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Financial Inclusion, ICT Diffusion and Poverty Reduction: Evidence from Sub-Sahara African Countries

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Abstract: This study explores the role of financial inclusion and ICT diffusion on poverty reduction across 27 Sub-Sahara African countries for the period of 2004 to 2017. We applied non-stationary heterogeneous panel estimation technique which comprises of pooled mean group (PMG), mean group (MG), and dynamic fixed effect (DFE) estimators. Based on the result of the pooled mean group estimator, we found that financial inclusion (proxied by number of commercial branches per 100,000 people (COM)) reduces poverty in the long run but it exerts no impact on poverty reduction in the short run. Further, the result indicates that ICT diffusion (proxied by internet penetration (IP)) exert a significant reduction in poverty in the short run but has no impact on poverty reduction in the long run. The study therefore concludes that financial inclusion and ICT diffusion (proxied by internet penetration) are crucial in alleviating poverty in SSA countries. Thus, to alleviate poverty in SSA region, government and monetary authorities should enhance financial inclusion strategies combined with latest ICT infrastructural development, especially the internet usage.

1. Introduction

One of the issues and tasks confronting low income economies today, especially sub-Saharan African (hereafter SSA) countries, is how to alleviate poverty in achieving sustainable development. According to United Nation (1995), poverty is the absence of productive resourcesand income toguaranteebearable livelihoods; includingstarvation and malfunction, ill health,inadequate access to education and other basic services. Extreme poverty has become a problematic issue in developing countries like SSA, particularly since the 1980s despite numerous measures which have been taken at both macro and micro level to combat it.

SSA countries are characterized with inadequate access to formal financial services by a large percentage of working population.Individuals and firmsdepend on limited resources to meet their financial provisions and pursue favorabledevelopment opportunities due to non-inclusive financial system (Aguera, 2015). However, financial inclusion which is critical in enhancing access to financial services by the impoverished is often considered as an effective tool in alleviating poverty. According to Sharma (2008), financial inclusion entails the ease and availability of formal financial services for all economic agents particularly the

poor. Moreover,financial inclusion alleviates poverty throughbroadens access to financial products and services which leads to efficient resource allocation, thus providing better financial leverage to the underprivileged (see Banerjee & Newman, 1993; Galor&Zeira, 1993; Aghion & Bolton, 1997).

The expectations of the 1980s and 1990s financial reforms in the SSA region was to ease and expand the availability of financial services such as credits, payment services and savings; thereby resulting in an increased financial depth in the region. However, despite these reforms, ease and access to formal financial services is still very low. In view of this, Aguera (2015) concludes thatthe examination of financial inclusion strategy has become necessary in SSA region especially when financial exclusions of different forms are involuntary.Also, despite the importance of financial inclusion to ensure the disadvantaged population are incorporated into the fold of financial services, it has received little attention in SSA region.

Information and Communication Technology (ICT), referred to various set of technological tools and resources used to communicate; to create, disseminate, store, and manage information (see Ndombi*et al.,* 2014). According to Carmen (2015), information and communication technology represents a collection of technologies and applications, enabling electronic processing, storing, retrieval and transfer of information to a wide variety of users or clients. It permits the exchange of data across multiple locations and helps to decentralized processes of information (Salahuddin and Gow, 2015). It also contributes towards the emergence of new business and firm-cooperation models that rely on the spatial exchange of large batches of information, which boosts competition and innovation processes. These IT tools offer new ways of exchanging information and transacting business and changes the nature of the financial and other service sectors (Ndombi *et al.*, 2014).

Furthermore, ICTs play an important role on rural development; offer prompt market information to farmers, improved connectivity with a view to improving their bargaining power and eliminating the middleman (Adonsou&Sylwester, 2016). It also boosts the efficiency of micro and small enterprises by boosting sales, procurement and marketing practices (Donner &Escobari, 2010). ICT penetration into the financial system is being felt in the form of introduction of ICT gadgets such as Automated Teller Machine (ATM), Electronic Fund Transfer (EFT), Electronic Purse (E-PURSE), and Electronic and Transfer at Point of Sale (EFTPOS), which have made financial transactions easy and convenient (see Osabuohien, 2008). These have paved way for automation, minimal banking hall transactions, less hectic procedures, and less congestion in banking halls in carrying out financial transactions (Salahuddin and Gow, 2015).

