Centre de Recherche pour le Développement Economique (CEREDEC)

CEREDEC Working Paper

WP/19/048

Technology, Education, Life and Non-life Insurance in Africa

Forthcoming: International Journal of Public Administration

Simplice A. Asongu
African Governance and Development Institute,
P.O. Box 8413, Yaoundé, Cameroon.
E-mails: asongusimplice@yahoo.com,
asongus@afridev.org

2019 Centre de Recherche pour le Développement Economique WP/19/048

Research Department

Technology, Education, Life and Non-life Insurance in Africa

Simplice A. Asongu

January 2019

Abstract

This article examines the relevance of information and communication technology (ICT) in modulating the effect of education on life insurance and non-life insurance consumption in 48 African countries for the period 2004-2014. Education is measured with primary school, secondary school and tertiary school enrollments. ICT is measured with mobile phone, internet and broadband subscriptions. The empirical evidence is based on generalized method of moments. The following main findings are established. First, from the nexuses between education, ICT and life insurance, there are positive conditional effects from the interaction between: (i) broadband subscriptions and primary school enrollment; (ii) broadband subscriptions and secondary school enrollment and (iii) internet penetration and tertiary school enrollment. Second, from the nexuses between education, ICT and non-life insurance: (i) there is a negative net effect from the interactions between mobile phone penetration and primary education while positive net effects are apparent from the interactions between: mobile phone penetration and secondary school enrollment; secondary school enrollment and broadband subscriptions and; tertiary school enrollment and broadband subscriptions.

JEL Classification: I28; I20; I30; O16; O55
Keywords: Education; Technology; Insurance

1. Introduction

This study is motivated by three main tendencies in policy and scholarly circles, notably: (i) the high potential for information, communication technology (ICT) in Africa, (ii) the comparatively low level of insurance subscriptions in the continent and (iii) gaps in the literature. The three points are substantiated in chronological order. First, compared to high-end markets in Asia and Europe where ICT penetration levels have reached saturation points, there is a still a great potential for ICT penetration in the African continent (Asongu, 2017; Tchamyou, 2018). Hence, this potential for ICT can be leveraged by policy makers in order to address policy syndromes such as the low subscriptions in insurance schemes. This is essentially because according to PwC (2015), the increasing rate of insurance subscriptions in Africa can be traceable to rising trends such as ICT.

Second, relative to other regions of the world, the subscription of insurance in Africa is comparatively low. According to Kyerematen (2015), with the exclusion of South Africa, only approximately 6% Africans have access to insurance services. The narrative maintains that such a low penetration of insurance can be explained by two main factors; on the one hand, structural economic characteristics and on the other, supply- and demand-side considerations.

Third, a great bulk of the literature has focused on two main dimensions, notably: the determinants of life insurance consumption (Guerineau & Sawadogo, 2015; Zerriaa *et al.*, 2017; Alhassan & Biekpe, 2016a) and linkages between insurance penetration and development outcomes (Ioncică *et al.*, 2012; Akinlo, 2015; Alhassan & Biekpe, 2015, 2016a). The two dimensions are briefly discussed in what follows.

In the first dimension on the determinants, Guerineau and Sawadogo (2015) have analyzed the determinants of life insurance development in Sub-Saharan Africa (SSA) using a panel of 20 countries for the period 1996-2011. Accounting for potential endogeneity bias, the authors have used an instrumental variable estimation strategy to establish a positive association between per capita income and life insurance premiums. Moreover, life insurance is an ostentatious commodity in SSA. Life insurance development is negatively influenced by young dependency and life expectancy ratios whereas the old dependency ratio, government stability and protection of property rights have positive effects.

Zerriaa et al. (2017) have investigated the determinants of life insurance demand in Tunisia using annual data for the period 1990 to 2014. The findings show that financial development, income, dependency, life expectancy and urbanization increase the demand for life insurance while pension expenditures have an opposite effect. Conversely, inflation and

interest rates do not have significant influences. Alhassan and Biekpe (2016a) have assessed determinants of life insurance in a panel of 31 African countries for the period 1996 to 2010 to conclude that compared to financial factors, demographic factors better explain the consumption of life insurance. According to the study, institutional quality, health expenditure, financial development and insurance consumption have a positive effect on life insurance subscriptions while the dependency ratio, life expectancy and inflation reduce life insurance consumption.

In the second dimension on linkage between the consumption of insurance and development outcomes, Alhassan and Biekpe (2015) examine connections between efficiency, productivity and returns to scale economies in the South African Non-life insurance market from 2007 to 2012. Using data envelopment analysis, logistic estimations and boostrapped regressions, the findings show that 20% of insurers operate at an optimal scale whereas, non-life insurers do so with approximately 50% inefficiency. It is also apparent that improvements in productivity are traceable to technological variations as well as evidence of a non-linear impact of size on efficiency and constant returns to scale. The findings also show that leverage, reinsurance and product line diversification also have significant nexuses with constant returns to scale and efficiency.

Alhassan and Biekpe (2016b) have investigated the nexus between economic growth and the development of insurance in 8 selected African countries for the period 1990 to 2010, namely: South Africa, Nigeria, Morocco, Mauritius, Madagascar, Kenya, Gabon and Algeria. Using an auto-regressive distributed lags bounds approach to cointegration, the findings show a long term nexus between economic growth and the insurance market for South Africa, Nigeria, Morocco, Mauritius and Kenya. Moreover, within a vector error correction model (VECM) framework, with the exception of Morocco where there is evidence of bidirectional causality, a unidirectional causality is apparent from the development of insurance to economic growth. Mixed causality is established in Gabon and consistent unidirectional causality is apparent in Madagascar and Algeria. Akinlo (2015) have assessed the causal relationship between insurance and economic growth in a panel of African countries using a heterogeneous panel causality approach. The study has focused on 30 SSA countries for the period 1995 to 2011. The findings reveal bidirectional causality between insurance and economic growth. The nature of causality is homogenous across countries.

