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Enhancing ICT for Insurance in Africa [1]

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Enhancing ICT for Insurance in Africa

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Abstract

This study assesses how enhancing information and communication technology (ICT) affects life insurance and non-life insurance in a panel of forty-eight African countries with data for the period 2004-2014. The adopted ICT dynamics are: mobile phone penetration, internet penetration and fixed broadband subscriptions. The empirical evidence is based on Generalized Method of Moments. The results show that enhancing mobile phone penetration and fixed broadband subscriptions has a positive net effect on life insurance consumption while enhancing fixed broadband subscriptions also has a positive net impact of on non-life insurance penetration.

JEL Classification: I28; I30; L96; O16; O55
Keywords: Insurance; Information technology

1. Introduction

Three main factors motivate the positioning of this study on the relevance of enhancing information and communication technology (ICT) for insurance penetration in Africa, notably, the: (i) low insurance consumption in the continent; (ii) potential for ICT penetration in the Africa in the light of the growing relevance of ICT in positive development outcomes and (iii) gaps in the attendant literature. The factors are expanded in the same order as they are highlighted.

First, insurance penetration represents a policy syndrome in Africa because its penetration rate is low compared to other regions of the world[2]. As maintained by Kyerematen (2015), with the exception of South Africa, just about five percent of countries in Africa subscribe to insurance services. In addition, the author articulates that the two main characteristics that explain this low penetration are: demand- and supply-side features and structural considerations. Some of these characteristics are: (i) the low penetration of ICT that is relevant for the effectiveness of information sharing offices (i.e. public credit registries and private credit bureaus) and (ii) other infrastructure essential for information synchronization and reduction of information asymmetry linked to insurance commodities. These, *inter alia*, represent challenges to doing business in Africa (Amankwah-Amoah et al., 2018; Asongu & Odhiambo, 2019).

Second, compared to other regions of the world which are experiencing saturation levels in ICT penetration, there is still a considerable potential for ICT development in Africa (Penard *et al*., 2012; Amankwah-Amoah & Sarpong, 2016; Afutu-Kotey *et al*., 2017; Efobi *et al*., 2018; Gosavi, 2018; Asongu & Boateng, 2018; Humbani & Wiese, 2018; Amankwah- Amoah, 2015, 2016, 2019). Hence, such a high potential for ICT development can be leveraged by policy makers to address policy syndromes such as the low penetration of insurance. This assertion builds on a growing strand of literature on the importance of ICT in economic development externalities (Asongu & Nwachukwu, 2016a, 2016b; Tchamyou, 2017; Abor *et al*., 2018; Isszhaku *et al*., 2018; Minkoua Nzie *et al*., 2018; Gosavi, 2018; Muthinja & Chipeta, 2018; Bongomin *et al*., 2018 ; Uduji & Okolo-Obasi, 2018a, 2018b;

[2] In the attendant literature, policy syndromes have been characterized by Fosu (2013) as features that are not conducive for economic prosperity. These include: "administered redistribution", "state breakdown", "state controls", and "suboptimal inter temporal resource allocation". In more contemporary literature, Asongu (2017), in a comparative analysis of cross-country differences in knowledge economy considers a policy syndrome to be a knowledge economy gap between two countries. In the pro-poor growth literature, a policy syndrome is growth that is not inclusive (Asongu & Nwachukwu, 2017a; Tchamyou *et al*., 2019a; Asongu *et al*., 2020a).

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Asongu *et al.*, 2019a). The purpose of the present study is to extend this strand of the literature by engaging the dimension of insurance, owing to an apparent gap in the literature.

