing countries and partners. *Cogent Business & Management*, 11(1). https://doi.org/10.1080/23311975.2024.2320814

Fahta, A. I. A., Moreni, A. F., & Anggita, A. (2022). The Impact of Digitalization to Accelerate Economic Performance During COVID-19 Pandemic. *East Java Economic Journal*, 6(2), 253-270.

Garcia-Murillo, M., & Velez-Ospina, J. A. (2017). ICTs and the informal economy: mobile and broadband roles. *Digital Policy, Regulation and Governance*, 19(1), 58-76.
Goaied, M., & Sassi, S. (2019). The effect of ICT adoption on labour demand: A cross-region comparison. Papers in Regional Science, 98(1), 3-17.
Gómez-Plana, A. G., & Latorre, M. C. (2019). Digitalisation, multinationals and employment: An empirical analysis of their causal relationships. *Jahrbücher für Nationalökonomie und Statistik*, 239(3), 399-439.
Gonese, D., & Ngepah, N. N. (2024). Fourth industrial revolution technologies and sectoral employment in South Africa. *Cogent Social Sciences*, 10(1). https://doi.org/10.1080/23311886.2024.2382282
Houngbonon, G. V., & Liang, J. (2018). The impact of broadband internet on employment in France. Available at SSRN 3112182. https://www.ncrm.ac.uk/resources/online/all/?id=20842 [accessed: 26 July 2024]
ILO (2019), Women and men in the informal economy: A statistical picture, International Labour Organization, Geneva, (third edition), www.ilo.org/wcmsp5/groups/public/---dgreports/--- dcomm/documents/publication/wcms_626831.pdf.
Isley, C., & Low, S. A. (2022). Broadband adoption and availability: Impacts on rural employment during COVID-19. *Telecommunications Policy*, 46(7), 10231
Katz, R., & Callorda, F. (2020). *How broadband, digitization and ICT regulation impact the global economy: econometric modelling*. International Telecommunication Union (ITU) publications. Retrieved from this link.
Kevin R. (2024). Fixed and random effects models for panel data in Stata. National Centre for Research Methods online learning resource.
Kolko, J. (2012). Broadband and local growth. *Journal of Urban Economics*, 71(1), 100-113.
Kouladoum, J. C. (2023). Digital infrastructural development and inclusive growth in Sub-Saharan Africa. *Journal of Social and Economic Development*, 25(2), 403-427.
Kovancı, Y. A., & Sapancalı, F. (2022). The impact of digitalisation on employment: A study on occupations classified by skill levels in Turkey. *Karamanoğlu Mehmetbey Üniversitesi Sosyal Ve Ekonomik Araştırmalar Dergisi*, 24(43), 1031-1050.
Lee, C. C., Chen, M. P., Wu, W., & Xing, W. (2021). The impacts of ICTs on tourism development: International evidence based on a panel quantile approach. *Information Technology & Tourism*, 23, 509-547.
Lowery, K. (2022). High-Tech Harvests: How broadband internet access affects agricultural Firms.
Luong, T. A., & Nguyen, T. H. (2021). The impact of ICT on service trade. *The Singapore Economic Review*, 66(04), 1073-1086.
Mačiulytė-Šniukienė, A., & Gaile-Sarkane, E. (2014). Impact of information and telecommunication technologies development on labour productivity. *Procedia-Social and Behavioral Sciences*, 110, 1271-1282.
Matthew, O. A., Osabohien, R., Omosehin, O. O., Jawaid, N., Aderemi, T., Olanrewaju, O., & Evans-Osabuohien, P. N. (2023). Information and Communication Technology deployment and agricultural value chain nexus in Nigeria. *Heliyon*, 9(9).
Melia, E. (2019). The impact of information and communication technologies on jobs in Africa. A literature review. *Deutsches Institut für Entwicklungspolitik*. Bonn.
Mercado, P. A., Granadino, G. A., Pasco, E. M., & Rosete, M. A. (2021). The Impact of ICT on Service Sector's Productivity and Employment in the Philippines. *Journal of Economics, Finance and Accounting Studies*, 3(2), 288-299.

Mercado, P. A., Granadino, G. A., Pasco, E. M., & Rosete, M. A. (2021). The Impact of ICT on Service Sector's Productivity and Employment in the Philippines. *Journal of Economics, Finance and Accounting Studies*, 3(2), 288-299.

Myovella, G., Karacuka, M., & Haucap, J. (2020). Digitalization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies. *Telecommunications Policy*, 44(2), 101856.

Ndubuisi, G., Otioma, C., & Tetteh, G. K. (2021). Digital infrastructure and employment in services: Evidence from Sub-Saharan African countries. *Telecommunications Policy*, 45(8), 102153.

Ndubuisi, G., Otioma, C., & Tetteh, G. K. (2021). Digital infrastructure and employment in services: Evidence from Sub-Saharan African countries. *Telecommunications Policy*, 45(8), 102153.