Two main tendencies are apparent as shortcomings in the discussed literature. First, the engaged studies are largely based on selected African countries. Within the framework of

this study, we focus on 48 countries in Africa. Moreover, the positioning on data for the period 2014 to 2014 is motivated by the need to establish results based on more updated data in view of providing findings with policy implications that are more contemporarily-relevant. Second, another criticism to most of the discussed papers is that the models adopted are tailored such that, the lagged outcome variable may not be estimated consistently. This is essentially because, by construction through fixed effects, the lagged dependent variable is correlated with the error term. In this paper, we address the underlying shortcoming (i.e. of the correlation between the error term and lagged dependent variable) by employing the generalized method of moments (GMM) empirical approach. In this empirical strategy, parallel or orthogonal conditions between the lagged dependent variable and the error term are satisfied, by means of forward orthogonal deviations.

Noticeably, the extant literature has failed to assess how the potential for ICT penetration (discussed in the first strand) can be leveraged in order to increase the low penetration of insurance (covered in the second strand) [1]. We complement this extant literature by focusing on how ICT can modulate the relevance of education on insurance consumption. Education is considered as another mediation variable because education has been documented to be instrumental in the sensitizing the public on the benefits of subscribing to insurances policies (Ioncică *et al*., 2012). In order to make the empirical investigation, we interact education with ICT in order to assess the overall net effect on insurance consumption. In so doing, we argue that just establishing determinants of insurance and the assessing linkages between insurance and macroeconomic outcomes (as done in the extant literature) has limited policy relevance. The policy relevance of this study builds on the fact that we are employing ICT variables (which have a potential for high penetration) as policy variables. As documented in recent literature, interactive regressions provide findings with more policy relevance because, contrary to direct linkages from non-interactive regressions, they involve the assessment of how some indicators can be considered simultaneously by policy makers in order to enhance macroeconomic outcomes (Asongu et al. 2017, 2018; Tchamyou, 2018).

Concerning the theoretical argument underpinning this study, the positioning of the inquiry is within the framework of theoretical exploration because the study is building on sound intuition in order to derive practical consequences that are relevant to policy makers.

[1] There is a growing body of African development literature on the importance of information and communication technology for social change, in doing business and economic development (Kuada, 2009; 2014; 2015; Tony & Kwan, 2015; Afutu-Kotey *et al*., 2017; Bongomin et al., 2018; Asongu & Boateng, 2018; Gosavi, 2018; Isszhaku et al., 2018; Hubani & Wiese, 2018; Muthinja & Chipeta, 2018; Minkoua Nzie et al., 2018; Abor et al., 2018).

Hence, this study is in accordance with recent literature in arguing that applied econometrics should not be exclusively limited to the acceptance and rejection of established theories (Costantini & Lupi, 2005; Narayan et al., 2011). Therefore, an empirical exercise such as this, that is motivated by strong commonsense may provide the basis for theory-building in future works. This underlying argument has been used in recent literature on the interactions between ICT and development outcomes (Asongu et al., 2017, 2018).

The rest of the study is structured as follows. The data and methodology are covered in Section 2. Section 3 presents and discusses the empirical results while Section 4 concludes with implications and future research directions.

2. Data and methodology

2.1. Data

The study examines a panel of 48 African countries for the period 2004-2014[2]. The geographical and temporal scopes are limited by data availability constraints. The data is sourced from World Development Indicators (WDI) and the Financial Development and Structure Database (FDSD) of the World Bank.

Two main insurance variables from the FDSD of the World Bank are employed, namely: life insurance and non-life insurance premiums. Consistent with recent literature, ICT is measured with internet penetration, mobile phone penetration and broadband subscriptions (Tchamyou, 2017; Efobi *et al*., 2018). Three main educational levels are used as in Tchamyou (2018) in order to improve room for policy implications. These include: primary school enrollment, secondary school enrollment and tertiary school enrollment.

Three control variables are adopted in order to account for variable omission bias, namely: political stability, financial depth and financial stability. Only three control variables are selected because accounting for more control variables leads to instrument proliferation in post-estimation diagnostics, which substantially biases estimated coefficients. We expect financial depth to increase insurance subscriptions while political stability and financial stability should have the opposite effects. However, it is important to note that the overall effect of political stability may be contingent on the weight of politically-unstable countries

[2] The 48 countries include: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo Democratic Republic, Congo Republic, Côte d'Ivoire, Djibouti, Egypt, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome & Principe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda and Zambia.

on the sample. Accordingly, given that the variable has both positive and negative values (i.e. -2.5 to +2.5), a different effect can be expected if the variable is negatively skewed. Financial depth increases financial activity and hence, the financial availability for insurance subscriptions. Conversely, financial stability decreases the degree of financial uncertainty that often motivates insurance subscriptions.

The definitions and sources of variables are provided in Appendix 1 whereas the summary statistics is disclosed in Appendix 2. The correlation matrix is covered by Appendix 3. From the summary statistics, it is apparent that the variables are comparable and judging from the corresponding standard deviations, we can be confident that reasonable estimated linkages will be derived from the estimations. The correlation matrix helps to avoid concerns about multicollinearity because if variables with a high degree of substitution are entered into the same specification, not all emerge victorious with the expected signs from the regression output.

2.2 Methodology

2.2.1 Specification

Consistent with recent literature (Tchamyou, 2018; Meniago & Asongu, 2018), the adoption of the GMM estimation approach is motivated by five factors, which are discussed in no order of importance. First, given that there are 48 sampled countries for 11 years (i.e. 2004 to 2014), the N>T condition for the implementation of the GMM strategy is met because the number of cross sections is higher than the number of years in each cross section. Second, the insurance outcome variables are persistent because the correlation between the level values and first lags of the outcome variables are higher than the rule of thumb threshold of 0.800. Accordingly: (i) the correlation between life insurance and its first lag is 0.9929 while (ii) the correlation between non-life insurance and its first lag is 0.9753. Third, since the GMM technique is implemented on a data structure that is panel, cross-country variations are not eliminated from the regression. Fourth, inherent biases in the *difference* estimator are considered in the *system* estimator. Fifth, the study accounts for endogeneity by addressing the concern of simultaneity in the explanatory variables with an instrumentation process. Furthermore, the employment of time-invariant omitted indicators also boosts the control for endogeneity.