Third, as critically engaged in Section 2, the extant scant literature on insurance in Africa has fundamentally focused on two main strands, notably: nexuses between insurance penetration and economic development (Ioncică *et al.*, 2012; Alhassan & Biekpe, 2015, 2016a; Akinlo, 2015; Asongu & Odhiambo, 2020a) and determinants of insurance subscriptions (Alhassan & Biekpe, 2016b; Guerineau & Sawadogo, 2015; Zerriaa *et al.*, 2017; Asongu & Odhiambo, 2020b). Unfortunately, an apparent gap in the engaged literature is the absence of studies on the nexus between ICT and insurance. While Asongu et al. (2020b) have investigated linkages between information technology, governance dynamics (political stability, voice and accountability, regulation quality, government effectiveness, rule of law and corruption-control) and insurance development in Africa, the extant literature is scant on how boosting ICT directly affects insurance development in the continent. Hence, the question this research aims to answer is the following: how does enhancing ICT affect insurance penetration in Africa?

The remainder of the study is organized as follows. The theoretical underpinnings, intuition and relevant literature are expanded in section 2. The data and methodology are covered in section 3 whereas the empirical results and discussion are disclosed in section 4. Section 5 concludes with future research directions.

2. Theoretical underpinnings, intuition and related literature

2.1 Theoretical underpinnings and intuition

The theoretical linkage between ICT and insurance is consistent with neoclassical models of information diffusion (Kwan & Chiu, 2015). In line with the corresponding literature, neoclassical growth models are in accordance with the relevance of information technology as a crucial source of economic development in developing countries (Abramowitz, 1986; Bernard & Jones, 1996; Asongu *et al.*, 2018). Moreover, according to the theoretical underpinnings, ICT improves both macroeconomic development and the livelihood of citizens (Bongomin *et al.*, 2018; Muthinja & Chipeta, 2018; Uduji & Okolo-Obasi, 2018a, 2018b; Asongu *et al.*, 2019b). One of such outcomes is insurance development.

Consistent with the OECD (2017), innovation by means of technologies is critical in determining change in the banking industry and by extension, efficiency gains. The insurance sector falls within this framework because it is not an exception. This is essentially because the technology changes accompanying financial sector development are characterized by doubts and uncertainties.

2.2 Insurance in Africa

In the light of the discussion in the introduction, the scant insurance literature in Africa has been oriented along two strands, namely: determinants of insurance consumption (Guerineau & Sawadogo, 2015; Alhassan & Biekpe, 2016b; Zerriaa *et al.*, 2017) and linkages between insurance consumption and economic development (Ioncică *et al.*, 2012; Akinlo, 2015; Alhassan & Biekpe, 2015, 2016a).

In relation to the first strand on determinants of insurance consumption, the drivers of insurance have been assessed by Guerineau and Sawadogo (2015). They have focused on twenty countries for the period 1996-2011 while controlling for potential issues of endogeneity with an instrumental variable strategy. The study concludes that a positive relationship exist between income per capita and life insurance premia. Furthermore, life insurance is an ostentatious service largely consumed by the wealthy. It is also established that life insurance is negatively related to young dependency and life expectancy ratios whereas property rights protection, the old dependency ratio and stability in governance generate positive externalities.

Zerriaa *et al.* (2017) have examined drivers of the demand for life insurance in Tunisia using annual data for the period 1990-2014. The results show that: (i) pension expenditures diminish “life insurance demand”, (ii) no significant incidence is apparent from inflation and interest rates while (iii) life expectancy, dependency, financial development, income and urbanization have positive effects on the demand for life insurance. Factors that affect life insurance have also been assessed by Alhassan and Biekpe (2016b) in a panel of thirty-one African countries for the period 1996-2010. The authors have concluded that when compared with financial determinants, a higher explanatory power is apparent from demographic factors. Furthermore, the study also demonstrates that life insurance consumption is mitigated by dependency, life expectancy and inflation while the following determinants engender a positive effect: quality of institutions, insurance consumption, health expenditure and financial development.

In the second strand that is relevant to the incidence of insurance premiums on macroeconomic outcomes, Alhassan and Biekpe (2015) have investigated the nexus between economies of scale, efficiency and productivity in the non-life insurance market. Focusing on South Africa using data for the period 2007-2012 and employing data development analysis, logistic and bootstrapped estimations, the results show that about 20% of insurers optimally perform their operations while about 50% of inefficiency characterizes non-life insurers. The findings reveal that improvements in productivity are contingent on technological ameliorations as well as evidence of a non-linear impact of size on constant returns to scale and efficiency. Furthermore, the findings also show that leverage, reinsurance and diversification have significant nexuses with constant returns to scale and efficiency.

