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Does ICT diffusion contribute to Bank Stability in Africa?

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Abstract: Nowadays, all financial institutions rely on ICT diffusion in gathering, processing, analyzing and providing information to meet customers' needs. In an environment that is complex, competitive and dynamic, the diffusion of ICT in the highly information sensitive banking sector comes with mixed blessings especially in African context with under developed ICT tools. This article seeks to investigate the effects of information and communication technologies (ICT) diffusion on bank stability in Africa using a panel of 45 countries from 2004 to 2020. We employ the system GMM as well as a two step GMM method of estimation to check for robustness of the relationship between the variables. The results show a positive and significant relationship between ICT and bank stability. This implies that policies aimed at boosting ICT diffusion should not be neglected.

Keywords: ICT diffusion, Bank stability, panel GMM, Africa.

1. INTRODUCTION

Information and communication technologies (ICT) is referred to in literature as a vast range of computerized technologies which facilitates the capturing, processing, transmission and communication of information through electronic devices (mobile telephone, laptops, computers, television, radio) and also encompassing the use wireless intranet and satellite systems. ICT diffusion is the process of adoption and implementation of the above ICT tools by organizations to achieve desired results. The contemporary diffusion of ICT worldwide has brought about enormous movements in all aspects in the economic life of all countries. Hence ICT diffusion is currently at the heart of the global transformation (Ekwonwune et al., 2017; Adekunle and Rafiu, 2014; Ashrafi and Murtaza, 2008; Margaret, 2005).

In boosting economic growth and development through invention and innovations, and reducing information asymmetries and inequalities, ICT has impacts on several economic sectors. For example, empirical studies have shown that ICT diffusion significantly stimulates CO2 emissions (Avoma et al. 2020); alleviate poverty and reduce inequality when used as instruments for financial inclusion (Mushtaqa and Bruneau 2019; Tchamyoua et al. 2019); prove that it improves economic diversification and product complexity by being segmenting level of income and countries' trade (Rodríguez-Crespoa and Martínez-Zarzoso 2019).

The contribution of ICT to the banking industry has also been a pool of attention to many authors because banks play a major role in channeling funds from those with capacity to finance to investment. It has been a major prerequisite for banks in terms competitiveness both at the local and the global scenes since it directly affects banking products, bank performance and banking stability (Del Gaudio et al., 2020; Peterson, 2018; Ekwonwune et al., 2016; Hasan et al., 2012).

With respect to bank products, ICT has provided self-service facilities such as automated customer service machines from where potential customers can complete their account opening files online directly, hence making business interactions more efficient, less time consuming and no distance as a barrier (Adekunle and Rafiu, 2014; Buhalis, 2003; Spanos et al., 2001). Concerning bank performance, literature is almost conclusive of the fact that ICT has a positive effect on the financial performance of banks, arguing that this is due to the several of benefits offered by ICT to users and service providers alike (DeYoung et al., 2007; Hernando and Nieto, 2007).

On its part, banking stability remains a multifaceted concept with several dimensions that has no agreed definition. However, a majority authors who talk of banking stability think of it as the "absence of banking crises" (Brunnermeier et al., 2009; Segoviano and Goodhart, 2009; Peterson, 2018). Despite the absence of agreement on the definition, literature has investigated its determinants across the world and advanced that adequate capital, respect of micro and macro prudential norms and structural and institutional factors are the key determinants in developed economies (Brunnermeier et al., 2009; Barth et al., 2013; Demirgüç-Kunt and Detragiache, 2002; Caprio and Honohan, 1999). Meanwhile in developing economies and Africa in particular, the presence of foreign banks, proportion of banking sector in economy, banking concentration, bank competitiveness and efficiency, protection of investors and property right, regulatory quality, political stability, government effectiveness, control of corruption, level of unemployment and most especially the institutional environment are the major determinant of banking

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stability (Peterson, 2018; Fernández et al., 2016; Klomp and de Haan, 2014).

This empirical literature employed diverse measures of banking stability including banks' loan loss coverage ratio, bank size, insolvency risk, funding risk asset quality ratio, and level of bank concentration. Recent crises in the last few years across the globe and in Africa in particular have highlighted the fragility of African banking and finance sector. The economic shock of the COVID19 pandemic preceded by a wave of commodity and oil volatilities created epileptic exchange rate, structural and institutional failures that weaken the efficiency, performance and stability of banks (Peterson, 2018; Beck and Cull, 2013).