Consistent with the attendant literature (Bond *et al.*, 2001; Tchamyou & Asongu, 2018), the *system* GMM estimator (Arellano & Bover, 1995; Blundell & Bond, 1998) has better properties of estimation relative to the *difference* estimator (Arellano & Bond, 1991).

The Roodman (2009a, 2009b) extension of Arellano and Bover (1995) is adopted in this study because it has been established to: (i) limit instrument proliferation or restrict over-identification and (ii) control for cross-sectional dependence (Tchamyou & Asongu, 2017; Boateng *et al.*, 2018). Therefore the extended estimation procedure adopts forward orthogonal deviations as opposed to first differences.

A *two-step* procedure is adopted instead of *one-step* approach because it addresses concerns of heteroscedasticity given that the *one-step* procedure only controls for homoscedasticity. The following equations in level (1) and first difference (2) summarise the standard *system* GMM estimation procedure.

$$I_{i,t} = \sigma_0 + \sigma_1 I_{i,t-\tau} + \sigma_2 Ed_{i,t} + \sigma_3 ICT_{i,t} + \sigma_4 EdICT_{i,t} + \sum_{h=1}^{3} \delta_h W_{h,i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (1)$$

$$\begin{aligned} I_{i,t} - I_{i,t-\tau} = {} & \sigma_1 (I_{i,t-\tau} - I_{i,t-2\tau}) + \sigma_2 (Ed_{i,t} - Ed_{i,t-\tau}) + \sigma_3 (ICT_{i,t} - ICT_{i,t-\tau}) + \sigma_4 (EdICT_{i,t} - EdICT_{i,t-\tau}) \\ & + \sum_{h=1}^{3} \delta_h (W_{h,i,t-\tau} - W_{h,i,t-2\tau}) + (\xi_t - \xi_{t-\tau}) + (\varepsilon_{i,t} - \varepsilon_{i,t-\tau}) \end{aligned} \quad (2)$$

where, $I_{i,t}$ is either life insurance or non-life insurance subscriptions in country i at period t, σ_0 is a constant, Ed entails education (primary, secondary and tertiary school enrollments), $EdICT$ denote interactions between education and ICT dynamics, W is the vector of control variables (Political stability, Financial depth and Financial stability), τ represents the coefficient of auto-regression which is one within the framework of this study because a year lag is enough to capture past information, ξ_t is the time-specific constant, η_i is the country-specific effect and $\varepsilon_{i,t}$ the error term.

2.2.2 Identification and exclusion restrictions

For a robust GMM specification, identification and exclusion restriction are fundamental. In line with the attendant literature (Asongu & Nwachukwu, 2016a; Boateng *et al.*, 2018; Tchamyou, 2018), all explanatory variables are acknowledged as predetermined and suspected endogenous whereas only years are considered to be strictly exogenous. This motivation for the identification strategy is consistent with Roodman (2009b) who has argued that it is unfeasible for years to become endogenous after a first difference[3].

[3] Hence, the procedure for treating *ivstyle* (years) is 'iv (years, eq(diff))' whereas the *gmmstyle* is employed for predetermined variables.

In the light of the above, years influence the insurance dynamics exclusively through the predetermined variables. Furthermore, the statistical validity of the exclusion restriction is investigated with the Difference in Hansen Test (DHT) which is employed to examine the relevance of the exclusion restriction assumption. Accordingly, for the underlying exclusion assumption to hold, the null hypothesis of the DHT should not be rejected. Hence, in the results that are reported in the next section, the assumption of exclusion restriction is validated if the alternative hypothesis of the DHT related to instrumental variables (IV) (year, eq(diff)) is not accepted. The identification procedure and mode of validating the assumptions pertaining to exclusion restrictions which is in accordance with the standard instrumental variable Sargan Overidentifying Restrictions (OIR) test, is an indication that the strictly exogenous variables do not affect insurance dynamics exclusively through the suggested endogenous mechanisms (Beck *et al*., 2003; Asongu & Nwachukwu, 2016b).

3. Empirical results

3.1 Presentation of results

The empirical results are disclosed in Tables 1-2. While Table 1 shows findings on life insurance, Table 2 provides results for non-life insurance. For all tables: (i) four information criteria are employed to assess the validity of the GMM model with forward orthogonal deviations[4] and (ii) a net effect is computed to assess the impact of ICT in education for insurance. For instance, in the second column of Table 2, the net effect from the interaction between mobile phone penetration and primary school education on non-life insurance is -0.037([-0.009× 48.455] + [0.399]), where: the mean value of mobile phone penetration is 48.455, the unconditional effect of primary education is 0.399 while the conditional effect from the interaction between primary education and mobile phone penetration is -0.009.

The following findings can be established from Table 1 on linkages between education, ICT and life insurance. First, net effects cannot be computed because at least one of the underlying estimates required for their computations is not significant. It is important to note that the unconditional effect of education and the conditional effect pertaining to the interaction between education and ICT should be significant before net effects can be computed. Second, there are positive conditional effects from the interaction between: (i)

[4] "*First, the null hypothesis of the second-order Arellano and Bond autocorrelation test (AR (2)) in difference for the absence of autocorrelation in the residuals should not be rejected. Second the Sargan and Hansen over-identification restrictions (OIR) tests should not be significant because their null hypotheses are the positions that instruments are valid or not correlated with the error terms. In essence, while the Sargan OIR test is not robust but not weakened by instruments, the Hansen OIR is robust but weakened by instruments. In order to restrict identification or limit the proliferation of instruments, we have ensured that instruments are lower than the number of cross-sections in most specifications. Third, the Difference in Hansen Test (DHT) for exogeneity of instruments is also employed to assess the validity of results from the Hansen OIR test. Fourth, a Fischer test for the joint validity of estimated coefficients is also provided*" (Asongu & De Moor, 2017, p.200).

broadband subscriptions and primary school enrollment; (ii) broadband subscriptions and secondary school enrollment and (iii) internet penetration and tertiary school enrollment. Third, most of the significant control variables have the expected signs because political stability and financial depth increase insurance subscriptions while financial stability has the opposite effect.