Alhassan and Biekpe (2016a) have examined the nexus between economic growth and the development of insurance over the period 1990-2010 in 8 African countries, namely: Algeria, Gabon, Kenya, Madagascar, Mauritius, Morocco, Nigeria and South Africa. Using an autoregressive distributed lag (ARDL) empirical strategy; the findings show that a long term nexus is apparent between economic growth and the insurance market in the following countries: South Africa, Nigeria, Morocco, Mauritius and Kenya. In the light of the results from the vector error correction model (VECM) framework, mixed causality is established in Gabon and there is bidirectional causality in Morocco whereas unidirectional causality is apparent in Madagascar and Algeria.

In another study, Akinlo (2015) has investigated the causal relationship between insurance and economic growth in a sample of thirty countries in Sub-Saharan Africa for the period 1995-2011. Employing a panel heterogeneous estimation technique, the findings reveal bidirectional causality between insurance and economic growth. Furthermore, a principal feature of the causality is that it is of homogenous nature cross the panel of countries.

3. Data and methodology

3.1 Data

This study is based on a sample of 48 African countries with data for the period 2004-2014[3]. The geographical and temporal scopes are due to data availability constraints. There are two main sources from which this data is obtained, notably: (i) the World Development Indicators of the World Bank and (ii) the Financial Development and Structure Database of the World Bank.

[3] 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".

The research employs the two insurance indicators provided by the Financial Development and Structure Database of the World Bank, namely: life insurance and non-life insurance premia or subscriptions. In accordance with the attendant ICT literature, three information technology variables are used for the analysis, namely: mobile phone penetration, internet penetration and fixed broadband subscriptions (Efobi *et al.*, 2018; Minkoua Nzie *et al.*, 2018).

Two main control variables are adopted in the study, namely: government expenditure and remittances. Only two control variables are adopted because from a preliminary analysis, adopting more than two control variables leads to instrument proliferation even when instruments are collapsed in the process. Hence, in order to tailor the Generalized Method of Moments (GMM) estimations to pass post-estimation diagnostic tests, the control variables are limited to two. This is consistent with the literature employing GMM estimations in which, no control variables are employed in some studies (Osabuohien & Efobi, 2013; Asongu & Nwachukwu, 2017b). First, we expect remittances to decrease insurance consumption because it offers opportunities for economic certainty and financial stability, both at the household and macroeconomic levels. While at the macroeconomic level, remittances have been documented to be less volatile compared to other external flows (Ssozi & Asongu, 2016), at the household level, remittances reduce uncertainties that would have motivated subscription to insurance premia as an attempt to hedge against risks associated with economic uncertainty. Second, government expenditure falls within the broader framework of boosting economic development and associated externalities. Hence, the insurance sector is broadly expected to be boosted by expenditure from the government.

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.

3.2 Methodology

3.2.1 GMM: Specification, identification and exclusion restrictions

Building on contemporary literature, the choice of the estimation strategy is in line with the data behavior (Li et al., 2014, 2016; Kou et al., 2012, 2014, 2016, 2019a, 2019b; Zhang et al., 2019). Accordingly, the adoption of the Generalised Method of Moments (GMM) as an estimation approach is underpinned by four principal insights from the attendant empirical literature. First, the number of cross sections (i.e. countries) is higher compared to the number of years in each country. Therefore, the N>T condition that is relevant for the adoption of the GMM approach is fulfilled because 11 (i.e. 2004 to 2014) <48 (i.e. forty eight countries). Second, the insurance variables are persistent given that the variables in levels are substantially correlated with their corresponding first lags. In essence, the correlations are higher than 0.800, which is established in the literature as the threshold for concluding that an indicator is persistent (Tchamyou, 2019, 2020). Accordingly, the corresponding correlation for life insurance and non-life insurance are respectively, 0.992 and 0.972. Third, in the light of the panel nature of the data structure, cross-country differences are accounted for in the GMM estimation approach. Fourth, endogeneity is tackled by the estimation technique for two main reasons. On the one hand, the issue of reverse causality or simultaneity is addressed through an instrumentation approach. On the other hand, time invariant variables are also used to control for the unobserved heterogeneity.