Certainly, existing literatures on the relationship between financial inclusion and poverty remain inconclusive. For instance, studies such as Muritala & Fasanya, 2013; Mohammed, Mensah & Gyeke-Dako, 2017; Kim, Yu & Hassan, 2017; among others discovered that financial inclusion enhance economic growth and reduces poverty while other studies report otherwise (Neaime & Gaysset, 2017; Tita & Aziakpono, 2017; and Ajide, 2017).Therefore, due to the lack of consensus on the nexus between financial inclusion and poverty, the significance of information and communication technology (hereafter ICT) which entailsmobile phone penetration and internet usage through which financial inclusion can reduce povertycome to play. Also, a large body of evidence from the literature has argued that poverty reduction is enhanced through ICT which engender sustainable economic growth and poverty reduction. This is because ICT enhance ease and availability of financial services,improves financial inclusion and boostsdirecteconomic transactions (Kpodar and Andrianaivo, 2011; Ajide, 2017; and Oumaet *al.,* 2017).

However, many of the previous studies have concentrated on the financial inclusion-povertynexus without examining what the role of ICT (internet usage and mobile phone penetration) is on this linkin SSA region. Hence, this study seeks to fill the gap in the literature by examining the effect of financial inclusion and ICT (mobile phone penetration and internet penetration) on poverty reduction in 27 SSA countries over the period of 2004 and 2016. The remaining part of this study is divided into four sections. Section 2 deals with relevant literatures while section 3 highlights the methodological issues, section 4 presentsdiscussion of results and section 5entails conclusion and recommendations.

2. Literature Review

The connection on finance-poverty reduction nexus has been thefocus of an immense body of theoretical and empirical research. For instance, in a panel study of 67 low- and middle-income countries over the period of 1986 to 2012, Boukhatem (2015) applied S-GMM estimation technique to evaluate finance-poverty reduction nexus. The study found that financial development improves the well-being of the poor through ease and availability of several sources of funding while financial instability subdues the benefit of financial development. Likewise, Rewilak (2017) also found that financial deepening reduces poverty via increasing physical financial access whereas financial instability is detrimental to poverty reduction. Also, Inoue (2017) found that finance and remittance are effective tools in reducing poverty in developing countries. Focusing on the relationship among financial development, microfinance institutions and poverty reduction, Donou-Adonsou & Sylwester (2016) employed fixed-effects 2SLS technique and

the result revealed that financial development measured by bank loans alleviate poverty whereas microfinance loans do not significantly reduce poverty.

However, Miled & Rejeb (2015) examined how microfinance reduces povertyusing a sample of 57 developing countries spanning 2005 to 2011. They found that higher microfinance loans per capita reduces poverty and increases consumption expenditure. Using GMM estimation technique, Kpodar & Andrianaivo (2011) assessed the growth impact of ICT development (mobile phone penetration and cost of communication) and financial inclusion in 44 African countries spanning 1988 and 2007. They found that the interaction of ICT development and financial inclusion stimulate economic growth.Recently, Ouma *et al.* (2017) assessed the impact of mobile phone on savings in selected SSA countries and the result disclosed that mobile phones enhance financial services and boost household savings.

In assessing financial inclusion-poverty reduction nexus in MENA countries, Neaime & Gaysset (2017) applied GMM and GLS techniques and found that inflation and trade openness worsen poverty while financial inclusion does not reduce poverty. However, Ahamed & Mallick (2017) found that financial inclusion stimulates bank stability in 87 developing countries. Using a sample of 55 IOC countries, Kim *et al.* (2017) with the aid of VAR technique evaluated the link between financial inclusion and economic growth. Their result indicate that financial inclusion improves economic growth. Using annual data spanning 1995-2013, Kaur and Singh (2015) employed OLS technique to explore the significance of ICT on growth in India. Their empirical result disclosed that ICT infrastructure specifically mobile phones and internet usage enhanced financial inclusion in India.