The following findings can be established in Table 2 on the connection between education, ICT and non-life insurance. First, there is a negative net effect from the interaction between mobile phone penetration and primary education while positive net effects are apparent from the interactions between: (i) mobile phone penetration and secondary school enrollment; (ii) secondary school enrollment and broadband subscriptions and (iii) tertiary school enrollment and broadband subscriptions. Second, most of the significant control variables have the expected signs.

Table 1: Life insurance, education and technology

	Dependent variable: Life Insurance (LifeIns)								
	Primary School Enrolment			Secondary School Enrolment			Tertiary School Enrolment		
	Mobile	Internet	BroadB	Mobile	Internet	BroadB	Mobile	Internet	BroadB
Constant	0.274	**0.343****	0.013	0.080	-0.015	-0.028	0.031	0.046	0.060
	(0.155)	**(0.021)**	(0.953)	(0.272)	(0.859)	(0.823)	(0.334)	(0.254)	(0.115)
LifeIns(-1)	**1.112*****	**1.152*****	**0.756*****	**1.109*****	**1.104*****	**0.787*****	**0.905*****	**0.898*****	**0.900*****
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
PSE	-0.347	**-0.405***	-0.071	---	---	---	---	---	---
	(0.108)	**(0.062)**	(0.757)						
SSE	---	---	---	**-0.164***	-0.038	-0.057	---	---	---
				(0.071)	(0.740)	(0.734)			
TSE	---	---	---	---	---	---	-0.070	-0.059	-0.052
							(0.164)	(0.143)	(0.119)
Mobile	0.005	---	---	0.0008	---	---	-0.0001	---	---
	(0.375)			(0.399)			(0.546)		
Internet	---	0.008	---	---	-0.0002	---	---	**-0.005****	---
		(0.524)			(0.968)			**(0.029)**	
BroadB	---	---	**-0.537*****	---	---	**-0.175*****	---	---	**0.028*****
			(0.004)			**(0.003)**			**(0.001)**
Mobile ×PSE	-0.005	---	---	---	---	---	---	---	---
	(0.319)								
Mobile×SSE	---	---	---	-0.0008	---	---	---	---	---
				(0.412)					
Mobile ×TSE	---	---	---	---	---	---	0.0005	---	---
							(0.151)		
Internet ×PSE	---	-0.008	---	---	---	---	---	---	---
		(0.499)							
Internet ×SSE	---	---	---	---	-0.001	---	---	---	---
					(0.812)				
Internet ×TSE	---	---	---	---	---	---	---	**0.003***	---
								(0.050)	
BroadB×PSE	---	---	**0.535*****	---	---	---	---	---	---
			(0.004)						
BroadB×SSE	---	---	---	---	---	**0.180*****	---	---	---
						(0.003)			
BroadB×TSE	---	---	---	---	---	---	---	---	-0.007
									(0.116)
Political Stability	0.031	**0.053****	-0.008	-0.002	**0.055*****	**-0.041***	**0.025****	**0.039****	**0.068*****
	(0.188)	**(0.016)**	(0.738)	(0.870)	**(0.004)**	**(0.083)**	**(0.029)**	**(0.012)**	**(0.000)**
Financial Depth	0.001	0.0005	**0.005*****	0.0009	0.0009	**0.006*****	**0.001*****	**0.002*****	-0.00009
	(0.492)	(0.680)	**(0.000)**	(0.561)	(0.552)	**(0.000)**	**(0.005)**	**(0.001)**	(0.872)
Financial Stability	0.0004	-0.001	-0.002	0.001	-0.001	**-0.008***	-0.0005	-0.0007	0.004
	(0.861)	(0.652)	(0.397)	(0.252)	(0.741)	**(0.054)**	(0.647)	(0.699)	(0.119)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Net Effects	na	na	na	na	na	na	na	na	na
AR(1)	**(0.148)**	**(0.141)**	**(0.136)**	**(0.145)**	**(0.151)**	**(0.141)**	**(0.289)**	**(0.284)**	**(0.279)**
AR(2)	**(0.373)**	**(0.374)**	**(0.376)**	**(0.326)**	**(0.338)**	**(0.337)**	**(0.393)**	**(0.393)**	**(0.409)**
Sargan OIR	(0.087)	**(0.216)**	(0.000)	(0.086)	**(0.287)**	(0.001)	(0.517)	(0.701)	(0.374)
Hansen OIR	**(0.830)**	**(0.923)**	**(0.911)**	**(0.853)**	**(0.912)**	**(0.944)**	**(0.903)**	**(0.825)**	**(0.851)**
DHT for instruments									
(a)Instruments in levels									
H excluding group	**(0.528)**	**(0.424)**	**(0.715)**	**(0.510)**	**(0.335)**	**(0.901)**	**(0.477)**	**(0.541)**	**(0.511)**
Dif(null, H=exogenous)	**(0.841)**	**(0.975)**	**(0.866)**	**(0.877)**	**(0.985)**	**(0.834)**	**(0.945)**	**(0.828)**	**(0.874)**
(b) IV (years, eq(diff))									
H excluding group	**(0.515)**	**(0.779)**	**(0.977)**	**(0.390)**	**(0.753)**	**(0.960)**	**(0.596)**	**(0.490)**	**(0.482)**
Dif(null, H=exogenous)	**(0.912)**	**(0.867)**	**(0.515)**	**(0.989)**	**(0.864)**	**(0.676)**	**(0.954)**	**(0.924)**	**(0.955)**
Fisher	**2329.79*****	**942.29*****	**8370.31*****	**9266.33*****	**6450.08*****	**5777.88*****	**53424.19*****	**6639.41*****	**46042.01*****
Instruments	36	36	36	36	36	36	36	36	36
Countries	40	40	39	39	39	38	38	38	38
Observations	239	237	218	219	216	198	194	194	178

***,**,*: significance levels at 1%, 5% and 10% respectively. DHT: Difference in Hansen Test for Exogeneity of Instruments Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. The significance of bold values is twofold. 1) The significance of estimated coefficients and the Wald statistics. 2) The failure to reject the null hypotheses of: a) no autocorrelation in the AR(1) & AR(2) tests and; b) the validity of the instruments in the Sargan and Hansen OIR tests. na: not applicable because at least an unconditional or a conditional effect needed for the computation of net effects is not significant.