Considering the recent growth in technology and innovation, the role of ICT diffusion is considered to be a non-negligible instrument of banking stability. But unfortunately little is known about the contribution of ICT diffusion on banking stability in Africa. In Africa, ICT is diffusing and growing very rapidly. The rate of internet penetration has moved from 0.004% in 1991 to 26.43% in 2017, 43.1% in 2021 and 84.1% in 2022 for Morocco, being the highest in the continent and Seychelles in Sub-Saharan Africa (SSA) with 79% in 2022. The number of connections in the rest of the world rose from 3.2 to 6.6 billion, a rise of about 107%. According to IMF (2019), mobile banking has grown exponentially for the past ten years in Africa but SSA remains the only region in the world where only 10% of its GDP transactions occur through mobile and internet banking.

The motivation for this study is therefore threefold. First there is wide race to improve national infrastructures and access to ICTs worldwide because ICTs are now seen as drivers of trade and other derived activities (Ben Ali, 2022). Literature is recently devoted to articulating the importance of ICT in the improvement of the banking sector. Little is known about the contribution of ICT on bank stability in Africa. To the best of our knowledge, Asongu and Biekpe (2018) and most recently Ben Ali, (2022) are the only authors that has worked on ICT-banking industry that concerns African countries. This study contributes to this literature on ICT externalities in the banking sector, through the verification of transmission channels of fragility in the banking sector caused by the diffusion of ICT.

Secondly, this study complements prior studies in banking literature that primarily proxied bank stability using other measures excluding, *Z-score, Sharpe ratio, non-performing loans ratio and bank concentration ratio*. Z-score in particular which is has gained wider acceptance in the banking and finance literature and has been considered as an unbiased parameter of bank riskiness that is also called "distance to default" (Banna and Alam, 2021; Yin, 2019; Fang et al., 2014), we complement these measures by using proxies which are commonly applicable in African context more frequently like; *ATM per 1000 people, exchange rate and domestic credit* for bank stability with more recent data over the horizon 2004-2021.

Thirdly, comparing with other developing parts of the world like Asia which have a good level of ICT penetration, there is still high need for ICT penetration in Africa (Tchamyou et al., 2019; Penard et al., 2012). Meaning from a policy standpoint, insights gained from our study can help policy makers especially banking policy makers in African countries to capture challenges of ICT penetration and benefit from its diffusion in the banking sector for its growth and stability.

The results bring out compounding evidence to show that there is need to improve ICT in Africa so as to enhance banking stability in particular and growth as a whole. As opposed to other recent works on the study, this study employs more robust techniques such as the GMM method of estimation which helps in controlling for possible endogeneity and unobserved heterogeneity. The rest of this paper is organized in the following manner: Section two reviews the related literature; Section three describes the econometric strategy; Section four discusses the empirical findings and finally Conclusion and policy implications are provided in Section five.

2. LITERATURE REVIEW

2.1. Theoretical Review

Banking stability and the economic impact of the diffusion of ICT have been points of interest since the 1980s. Solow in 1987 brought up what is called the Paradox of Solow on ICT diffusion and adoption by arguing that the computer age everywhere but only in the productivity statistics (Solow, 1987). This argument of Solow divided the literature in to two strands; on one hand a strand of literature that attributes technological growth a negative role in terms of productivity (e.g., Ho and Mallick, 2010; Shu and Strassmann, 2005) and on the other hand a strand of literature that attributes a positive and significant correlation between ICT diffusion and productivity (e.g., Brynjolfsson and Hitt, 2000; Jorgenson and Stiroh, 1995; Oliner and Sichel, 1994). There are two main theories that try to explain the link between technological change (ICT) and banking performance and stability: *Resource-based and diffusion of Innovations theories*.

First, the Resource-based theory of Barney (1991) has the instincts that firms compete using a rare and valuable resource which determines their performance and consequently their stability. This valuable resource can be tangible: that is physical assets like plant, equipment, raw materials; or intangible like reputation, brand image and technical know-how (ICT). Therefore investment in ICT like the creation of ATM influences bank performance and consequently its stability.

Second, the diffusion of innovations theory of Rogers (1962) illustrates how and why new technologies spread quickly using five stages; knowledge, persuasion, decision, implementation and confirmation. These innovations have become key drivers in enhancing organizational performance. In the spirit of this theory, the rapidly changing business environment is not without consequences. ICT diffusion, adoption and implementation impact the stability of organizations including banks. To this effect some authors have advanced dynamic capabilities as a source to create and allocate resources to achieve competitive advantage in a rapidly changing world. That is to say entrepreneurs and managers should be proficient in the language of technology in other to be performant and stable (Yunis et al., 2017; Eisenhardt and Martin, 2000).