In this research, the Arellano and Bover (1995) improvement by Roodman (2009a, 2009b) is adopted because it has been documented to generate more efficient estimates compared to traditional GMM approaches (Love & Zicchino, 2006; Baltagi, 2008; Asongu & Nwachukwu, 2016a; Boateng *et al.*, 2018). Moreover, the strategy with forward orthogonal deviations restricts the proliferation of instruments or limits over-identification.

The following equations in level (1) and first difference (2) summarise the standard *system* GMM estimation procedure.

$$I_{i,t} = \sigma_0 + \sigma_1 I_{i,t-\tau} + \sigma_2 T_{i,t} + \sigma_3 TT_{i,t} + \sum_{h=1}^{2} \delta_h W_{h,i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \qquad (1)$$

$$\begin{aligned} I_{i,t} - I_{i,t-\tau} = {} & \sigma_1 (I_{i,t-\tau} - I_{i,t-2\tau}) + \sigma_2 (T_{i,t} - T_{i,t-\tau}) + \sigma_3 (TT_{i,t} - TT_{i,t-\tau}) \\ & + \sum_{h=1}^{2} \delta_h (W_{h,i,t-\tau} - W_{h,i,t-2\tau}) + (\xi_t - \xi_{t-\tau}) + (\varepsilon_{i,t} - \varepsilon_{i,t-\tau}) \end{aligned} \qquad (2)$$

where, $I_{i,t}$ is an insurance indicator (i.e. life insurance and non-life insurance) of country i in period t, σ_0 is a constant, T entails ICT (mobile phone penetration, internet penetration and fixed broadband subscriptions), TT denote quadratic interactions between ICT indicators ("mobile phone penetration" × "mobile phone penetration", "internet penetration" × "internet penetration" and "fixed broadband subscriptions" × "fixed broadband subscriptions"), W is the vector of control variables (government expenditure and remittances), 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.

3.2.2 Identification and exclusion restrictions

In order to provide an empirical analysis that is tight and robust, it is relevant to discuss the identification and exclusion restrictions strategy pertaining to the GMM specification. In the light of the extant contemporary literature (Asongu & Nwachukwu, 2016b; Tchamyou & Asongu, 2017; Boateng *et al.*, 2018; Tchamyou *et al.*, 2019b), all explanatory variables are considered as suspected endogenous or endogenous explaining variables. Moreover, variables that exibit strict exogeneity are acknowledged to be the time invariant variables. As argued by Roodman (2009b), the identification approach is relevant because it is unfeasible for the time invariant variables to become endogenous after a first difference (Roodman, 2009b)[4].

In the light of the above clarification, the exclusion restriction assumption is investigated by examining whether the strictly exogenous indicators influence the insurance variables exclusively via the predetermined channels. Therefore, the corresponding assumption of exclusion restriction is validated if the null hypothesis of the Difference in Hansen Test (DHT) for the exogeneity of instruments is not rejected. In essence, for the exclusion restriction assumption to hold, the alternative hypothesis of the DHT should be rejected. Hence, the null hypothesis of the DHT is the position that the strictly exogenous variables or instruments are valid. It is relevant to also articulate that this criterion for exclusion restriction is not in principle dissimilar to the criterion adopted in a standard instrumental variable (IV) procedure in which, failure to reject the null hypothesis of the Sargan Overidentifying Restrictions (OIR) test reflects the position that insurance is exclusively influenced by the strictly exogenous variables through the endogenous explaining channels (Beck *et al.*, 2003; Asongu & Nwachukwu, 2016c).