Table 2: Non-Life insurance, education and technology

	Dependent variable: Non-Life Insurance (NonLifeIns)								
	Primary School Enrolment			Secondary School Enrolment			Tertiary School Enrolment		
	Mobile	Internet	BroadB	Mobile	Internet	BroadB	Mobile	Internet	BroadB
Constant	-0.327	-0.378	-0.225	-0.165	-0.213	**-0.168***	0.018	0.036	0.038
	(0.161)	(0.225)	(0.375)	(0.197)	(0.124)	**(0.077)**	(0.847)	(0.555)	(0.310)
NonLifeIns(-1)	**0.887*****	**0.571*****	**0.771*****	**0.909*****	**0.876*****	**0.843*****	**0.942*****	**1.030*****	**0.942*****
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
PSE	**0.399***	0.510	0.304	---	---	---	---	---	---
	(0.093)	(0.141)	(0.264)						
SSE	---	---	---	**0.304***	0.317	**0.260****	---	---	---
				(0.088)	(0.143)	**(0.013)**			
TSE	---	---	---	---	---	---	0.107	0.124	**0.161*****
							(0.408)	(0.129)	**(0.009)**
Mobile	**0.007****	---	---	**0.003***	---	---	**0.001****	---	---
	(0.021)			**(0.064)**			**(0.046)**		
Internet	---	-0.026	---	---	-0.002	---	---	0.001	---
		(0.350)			(0.825)			(0.471)	
BroadB	---	---	**0.422****	---	---	**0.199*****	---	---	**0.026****
			(0.017)			**(0.000)**			**(0.017)**
Mobile ×PSE	**-0.009*****	---	---	---	---	---	---	---	---
	(0.007)								
Mobile×SSE	---	---	---	**-0.005****	---	---	---	---	---
				(0.010)					
Mobile ×TSE	---	---	---	---	---	---	-0.001	---	---
							(0.106)		
Internet ×PSE	---	0.019	---	---	---	---	---	---	---
		(0.480)							
Internet ×SSE	---	---	---	---	-0.002	---	---	---	---
					(0.807)				
Internet ×TSE	---	---	---	---	---	---	---	-0.003	---
								(0.106)	
BroadB×PSE	---	---	**-0.428****	---	---	---	---	---	---
			(0.015)						
BroadB×SSE	---	---	---	---	---	**-0.211*****	---	---	---
						(0.000)			
BroadB×TSE	---	---	---	---	---	---	---	---	**-0.027*****
									(0.001)
Political Stability	0.007	0.044	0.020	0.016	**0.053***	**0.037*****	**0.076****	**0.078****	**0.095*****
	(0.753)	(0.128)	(0.263)	(0.528)	**(0.053)**	**(0.003)**	**(0.042)**	**(0.025)**	**(0.001)**
Financial Depth	**0.006*****	**0.012*****	**0.004*****	**0.005*****	**0.004*****	**0.002*****	0.0005	0.0004	**-0.001***
	(0.000)	**(0.000)**	**(0.000)**	**(0.002)**	**(0.004)**	**(0.003)**	(0.723)	(0.635)	**(0.093)**
Financial Stability	**-0.006****	**-0.011*****	-0.001	**-0.007*****	**-0.005****	0.0003	**-0.006****	-0.004	-0.0008
	(0.012)	**(0.000)**	(0.306)	**(0.004)**	**(0.022)**	(0.769)	**(0.044)**	(0.106)	(0.686)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Net Effects	-0.037	na	na	0.061	na	0.101	na	na	0.140
AR(1)	(0.009)	(0.037)	(0.002)	(0.010)	(0.017)	(0.007)	(0.004)	(0.002)	(0.006)
AR(2)	**(0.542)**	**(0.556)**	**(0.249)**	**(0.333)**	**(0.301)**	**(0.206)**	**(0.315)**	**(0.461)**	**(0.172)**
Sargan OIR	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.070)	**(0.102)**	(0.049)
Hansen OIR	**(0.397)**	**(0.682)**	**(0.265)**	**(0.749)**	**(0.536)**	**(0.377)**	**(0.266)**	**(0.577)**	**(0.584)**
DHT for instruments									
(a)Instruments in levels									
H excluding group	**(0.858)**	**(0.850)**	**(0.811)**	**(0.600)**	**(0.836)**	**(0.881)**	**(0.186)**	**(0.397)**	**(0.549)**
Dif(null, H=exogenous)	**(0.183)**	**(0.451)**	**(0.111)**	**(0.693)**	**(0.306)**	**(0.161)**	**(0.403)**	**(0.615)**	**(0.517)**
(b) IV (years, eq(diff))									
H excluding group	**(0.483)**	**(0.920)**	**(0.052)**	**(0.399)**	**(0.497)**	**(0.222)**	**(0.186)**	**(0.567)**	**(0.297)**
Dif(null, H=exogenous)	**(0.316)**	**(0.270)**	**(0.895)**	**(0.906)**	**(0.491)**	**(0.610)**	**(0.469)**	**(0.479)**	**(0.811)**
Fisher	**233.02*****	**881.31*****	**1341.93*****	**141.76*****	**225.26*****	**1555.09*****	**617.44*****	**159.91*****	**3850.69*****
Instruments	36	36	36	36	36	36	36	36	36
Countries	42	42	40	41	41	39	40	40	39
Observations	251	248	226	232	228	207	206	205	186

***,**,*: significance levels at 1%, 5% and 10% respectively. DHT: Difference in Hansen Test for Exogeneity of Instruments Subsets. Dif: Difference. OIR: Over-identifying Restrictions Test. The significance of bold values is twofold. 1) The significance of estimated coefficients and the Wald statistics. 2) The failure to reject the null hypotheses of: a) no autocorrelation in the AR(1) & AR(2) tests and; b) the validity of the instruments in the Sargan and Hansen OIR tests. na: not applicable because at least an unconditional or a conditional effect needed for the computation of net effects is not significant. Mean values of mobile phone penetration, internet penetration and fixed broad band subscriptions are respectively 48.455, 8.929 and 0.753.