In Nigeria, Omojolaibi (2017) with the aid of Generalized Method of Moment (GMM) consider the role of governance on the relationship between financial inclusion and economic growth spanning the period 1980-2014 and found that governance and financial inclusion promote economic progress and improves standard of living. Contrarily, Okoye *et al.* (2016) found that financial inclusion inhibits economic growth but reduces poverty in Nigeria. This result opposes the finding of Onaolapo (2015), who employed the same methodology and established that financial inclusion stimulates economic growth in Nigeria.Muritala and Fasanya (2013) applied Error Correction Model (ECM) to assess the nexus between financial services and poverty reduction and found financial inclusion plays a critical role in reducing poverty. Furthermore, Ajide (2017) investigated the impact of financial inclusion (proxied by loan granted to rural dwellers) on poverty reduction in Nigeria over the period of 1996 and 2013. The result of the ARDL technique revealed that financial inclusion does not reduces rural poverty as a result of high interest rate and low level of financial literacy in rural areas. Recently, Harley *et al* (2017)

found that financial inclusion improves economic growth among three African countries spanning 2006 and 2015.Focusing on the financial inclusion-monetary policy nexus in Nigeria over the period of 1980 and 2012, Mbutor & Uba (2013) found that financial inclusion enhances the efficiency of monetary policy in Nigeria.

In a cross-country study, Tita & Aziakpono (2017) explored the effect of financial inclusion on income inequality in sub-Saharan African, they found that financial inclusion worsens income inequality as a result of low level of financial inclusion in the SSA region. Also, in SSA region, Mohammed *et al.* (2017) used World Bank micro data on the Global Financial Inclusion Index to examine the effect of financial inclusion on poverty reduction in 35 selected SSA countries. The result of the logistic model indicate that financial inclusion has a larger welfare benefit for the poor who are financially included. In a related study, Ajide (2017) analyzed the determinant of financial inclusion in 18 SSA countries covering 2004 and 2010. The result of the S-GMM estimator disclosed that economic growth, inflation, bank concentration and institutions play significant role in influencing financial inclusion in the region. Lastly, Mushtaq & Bruneau (2016) explored how financial inclusion (microfinance) can reduce poverty through ICT diffusion proxied by mobile phone penetration in a panel of 62 developing countries over the period of 2001 and 2012. The result of the GMM technique disclosed that financial inclusion reduces poverty and ICT diffusion enhances financial inclusion and thereby reduces poverty.

3. Methodology

3.1 Panel Model

Following Naime & Gaysset (2017), the empirical model to examine role offinancial inclusion and ICT diffusionon poverty reduction in SSA region is specified as:

$$POV_{i,t} = \alpha + \beta FIN_{i,t} + \varphi ICT_{i,t} + \phi Z_{i,t} + \varepsilon_{i,t} \quad [3.1]$$

Where POV_{it} denotes poverty reduction, α denotes country – specific intercept, FIN_{it} is financial inclusion, ICT_{it} represents ICT diffusion indicatorand Z_{it} corresponds alternatively to the level of economic growth and macroeconomic instability across countries while $i$denotes the country index, t is the time period andε_{it} is a time varying error term.

This study employs dynamic panel estimation technique to investigate the impact of financial inclusion and ICT diffusion on poverty reduction in SSA region because this methodology considered the heterogeneity of the dynamic panel setting, it takes into consideration the substantial persistence as well as the adjustment dynamics in the variables. Furthermore, it lessens endogeneity problems

and it includes individual-specific effects in the link between the variables of interest across countries to get rids of heterogeneityand it can generate both long- and short-run estimates concurrently (Rafindadi, Muye and Kaita, 2018).Thus, the ARDL (p, q) model on the role of financial inclusion and ICT diffusion on poverty reduction is stated as follows:

$$POV_{i,t} = \mu_i + \sum_{j=1}^{p} \gamma_{ij} POV_{i,t-j} + \sum_{j=0}^{q} \phi_{ij}^{'} X_{i,t-j} + \varepsilon_{it} \quad [3.2]$$

Where $X_{i,t} = \left(FIN_{i,t}, ICT_{i,t}, Control_{i,t}\right)$, and $Control_{i,t} = \left(GDP_{i,t}, INF_{i,t}\right)$ [3.3]