4. Empirical results

Table 1 and Table 2 present the empirical results used to assess the relevance of ICT for insurance penetration in Africa. While Table 1 focuses on life insurance, Table 2 is concerned with non-life insurance. For all tables, four information criteria are employed to assess the validity of the GMM model with forward orthogonal deviations[5]. Based on these

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

[5] "*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*

criteria, with the exception of two specifications that do not pass post-estimation diagnostic tests, the models are overwhelmingly valid. The invalid specifications are in the second and sixth columns of Table 1 and Table 2, respectively. Accordingly, these are invalid because of the presence of autocorrelation in the residuals (i.e. in the second order autocorrelation in difference).

Each table also has three sets of specifications pertaining to each ICT dynamic. Each specification is modelled with and without the conditioning information set in order to further assess the robustness of the findings. As clarified in the data section, some research findings based on the GMM approach do not engage control variables (Osabuohien & Efobi, 2013; Asongu & Nwachukwu, 2017b). Hence, the relevance of the specifications without conditioning information set. In order to assess the overall impact of enhancing ICT on insurance, the net effect of unconditional and marginal effects of ICT dynamics are computed. For instance, in the third column of Table 1, the net impact from increasing mobile phone penetration is 0.0031 (2×[-0.00002× 45.330] + [0.005]). In the computation, the mean value of mobile phone penetration is 45.330, the unconditional effect of mobile phone penetration is 0.005 while the conditional effect from enhancing mobile phone penetration is -0.00002. In the same vein, in the sixth column of Table 1, the net impact from fixed broadband subscriptions is 0.0397 (2×[-0.001× 0.643] + [0.041]). In the computation, the mean value of fixed broadband subscriptions is 0.643, the unconditional effect of fixed broadband subscriptions 0.041 while the conditional effect from enhancing fixed broadband subscriptions is -0.001.

Following the above computation insights, in the sixth column of Table 2, the net impact from fixed broadband subscriptions is 0.0089 (2×[-0.0008× 0.643] + [0.010]). In the computation, the mean value of fixed broadband subscriptions is 0.643, the unconditional effect of fixed broadband subscriptions is 0.010 while the conditional effect from enhancing fixed broadband subscriptions is -0.0008.

In the light of the above insights, the following findings can be established. Enhancing mobile phone penetration and fixed broadband subscriptions has a positive net effect on life insurance consumption while enhancing fixed broadband subscriptions also has a positive net effect on non-life insurance consumption. The significant control variables have the expected signs.

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results from the Hansen OIR test. Fourth, a Fisher test for the joint validity of estimated coefficients is also provided" (Asongu & De Moor, 2017, p.200).

Table 1: ICT and Life Insurance

	Dependent variable: Life Insurance					
	Mobile phone penetration		**Internet penetration**		**Broadband subscription**	
Constant	-0.019	0.019	**0.205*** **	0.175	**0.105*** **	0.073
	(0.853)	(0.802)	**(0.005)**	(0.312)	**(0.005)**	(0.277)
Life Insurance (-1)	**0.779*** **	**0.763*** **	**0.688*** **	**0.744*** **	**0.792*** **	**0.834*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Mobile (Mob)	0.002	**0.005*** **	---	---	---	---
	(0.200)	**(0.006)**				
Mob×Mob	-0.000	**-0.00002*** **	---	---	---	---
	(0.205)	**(0.006)**				
Internet	---	---	**-0.006***	**-0.006***	---	---
			(0.077)	**(0.078)**		
Internet ×Internet	---	---	0.0001	0.0001	---	---
			(0.117)	(0.104)		
Broadband(BroadB)	---	---	---	---	**0.041*** **	**0.019*** **
					(0.000)	**(0.001)**
BroadB×BroadB	---	---	---	----	**-0.001*** **	0.0001
					(0.000)	(0.605)
Remittances	---	**-0.019** **	---	-0.021	---	**-0.030*** **
		(0.047)		(0.246)		**(0.003)**
Government Exp.	---	0.006	---	-0.0003	---	0.005
		(0.261)		(0.930)		(0.146)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Net Effects	nsa	0.0031	na	na	0.0397	na
AR(1)	**(0.414)**	(0.079)	**(0.161)**	**(0.158)**	**(0.148)**	**(0.135)**
AR(2)	(0.074)	**(0.410)**	**(0.478)**	**(0.483)**	**(0.359)**	**(0.336)**
Sargan OIR	**(0.155)**	**(0.793)**	**(0.694)**	**(0.734)**	(0.001)	(0.015)
Hansen OIR	**(0.800)**	**(0.980)**	**(0.784)**	**(0.872)**	**(0.186)**	**(0.703)**
DHT for instruments						
(a)Instruments in levels						
H excluding group	**(0.907)**	**(0.914)**	**(0.404)**	**(0.556)**	**(0.790)**	**(0.804)**
Dif(null, H=exogenous)	**(0.604)**	**(0.925)**	**(0.828)**	**(0.873)**	**(0.088)**	**(0.508)**
(b) IV (years, eq(diff))						
H excluding group	---	**(0.868)**	---	**(0.977)**	---	**(0.488)**
Dif(null, H=exogenous)	---	**(0.941)**	---	**(0.629)**	---	**(0.694)**
Fisher	**3159.58*** **	**6973.24*** **	**378.29*** **	**3866.86*** **	**1731.43*** **	**25885.23*** **
Instruments	20	28	20	28	20	28
Countries	37	33	37	33	35	30
Observations	301	235	299	233	258	207