Two main findings are worth articulating further, notably: (i) an explanation as to why Africans are more interested in non-life insurance policies compared to life insurance policies and (ii) within the framework of non-life insurance, why broadband penetration is the most effective ICT channel through which education improves non-life insurance policies. The two points are substantiated in the same order of chronology.

First, the absence of net effects from the role of ICT in modulating the effect of education on life insurance is an indication that African nations do not overwhelmingly subscribe to life insurance policies. This is not the case with the non-life insurance scheme. There are both traditional and logical explanations to this tendency. (i) On the logical front, some non-life insurance policies are indispensible for the running of the economy and households, *inter alia*: car insurance, travel insurance and house insurance. These policies are compulsory while the life insurance scheme is voluntary. Hence, regardless of the level of education and ICT penetration in the African society, embracing life insurance will be left to the choice of citizens. (ii) In relation to the traditional front, African societies still substantially rely on an ancestral genius of African solidarity, such that, death ceremonies are celebrated through generous contributions from relatives and friends. Moreover, a male relative passing away (i.e. dying) is accompanied with the idea and culture that other relatives have the moral and cultural responsibility to look after his children and wife.

It is worthwhile to note that whereas net effects are not apparent from life insurance regressions, there is some evidence of positive conditional effects, which indicates that ICT marginally modulates education to positively influence subscriptions to life insurance policies. Hence, as African societies become increasingly Westernized, urbanized and individualistic, more life insurance policies will be adopted because of more education on the benefits of such insurance schemes and better penetration in complementary educational channels by means of ICT.

Second, within the exclusive framework of non-life insurance, it apparent that broadband penetration is the most effective ICT mechanism with which education is modulated by ICT to improve insurance subscriptions. The finding on the comparative edge of broadband subscriptions is in accordance with a recent World Bank report which has documented that the economic development impact from broadband subscriptions is comparatively higher than that of other ICT indicators (World Bank, 2016). Concerning the three ICT indicators used this study, the results are broadly consistent with those of Efobi et al. (2018) in which, the magnitude of broadband subscriptions on economic development (by means of female economic participation) is substantially higher when compared with internet

penetration and mobile phone penetration. The established findings are contrary to Zerriaa et al. (2017) who have concluded that the levels education reduces the consumption of life insurance.

4. Concluding remarks and future directions

This article has examined the relevance of information and communication technology (ICT) in modulating the effect of education on life insurance and non-life insurance consumption in 48 African countries for the period 2004-2014. Education is measured with primary school, secondary school and tertiary school enrollments. ICT is measured with mobile phone, internet and broad band subscriptions. The empirical evidence is based on Generalised Method of Moments. The following main findings are established. First, from the nexuses between education, ICT and life insurance, there are positive conditional effects from the interaction between: (i) broadband subscriptions and primary school enrollment; (ii) broadband subscriptions and secondary school enrollment and (iii) internet penetration and tertiary school enrollment. Second, from the nexuses between education, ICT and non-life insurance: (i) there is a negative net effect from the interaction between mobile phone penetration and primary education while positive net effects are apparent from the interactions between: mobile phone penetration and secondary school enrollment; secondary school enrollment and broadband subscriptions and; tertiary school enrollment and broadband subscriptions. Some explanations to the patterns in results have been provided.

The main policy implication is that, ICT is valuable in modulating the relevance of education on the subscriptions to life and non-life insurance policies by citizens in Africa. Though the underlying relevance is more apparent for non-life insurance than it is for life insurance schemes, positive effects indicate that increasing ICT can enhance awareness on the importance of life insurance. Hence, governments of sampled countries can pursue policies of completely liberalizing the ICT sector in order to increase competition and penetration in ICT. Moreover, the establishment of universal ICT access policies would also facilitate the adoption of these insurances schemes. Broadband subscriptions should be prioritized in ICT penetration policies because, the findings in this study have confirmed a previously established tendency that compared to other ICT mechanisms the positive externalities from broadband subscriptions are highest.

Future studies can focus on country-specific inquiries in order to assess whether the established linkages withstand empirical scrutiny within control-specific frameworks. Such country-specific studies are necessary for more targeted policy implications.

Appendices

Appendix 1: Definitions of Variables

Variables	Signs	Definitions of variables (Measurements)	Sources
Life Insurance	LifeIns	Life Insurance Premium Volume to GDP (%)	FDSD
Non-Life Insurance	NonLifeIns	Non-life Insurance Premium Volume to GDP (%)	FDSD
Primary School	PSE	School enrollment, primary and secondary (gross), gender parity index (GPI)	WDI
Secondary School	SSE	School enrollment, secondary (gross), gender parity index (GPI)	WDI
Tertiary School	TSE	School enrollment, tertiary (gross), gender parity index (GPI)	WDI
Mobile Phones	Mobile	Mobile cellular subscriptions (per 100 people)	WDI
Internet	Internet	Internet users (per 100 people)	WDI
Fixed Broad Band	BroadB	Fixed broadband subscriptions (per 100 people)	WDI
Political Stability	PolS	"Political stability/no violence (estimate): measured as the perceptions of the likelihood that the government will be destabilised or overthrown by unconstitutional and violent means, including domestic violence and terrorism"	WDI
Financial Depth	FinDepth	Money Supply (% of GDP)	FDSD
Financial Stability	Z-score	Prediction of the likelihood that a bank might survive and not go bankrupt.	FDSD

WDI: World Bank Development Indicators of the World Bank. FDSD: Financial Development and Structure Database of the World Bank.