Where, $i = 1, 2, 3, \ldots, N$ designates country index, and $t = 1, 2, 3, \ldots, T$ specifies time element (annual) while μ_i denotes country fixed effects. Furthermore, j represents the number of time lags. In equation (3.2), is the dependent variable; the vector includes the key explanatory variables of financial inclusion (proxied by number of commercial bank branches per 100,000 adult (*COM*)), ICT diffusion (proxied byinternet penetration (IP)and mobile phone penetration (MP) while $Control_{it}$ indicates other variables such as economic growth(proxied by gross domestic product per capita (GDP))and macroeconomic instability (proxied by inflation rate (INF)) that can influence poverty level. Equation (3.2) can be re-parameterized into:

$$\Delta POV_{i,t} = \mu_i + \phi_i POV_{i,t-j} + \vartheta_i^{'} X_{i,t} + \sum_{j=1}^{p} \gamma_{ij} POV_{i,t-j} + \sum_{j=0}^{p} \theta_{ij}^{'} X_{i,t-j} + \varepsilon_{it} \quad [3.4]$$

Where

$$\phi_i = -1\left(1 - \sum_{j=1}^{p} \gamma_{ij}\right) \quad [3.5]$$

$$\vartheta_i = \frac{\sum_{j=0}^{q} \theta_{ij}}{\left(1 - \sum_{j=1}^{p} \gamma_{ij}\right)}, \gamma_{ij}^{*} = -\sum_{m=j+1}^{p} \gamma_{ij} \text{ and } \theta_{ij}^{*} = -\sum_{m=j+1}^{q} \theta_{ij} \quad [3.6]$$

Equation (3.6) in Error correction form is specified as:

$$\Delta POV_{i,t} = \mu_i + \phi_i (POV_{i,t-j} - \vartheta_i^{'} X_{i,t}) + \sum_{j=1}^{p} \gamma_{ij} POV_{i,t-j} + \sum_{j=0}^{p} \theta_{ij}^{'} X_{i,t-j} + \varepsilon_{it}$$
$$\phi_i < 0 \quad [3.7]$$

Where $\phi_i (POV_{i,t-j} - \vartheta_i^{'} X_{i,t})$ is the adjustment in *POV* to the deviation from its long-run relationship and short-run coefficients linking *POV* with its lag values

and other independent variables are γ_{ij}^{*} and θ_{ij}^{*}. In addition, θ_i is the error-correction coefficient estimates which measures the speed of adjustment of POV_{it} toward its long-run equilibrium in case of a change in any of the independent variables X_{it}. In order to ensure that long run relationship exist among the variables, the speed of adjustment ϕ_i must be negative and significant.

The dynamic panel Autogressive Distributed Lag model specified above can be estimated in three ways namely pooled mean group (PMG), mean group (MG) and dynamic fixed effect (DFE). The first technique which is pooled mean group (PMG) estimator was proposed by Pesaran, Shin & Smith (1999). This estimation techniqueallows the short run coefficient to be heterogeneous across countries while the slope and intercept parameters are restricted to be identical across countries in the long-run, that is, homogenous. Furthermore, the second estimation technique is mean group (MG) and was proposed by Pesaran& Smith (1995). It allows both the short run and the long run estimate to be heterogeneous and estimate separate regression for each country,then measures the parameters with unweighted means of the estimated coefficients for the individual countries without imposing any restriction. The third approach of estimating panel ARDL is the dynamic fixed effect (DFE) estimator. This estimator allows the intercepts to vary across panel members while the short and the long run estimates are identical or homogenous across panel.

3.2 Data and preliminary analysis

We use annual dataset of 27 countries for the period 2004–2017. All the data are obtained from the World Bank, World Development Indicator, 2018 edition. The annual data on household final consumption expenditure by capita (constant 2010 US $) is used as a proxy for poverty in line with Ogun (2010) and Oladipo and Olomola (2016). Secured internet penetration and mobile phone subscription is used as a proxy for ICT diffusion due to its relative importance in enhancing financial inclusion. Commercial bank branches per 100,000 adults is used as proxy for financial inclusion. Economic growth is measured by gross domestic product per capita (constant 2010 US $), while inflation rate is proxied by consumer price index (INF) to control for macroeconomic instability. Selected 27 SSA countries for this study are based on data availability and is presented in Appendix A1.