***,**,*: 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. The mean value of mobile phone penetration is 45.330, the mean value of internet penetration is 7.676 and the mean value of fixed broad band subscriptions is 0.643. na: not applicable because at least one of the estimated coefficients needed for the computation of net effects is not significant. nsa: not specifically applicable because the model does not pass post-estimation diagnostics tests.

Table 2: ICT and Non-life Insurance

	Dependent variable: Non Life Insurance					
	Mobile phone penetration		**Internet penetration**		**Broadband subscription**	
Constant	0.026	-0.041	0.051	0.033	**0.152*** **	**0.095** **
	(0.348)	(0.505)	(0.390)	(0.665)	**(0.000)**	**(0.017)**
Non Life Insurance (-1)	**0.936*** **	**0.895*** **	**0.905*** **	**0.908*** **	**0.793*** **	**0.856*** **
	(0.000)	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Mobile (Mob)	0.0003	-0.0004	---	---	---	---
	(0.632)	(0.619)				
Mob×Mob	-0.000	-0.000	---	---	---	---
	(0.588)	(0.767)				
Internet	---	---	0.002	-0.0007	---	---
			(0.408)	(0.704)		
Internet ×Internet	---	---	-0.000	-0.000	---	---
			(0.399)	(0.976)		
Broadband(BroadB)	---	---	---	---	**0.024*** **	**0.010*** **
					(0.000)	**(0.006)**
BroadB×BroadB	---	---	---	----	**-0.001*** **	**-0.0008** **
					(0.003)	**(0.024)**
Remittances	---	-0.003	---	-0.001	---	-0.003
		(0.145)		(0.566)		(0.137)
Government Exp.	---	**0.009*** **	---	0.003	---	0.001
		(0.003)		(0.150)		(0.526)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Net Effects	na	na	na	na	nsa	0.0089
AR(1)	(0.000)	(0.001)	(0.000)	(0.002)	(0.000)	(0.001)
AR(2)	**(0.169)**	**(0.140)**	**(0.121)**	**(0.110)**	(0.092)	**(0.165)**
Sargan OIR	**(0.460)**	**(0.175)**	**(0.101)**	(0.024)	**(0.462)**	**(0.133)**
Hansen OIR	**(0.602)**	**(0.316)**	**(0.375)**	**(0.314)**	(0.096)	**(0.263)**
DHT for instruments						
(a)Instruments in levels						
H excluding group	**(0.215)**	**(0.470)**	**(0.180)**	**(0.648)**	**(0.470)**	**(0.213)**
Dif(null, H=exogenous)	**(0.792)**	**(0.255)**	**(0.533)**	**(0.191)**	(0.059)	**(0.356)**
(b) IV (years, eq(diff))						
H excluding group	---	**(0.711)**	---	**(0.325)**	---	**(0.467)**
Dif(null, H=exogenous)	---	**(0.175)**	---	**(0.331)**	---	**(0.204)**
Fisher	**168.45*** **	**2538.88*** **	**113.66*** **	**371.68*** **	**173.60*** **	**9183.85*** **
Instruments	20	28	20	28	20	28
Countries	38	34	38	34	36	31
Observations	321	255	318	252	272	221