Appendix 2: Summary statistics (2004-2014)

	Mean	SD	Minimum	Maximum	Observations
Life Insurance	0.798	1.978	0.0006	12.220	405
Non-Life Insurance	0.799	0.531	0.005	2.774	428
Primary School Enrollment	0.923	0.106	0.600	1.105	363
Secondary School Enrollment	0.874	0.203	0.333	1.422	338
Tertiary School Enrollment	0.775	0.437	0.064	3.295	293
Mobile Phone Penetration	48.455	38.082	0.209	171.375	524
Internet Penetration	8.929	11.543	0.031	56.800	519
Fixed Broad Band	0.753	1.924	0.000	14.569	434
Political Stability	-0.490	0.867	-2.687	1.182	528
Financial Depth	10.054	6.842	-12.024	41.803	467
Financial Stability	35.460	22.409	4.383	108.899	503

S.D: Standard Deviation.

Appendix 3: Correlation matrix (uniform sample size : 155)

Education variables			ICT variables			Control variables			Insurance		
PSE	SSE	TSE	Mobile	Internet	BroadB	PolS	FinDepth	Z-score	LifeIns	NonLifeIns	
1.000	0.867	0.590	0.471	0.427	0.373	0.326	0.301	0.123	0.348	0.328	PSE
	1.000	0.731	0.536	0.524	0.407	0.378	0.388	0.213	0.418	0.474	SSE
		1.000	0.643	0.681	0.682	0.293	0.352	0.209	0.254	0.340	TSE
			1.000	0.795	0.650	0.211	0.452	0.402	0.260	0.235	Mobile
				1.000	0.723	0.185	0.628	0.615	0.249	0.439	Internet
					1.000	0.349	0.490	0.259	0.404	0.273	BroadB
						1.000	0.275	0.005	0.411	0.409	PolS
							1.000	0.650	0.399	0.683	FinDepth
								1.000	0.166	0.485	Z-score
									1.000	0.629	LifeIns
										1.000	NonLifeIns

PSE : Primary School Enrollment. SSE : Secondary School Enrollment. Mobile: Mobile phone penetration. Internet: Internet penetration. BroadB: Fixed broad band subscriptions. PolS; Political stability. FinDepth: Financial Depth. Z-score: Financial Stability. LifeIns: Life Insurance. NonLifeIns.

References

Abor, J. Y., Amidu, Y., & Issahaku, H., (2018). "Mobile Telephony, Financial Inclusion and Inclusive Growth", *Journal of African Business*, 18(4), pp. 430-453.

Afutu-Kotey, R. L., Gough, K. W., & Owusu, G., (2017). "Young Entrepreneurs in the Mobile Telephony Sector in Ghana: From Necessities to Aspirations". *Journal of African Business*, 18(4), pp. 476-491.

Aglionby, J., (2016). "Africa's insurance market a 'giant waking up'", Financial Times, https://www.ft.com/content/bc87016a-2430-11e6-9d4d-c11776a5124d (Accessed: 09/06/2018).

Akinlo, T., (2015). "Causal Relation between Insurance and Economic Growth in selected Sub-Saharan Africa: A Heterogeneous Panel Causality Approach", *Canadian Open Economics Journal*, 2(1), pp. 1-22.

Alhassan, A, L., & Biekpe, N., (2015). "Efficiency, Productivity and Returns to Scale Economies in the Non-Life Insurance Market in South Africa", The Geneva Papers on Risk and Insurance - Issues and Practice, 40(3), pp 493–515.

Alhassan, A. L., & Biekpe, N., (2016a). "Determinants of life insurance consumption in Africa", *Research in International Business and Finance*, 37(May), pp. 17-27.

Alhassan, A. L., & Biekpe, N., (2016b). "Insurance market development and economic growth: Exploring causality in 8 selected African countries", *International Journal of Social Economics*, 43(3), pp.321-339.

Arellano, M., & Bond, S., (1991). "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations" *The Review of Economic Studies,* 58(2), pp. 277-297.

Arellano, M., & Bover, O., (1995). "Another look at the instrumental variable estimation of error components models", *Journal of Econometrics,* 68(1), pp. 29-52.

Asongu, S. A., (2017). "Is information diffusion a threat to market power for financial access? Insights from the African banking industry", *Journal of the Knowledge Economy*, 9(1), pp 81–135.

Asongu, S. A., & Boateng, A., (2018). "Introduction to Special Issue: Mobile Technologies and Inclusive Development in Africa", *Journal of African Business*, 19(3), pp. 297-301.

Asongu S. A. & De Moor, L., (2017). "Financial globalisation dynamic thresholds for financial development: evidence from Africa", *European Journal of Development Research*, 29(1), pp. 192–212.

Asongu, S. A., le Roux, S., & Biekpe, N., (2017). "Environmental degradation, ICT and inclusive development in Sub-Saharan Africa", *Energy Policy*, 111(December), pp. 353-361.

Asongu, S. A., le Roux, S., & Biekpe, N., (2018). "Enhancing ICT for Environmental Sustainability in Sub-Saharan Africa", *Technological Forecasting and Social Change*, 127(February), pp. 209-216.

Asongu, S. A, & Nwachukwu, J. C., (2016a). "The Mobile Phone in the Diffusion of Knowledge for Institutional Quality in Sub Saharan Africa", *World Development*, 86(October), pp. 133-147.

Asongu, S. A, & Nwachukwu, J. C., (2016b). "Foreign aid and governance in Africa", *International Review of Applied Economics*, 30(1), pp. 69-88.