Table 1 presents the descriptive statistics of our data. These include the mean, standard deviation, minimum, and maximum. The results indicate that the average of poverty proxied by household final consumption expenditure per capita (POV), financial inclusion (proxied by Commercial bank branches per 100,000 adults (COM)), economic development, and inflation rate are equal to 1360.27, 5.48,

10.55, 2248.78, 34.30 and 6.26 respectively while the standard deviation values signify high variability in the series.

Table 1
Descriptive Statistics

Variable	*Obs*	*Mean*	*Std. Dev*	*Min*	*Max*
POV	351	1360.29	1413.64	0	6811.64
COM	351	5.48	6.22	0	34.45
IP	351	9.06	25.21	0	186.78
MP	351	59.17	40.93	1.43	171.37
GDP	351	2284.78	2585.72	272.85	9822.00
INF	351	6.26	6.57	-35.83	37.39

Note: POV, COM, IP, MP, GDP and INF represent poverty (proxied by household consumption per capita), financial inclusion (proxied by commercial bank branches per 100 people), ICT (proxied by Internet penetration per 100 people and Mobile phone penetration per 100 people), Gross domestic product per capita, and inflation rate respectively.

4. Discussion of Results

4.1 Panel Unit Root Tests

Table 2 reports the results of panel unit root tests (Breitung and Im, Pesaran and Shin (IPS)) utilized to determine the order of integration of the series employed in this study.The result of the Breitung and Im, Pesaran and Shin (IPS) in Table 2 revealed that all the variables (POV, COM, IP, MP and LGDP) are stationary at first difference, that is, integrated of order I(I) whereas inflation rate (INF) is stationary at level, that is, integrated of order I(0). Since the order of the integration of all the variables does not exceed 1, then dynamic panel estimation technique is suitable.

Table 3 reports the results of panel ARDL estimate which consists of pooled mean group, mean group, and dynamic fixed effect estimate.In order to determine the efficient model out of the three estimation techniques (pooled mean group, mean group, and dynamic fixed effect), we make use of Hausman test. The rule is that if the P-value of the Hausman test is insignificant at the 5% level, then the PMG is efficient but if P-value of the Hausman testis significant, then the use of a MG or DFE estimator is appropriate. Since the P-value of the Hausman test between PMG and MG is insignificant which suggest that the PMG estimate is efficient. Based on this, our interpretation of the impact of financial inclusion and ICT on poverty reduction will be based on the pooled mean group estimate or result.

Table 2
Panel Unit Root Test

	Breitung Test		*IPS Test*	
Variables	*Level*	*First Diff*	*Level*	*First Diff*
POV	4.5385	-5.7369***	-0.8101	-5.2041***
COM	4.0629	-6.3651***	0.4130	-4.9972***
IP	8.3982	-5.5291***	0.7553	-3.9602***
MP	8.9661	-6.5057***	-2.9751	-4.1575***
LGDP	7.0824	-5.6449***	2.9970	-4.3545***
INF	-5.2476***	-8.3710***	-4.5467***	-8.1182***

Note: POV, COM, IP, MP, GDP and INF represent poverty, commercial bank branches per 100 people, Internet penetration per 100 people, Mobile phone penetration per 100 people, Gross domestic product per capita, and inflation rate respectively. Note 2: ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. The null hypotheses of Breitung and Im, Pesaran and Shin (IPS) tests are that the underlying series are nonstationary.

As shown in Table 3, the results of the Pooled Mean Group (PMG) indicate that in the long, financial inclusion (COM) exert a significant positive influence onhousehold consumption per capita which suggest that financial inclusion reduces poverty in the long run. This result supports with the findings of Muritala&Fasanya (2013), Okoye *et al.* (2016) Omojolaibi (2017), Mohammed *et al.* (2017): they suggest that financial inclusion is an important tool in alleviating poverty. However, financial inclusion exerts a significant negative impact on poverty in the short run. This result indicate that financial inclusion worsens poverty level in the short run. This result confirmed the outcomes of Ajide (2017) in Nigeria and Neaime & Gaysset (2017) in Mena countries. Further, the result indicates that ICT diffusion proxied by mobile phone penetration (MP) has no impact on poverty reduction both short and long run. This result negates with the finding of Mushtaq & Bruneau (2016) that ICT diffusion enhances financial inclusion and thereby reduces poverty. Conversely, ICT diffusion proxied by internet penetration (IP) exert a significant positive impact on household consumption per capita which designates internet penetration reduces poverty in the long run but negative influence in the short run. This result indicate that ICT diffusion measured by internet penetration (IP) is an effective tool in reducing poverty in SSA region. In addition, the result shows that economic growth (GDP) positively influence household consumption per capita whichdepicts that economic growth is a key means of poverty alleviation both short and long run.This outcome supports the trickle-down theory which makes claim that economic growth is anecessaryfactor in reducing poverty so far