***,**,*: 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. The mean value of mobile phone penetration is 45.330, the mean value of internet penetration is 7.676 and the mean value of fixed broad band subscriptions is 0.643. na: not applicable because at least one of the estimated coefficients needed for the computation of net effects is not significant. nsa: not specifically applicable because the model does not pass post-estimation diagnostics tests.

5. Conclusion and future research directions

This study has assessed how enhancing information and communication technology (ICT) affects life insurance and non-life insurance in a panel of forty-eight African countries with data for the period 2004-2014. The adopted ICT dynamics are: mobile phone penetration, internet penetration and fixed broadband subscriptions. The empirical evidence is based on Generalised Method of Moments. The results show that enhancing mobile phone penetration and fixed broadband subscriptions has a positive net effect on life insurance consumption while enhancing fixed broadband subscriptions also has a positive net effect on non-life insurance consumption.

This study has been partly motivated by the fact that there is a great potential for ICT penetration in Africa. As a continent with an emerging market, it is also associated with a less established distribution network of technology, innovation and insurance which can have a substantial impact in such markets. Accordingly, the insurance sector offers development possibilities such as the use of new methods in the delivery of services as well as enhanced opportunities for fraud detection and data collection that can engender better mitigation measures and risk identification. The main implication of the study is that governments of sampled countries should consolidate existing policies that favor the penetration of ICT, notably, by promoting, *inter alia*: universal access mechanisms, low pricing facilities and sharing frameworks (such as public credit registries and private credit bureaus) and infrastructure.

Future studies can focus on country-specific effects using alternative estimation strategies. This recommendation builds on the caveat that the country-specific effects are eliminated by the GMM approach in order to control for endogeneity. Moreover, case studies can also be considered on insurance start-ups as well as on how the following phenomena are influencing the insurance industry, notably: block chain technology, data aggregation and the sharing economy.

Appendices

Appendix 1: Definitions of Variables

Variables	Signs	Definitions of variables (Measurements)	Sources
Insurance	LifeIns	Life Insurance Premium Volume to GDP (%)	FDSD
	NonLifeIns	Non-life Insurance Premium Volume to GDP (%)	FDSD
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
Remittances	Remit	Remittance inflows to GDP (%)	WDI
Government Expenditure	Gov. Exp.	Government Final Consumption Expenditure (% of GDP)	WDI

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	0.881	2.126	0.0006	12.220	346
Non Life Insurance	0.798	0.536	0.005	2.774	367
Mobile Phone Penetration	45.330	37.282	0.209	171.375	558
Internet Penetration	7.676	10.153	0.031	56.800	453
Fixed Broad Band	0.643	1.969	0.000	14.569	369
Remittances	4.313	6.817	0.00003	50.818	416
Government Expenditure	14.664	5.943	4.157	63.935	415

S.D: Standard Deviation.

Appendix 3: Correlation matrix (uniform sample size: 270)

ICT variables			Control variables		Insurance variables		
Mobile	Internet	BroadBand	Remit	Gov. Exp.	LifeIns	NonLifeIns	
1.000	0.701	0.598	0.077	0.223	0.250	0.221	Mobile
	1.000	0.676	0.248	0.184	0.132	0.339	Internet
		1.000	0.032	0.204	0.245	0.213	BroadBand
			1.000	-0.166	-0.230	0.051	Remit
				1.000	0.156	0.113	Gov. Exp.
					1.000	0.655	LifeIns
						1.000	NonLifeIns

Mobile: Mobile phone penetration. Internet: Internet penetration. BroadB: Fixed broad band subscriptions. Remit: Remittances. Gov. Exp: Government Expenditure. LifeIns: Life Insurance. NonLifeIns: Non Life Insurance.

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