Beck, T., Demirgüç-Kunt, A., & Levine, R., (2003). "Law and finance: why does legal origin matter?", *Journal of Comparative Economics*, 31(4), pp. 653-675.

Blundell, R., & Bond, S., (1998). "Initial conditions and moment restrictions in dynamic panel data models" *Journal of Econometrics*, 87(1), pp. 115-143.

Boateng, A., Asongu, S. A., Akamavi, R., & Tchamyou, V. S., (2016). "Information Asymmetry and Market Power in the African Banking Industry", *Journal of Multinational Financial Management,* 44(March), pp. 69-83.

Bond, S., Hoeffler, A., & Tample, J. (2001). "GMM Estimation of Empirical Growth Models", University of Oxford.

Bongomin, G. O. C., Ntayi, J. M., Munene J. C., & Malinga, C. A., (2018). "Mobile Money and Financial Inclusion in Sub-Saharan Africa: the Moderating Role of Social Networks", *Journal of African Business,* 18(4), pp. 361-384.

Costantini, M., & Lupi, C., (2005). "Stochastic Convergence among European Economies". *Economics Bulletin*, 3(38), pp.1-17.

Efobi, U.R., Tanankem, B. V., & Asongu, S. A., (2018). "Female Economic Participation with Information and Communication Technology Advancement: Evidence from Sub- Saharan Africa". *South African Journal of Economics*, 86(2), pp. 231-246.

Gosavi, A., (2018). "Can Mobile Money Help Firms Mitigate the Problem of Access to Finance in Eastern sub-Saharan Africa", *Journal of African Business,* 18(4), pp. 343-360.

Guerineau, S., & Sawadogo, R., (2015)."On the determinants of life insurance development in Sub Saharan Africa: the role of the institutions quality in the effect of economic development", *CERDI Working Paper* No. 19, Auvergne.

Hubani, M., & Wiese, M., (2018). "A Cashless Society for All: Determining Consumers' Readiness to Adopt Mobile Payment Services", *Journal of African Business*, 18(4), pp. 409-429.

Ioncica, M., Petrescu, E-C., Ioncica, D., & Constantinescu, M., (2012). "The Role of Education on Consumer Behavior on the Insurance Market", *Procedia - Social and Behavioral Sciences*, 46(2012), pp. 4154-4158.

Issahaku, H., Abu, B. M., & Nkegbe, P. K., (2018). "Does the Use of Mobile Phones by Smallholder Maize Farmers Affect Productivity in Ghana?", *Journal of African Business,* 19(3), pp. 302-322.

Kuada, J., (2009). "Gender, social networks, and entrepreneurship in Ghana", *Journal of African Business*, 10 (1), pp. 85-103.

Kuada, J. (2014). "Cross- border interfirm knowledge generation and enterprise development in Africa", in Nwankwo, S. and Ibeh, K. (Eds), The Routledge Companion to Business in Africa, Routledge, London and New York, pp. 352-370.

Kuada, J., (2015). "Entrepreneurship in Africa – a classificatory framework and a research Agenda", *African Journal of Economic and Management Studies*, 6(2), pp. 148-163.

Kyerematen, S., (2015). "Africa's low insurance coverage: Apathy or ignorance?" Activa http://www.activa-ghana.com/news/africas-low-insurance-coverage-apathy-or-ignorance (Accessed: 19/06/2018).

Mayer-Foulkes, D., (2010). "Divergences and Convergences in Human Development". *UNDP Human Development Research Paper* 2010/20, New York.

Meniago, C., & Asongu, S. A., (2018). "Revisiting the finance-inequality nexus in a panel of African countries", *Research in International Business and Finance*, 46(December), pp. 399-419.

Minkoua Nzie, J. R., Bidogeza, J. C., & Ngum, N. A., (2017). "Mobile Phone Use, Transaction Costs, and Price: Evidence from Rural Vegetable Farmers in Cameroon", *Journal of African Business*, 19(3), pp. 323-342.

Muthinja, M. M., & Chipeta, C., (2018). "What Drives Financial Innovations in Kenya's Commercial Banks? An Empirical Study on Firm and Macro-Level Drivers of Branchless Banking", *Journal of African Business*, 18(4), pp. 385-408.

Narayan, P.K., Mishra, S., & Narayan, S., (2011). "Do market capitalization and stocks traded converge? New global evidence". *Journal of Banking and Finance*, 35(10), pp. 2771-2781.

PwC (2015). "Africa insurance trends", Insurance Industry Survey 2015 – Nigeria. https://www.pwc.com/ng/en/assets/pdf/nigeria-insurance-survey.pdf (Accessed: 09/06/2018).

Tchamyou, V. S., (2017). "The Role of Knowledge Economy in African Business". Journal of the Knowledge Economy, 8(4), pp. 1189-1228.

Tchamyou, V. S., (2018). "Education, Lifelong learning, Inequality and Financial access: Evidence from African countries", *Contemporary Social Science*. DOI: 10.1080/21582041.2018.1433314.

Tchamyou, V. S., & Asongu, S. A., (2017). "Information Sharing and Financial Sector Development in Africa", *Journal of African Business*, 18(1) pp. 24-49.

Tchamyou, V. S., Asongu, S. A., & Nwachukwu, J. C., (2018). "Effects of asymmetric information on market timing in the mutual fund industry", *International Journal of Managerial Finance*, 14(5), pp.542-557.

Tony, F. L., & Kwan, D. S., (2015). "African Entrepreneurs and International Coordination in Petty Businesses: The Case of Low-End Mobile Phones Sourcing in Hong Kong". *Journal of African Business*, 15(1-2), pp. 66-83.

World Bank (2016)."Information Communications Technology for Development, Washington" World Bank.http://live.worldbank.org/information-communications-technologydevelopment (Accessed: 05/12/2016).

Zerriaa, M., Amiri, M. M., Noubbigh, H., & Naoui, K., (2017). "Determinants of Life Insurance Demand in Tunisia", *African Development Review*, 29(1), pp. 69-80,