Table 3
PMG, MG, and DFE estimates on financial inclusion-ICT-Poverty nexus in SSA countries

	PMG		*MG*		*DFE*	
Variables	*Long run*	*Short run*	*Long run*	*Short run*	*Long run*	*Short run*
ECT		-0.438***		-0.419***		-0.408***
		(0.0672)		(0.0564)		(0.0459)
Δ COM		0.0191**		-1.392		0.00303
		(0.00862)		(1.364)		(0.00603)
Δ MP		-3.6605		0.233		0.000161
		(0.00178)		(0.251)		(0.000416)
Δ IP		-0.00276		-4.190		-8.99e-05
		(0.0221)		(3.561)		(0.00104)
Δ LGDP		0.631**		-51.27		0.478***
		(0.303)		(53.43)		(0.0871)
Δ INF		0.00118		-0.0805		0.000299
		(0.00133)		(0.0684)		(0.000715)
COM	0.00556***		-0.0535		9.18e-05	
	(0.00125)		(0.0996)		(0.00695)	
MP	0.000215		0.00641		0.000895**	
	(0.000144)		(0.00575)		(0.000439)	
IP	0.000779***		-0.106		0.000315	
	(0.000159)		(0.166)		(0.000690)	
LGDP	0.396***		0.366		0.478***	
	(0.0539)		(1.271)		(0.116)	
INF	0.00106		0.0136		2.49e-05	
	(0.000682)		(0.0129)		(0.00191)	
Constant	1.755***		-343.6		1.392***	
	(0.276)		(342.2)		(0.357)	
Observations	324	324	324	324	.	.
No of Countries	27	27		27	27	
Hausman Test	MG vs PMG				PMG vs DFE	
Chi2 (5)	12.29				10.88	
Prob	0.3011				0.5039	

Note 1: POV, COM, IP, MP, GDP and INF represent poverty, commercial bank branches per 100 people, Internet penetration per 100 people, Mobile phone penetration per 100 people, Gross domestic product per capita, and inflation rate respectively. *Note 2:* Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

income distribution remains unchanged in any given country. Also, inflation rate has a positive effect on poverty reduction both in the short and long run. Lastly, the coefficient of the error-correction term is required to be negative and significant. The estimate of the lagged error term (ECT) is negative (-0.43), and it is statistically significant at the 5% level indicating the existence of long-run relationship among financial inclusion, ICT diffusion and poverty reduction.

5. Conclusion and Policy Recommendations

This study examines the impact of financial inclusion and ICT diffusion on poverty reduction in Sub-Sahara African countries for the period of 2004 to 2016 across 27 countries.The results from the PMG estimator indicate that financial inclusion (measured by number of commercial branches per 100,000 people (COM))reduces poverty in the long run. Further, the result indicates that ICT diffusion (proxied by mobile phone penetration (MP)) has no impact on poverty both short and long run. However, ICT diffusion proxied by internet penetration (IP) reduces poverty significantly in the short run.Based on this result, we conclude that financial inclusion must be strengthening with internet penetration to achieve poverty reduction in SSA region. In line with the findings,the study recommends thatmeeting the new target of poverty reduction requires adequate financial inclusion strategies combined with latest ICT infrastructural development, especially the internet usage because financial inclusion and ICT can reduce poverty by improving poor people's access to financial services, and by connecting the poor to markets.

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Appendix 1: List of the sample countries (27)

Benin	Ghana	Nigeria
Botswana	Guinea-Bissau	Senegal
Cabo Verde	Kenya	Sierra Leone
Cameroon	Lesotho	South Africa
Central Africa Republic	Liberia	Sudan
Comoros	Malawi	Swaziland
Cote d'voire	Mali	Tanzania
Gabon	Mauritius	Togo
Gambia	Namibia	Zambia