Nicoletti, G., von Rueden, C., & Andrews, D. (2020). Digital technology diffusion: A matter of capabilities, incentives or both? European economic review, 128, 103513.

Nipo, D. T. A., Bujang, I., & Hassan, H. (2018). Global digital divide: Reassessing the evidence behind ICT and its contribution to trade among the ICT haves and have-nots in developing economies. *Journal of Business and Retail Management Research*, 12(3).

Nsabimana, A., & Funjika, P. (2019). Mobile phone use, productivity and labour market in Tanzania (No. 2019/71). WIDER Working Paper.

O'Dea, M. (2025). Book Review: The Technology Acceptance Model-30 Years of TAM by Fred D. Davis and Andrina Granic. *Journal of University Teaching and Learning Practice*, 21(08).

OECD (2016), Skills Matter: *Further results from the survey of adult skills, OECD skills studies*. OECD Publishing, Paris, https://doi.org/10.1787/9789264258051-en

Oladokun, Y. O., & Alawode, O. O. (2022). Employment Dynamics and Job Loss among Households in Nigeria: Pre-COVID-19 and COVID-19 Periods. *Research in Social Sciences*, 5(2), 54-64.

Olofin, O., (2023). Digital Economy, Institutional Quality and Economic Growth in Selected Countries. *Central Bank of Nigeria Journal of Applied Statistics*. 14. 25-46. 10.33429/Cjas.14123.2/5.

Olorundare, J. K., Olowe, A., & Olorundare, A. O. (2022, April). Digital transformation in Nigeria: The prospects and challenges of the gig economy. In 2022 IEEE Nigeria 4th International Conference on Disruptive Technologies for Sustainable Development (NIGERCON) (pp. 1-5). IEEE.

Owolabi, O. A., Adedeji, A. O., Aderounmu, B., Oku, A. R. O., & Ogunbiyi, T. (2023). Do Information and Communications Technology (ICT) and financial development contribute to economic diversification? Evidence from sub-Saharan Africa. *Journal of Economic Structures*, 12(1), 5.

Oyelami, L. O., Sofoluwe, N. A., & Ajeigbe, O. M. (2022). ICT and agricultural sector performance: empirical evidence from sub-Saharan Africa. *Future Business Journal*, 8(1), 18.

Puttin, G. (2023, January 24). Digital skills for youth employment in Africa. INCLUDE Platform. https://includeplatform.net/news/digital-skills-for-youth-employment-in-africa/

Rodriguez-Crespo, E., Marco, R., & Billon, M. (2021). ICTs impacts on trade: a comparative dynamic analysis for internet, mobile phones and broadband. *Asia-Pacific Journal of Accounting & Economics*, 28(5), 577-591.

Ronen, E. (2021). *ICT services exports and labour demand: A global perspective and the case of Israel. Changing Skills for a Changing World: Understanding skills demand in EU neighbouring countries*. European Training Foundation. ed. Fetsi A., Bardak U. and Rosso F.

Salsabila, R., & Oktora, S. I. (2022). The Impact of Broadband Access on Unemployment Rate in Indonesia 2016-2019. *Asian Journal of Business Environment*, 12(3), 23-30.

Schlogl, L. (2020). *Leapfrogging into the unknown: The future of structural change in the developing world (No. 2020/25)*. WIDER Working Paper.

Solomon, E. M. (2020). The impact of digital technology usage on economic growth in Africa. *Utilities Policy*, *67*, 101104. https://doi.org/10.1016/j.jup.2020.101104

Stockinger, B. (2019). Broadband internet availability and establishments' employment growth in Germany: evidence from instrumental variables estimations. *Journal for Labour Market Research*, 53(1), 7.

Ujah-Ogbuagu, B. C. (2023). An assessment of state of digital economy development in Nigeria: A survey. *In International Conference on Communication and E-Systems For Economic Stability| CeSES* (p. 380).

Viete, S., & Erdsiek, D. (2020). Mobile information technologies and firm performance: The role of employee autonomy. *Information Economics and Policy*, 51, 100863.

Vyshnevskyi, O., Stashkevych, I., Shubna, O., & Barkova, S. (2020). Economic growth in the conditions of digitalization in the EU countries. *Studies of Applied Economics*, 38(4).

Wang, W., Khelfaoui, I., Ahmed, D., Xie, Y., Hafeez, M., & Meskher, H. (2024). Nexus between information and communication technologies and life expectancies of low-income countries: Does technological advancement increase their life span? *SSM-Population Health*, 25, 101600.

Whitacre, B., Gallardo, R., & Strover, S. (2014). Does rural broadband impact jobs and income? Evidence from spatial and first-differenced regressions. *The Annals of Regional Science*, 53, 649-670.

Zhang, J., Zhao, W., Cheng, B., Li, A., Wang, Y., Yang, N., & Tian, Y. (2022). *The impact of digital economy on the economic growth and the development strategies in the post-COVID-19 era: Evidence from countries along the "Belt and Road"*. Frontiers in public health, 10, 856142.