2.2. Empirical Literature

In empirical literature, the pioneer study on mobile telephone (a measure of ICT) on economic activities as a whole was carried out by Hardy in 1980. He showed that telephone plays a vital role on different economics sectors. More specifically, According to Segoviano and Goodhart (2009), banking stability is interdependent either directly or indirectly with the loanable funds market. It is directly dependent through the inter-bank deposits

market and indirectly dependent through lending to similar sectors. This means therefore that the relationship between ICT and bank stability has been investigated from two angles; the direct and indirect effect of ICT on banking stability.

2.2.1. Direct effects of ICT on Banking stability

Asongu and Biekpe (2018) were amongst the first authors to assess the contribution of ICT on the market power of the African banking industry. By using a sample of 42 African countries over the period 2001-2011, they performed four estimation techniques (instrumental variables fixed effect, Tobit regression, instrumental Quantile Regression and OLS) and found that when a certain threshold of mobile phone penetration is attained, ICT tends to decrease the market power of the African banking industry.

Del Gaudio et al. (2020) investigated the effect of ICT on the profits and risk of financial distress of the EU banking industry. Using a sample of 28 countries over the horizon 1995-2015, they found that ICT diffusion (ATM penetration) exerts a positive role in improving the performance of financial institutions and also in enhancing financial stability in the banking industry.

Most recently, Ben Ali (2022) recently studied the impact of ICT on the occurrence of banking crisis for a sample of 113 countries over the period 1996 to 2017 while considering the role of corruption and found that countries highly endowed with ICT can improve the resilience of the banking system and improve the stability when corruption is relatively low.

2.2.2. Indirect effects of ICT on Banking Stability: the transmission channels

Two potential channels emerge from literature. The first channel is financial development and the second is exchange rate. To begin with, financial sector has a deeper and wider application of ICT, because ICT diffusion can significantly improve the operating efficiency of financial institutions, hence the numerous studies on the relationship between ICT diffusion and financial development (Cheng et al., 2020).

Cheng et al., (2020), explored the relationship between financial development, ICT diffusion, and economic growth for a sample of 72 countries over the period 2000 to 2015 while considering the interlinkage of finance and ICT and found that passing through ICT, financial development would be unfavorable for economic growth in low income countries, but that ICT diffusion can improve economic growth in high-income countries with better level of financial development. This disagreed to some extent with the earlier study of Das et al. (2018) who examined the effect of ICT on financial development using the GMM method in forty-three developing countries over the horizon 2000-2014, and found that the economic growth of low-income countries can improve, but not in lower middle-income countries. In the same vein, Shamim (2007) earlier used a panel data of 61 countries from 1990-2002 in trying to look at the interactive effect of ICT and financial development on economic growth, found that a greater number of mobile phone subscribers and Internet users can increase financial depth which is good for economic growth.

With this few recent studies not being unanimous, it gives room for more investigations to carry out on not only the interactive relationship between ICT and financial performance to affect economic growth, but also on the effect of this interactive relationship on the stability of banks. Hence, to improve the weak points of this literature, our paper makes use of domestic credit to private sector to capture the generalized effect of financial development on sample with similar characteristics of the level of ICT diffusion and level of financial depth. Based on the above, our dataset composed of 45 African low and middle income countries will verify the effect of ICT diffusion on bank stability in Africa.

3. THE EMPIRICAL STRATEGY

In this section, we justify our estimation technique and the empirical model (3.1). Secondly, we present the data used to compute the results (3.2).

3.1. Econometric approach and empirical model

3.1.1. Econometric Approach

We adopt the General Method of Moment (GMM) for dynamic panels. This is because the panel data used in this paper includes lagged explanatory variables as independent variables in the empirical model. The GMM for dynamic panels resolves issues associated with endogeneity, inverse causality and omitted variables that appear when studying the relation between ICT and banking stability. In this paper we choose to adopt the system GMM estimator suggested by Blundel and Bond (Blundell & Bond, 1998) over the Arellano and Bond (1991) first difference GMM estimator because our sample is finite and we use lagged first differences of the dependent variable as instruments in the level equations.

Nonetheless, a sudden increase of instruments may over fit endogenous variables and therefore requires testing for these issues in the estimation techniques. In addition to adopting the system GMM model for dynamic panels, we also run a two-step GMM model to check for the robustness of the results and the presence of a simultaneity bias between ICT diffusion and bank stability. Banking stability is likely to be influenced by ICT diffusion because its institution gives rise to diversification and better efficiency in the banking sector.

3.1.2. Econometric Model

In this manuscript, we suggest an empirical model that is a combination of both behavioral and causal theories because results obtained seek to provide insight into (a) identifying effects of ICT diffusion on banking stability with the need of suggesting policies that enact effective programs that target the banking sector and (b) the need to evaluate causes of instability in banks and its relationships with clusters of significant factors (social, economic, and others) in order to attenuate causes or consequences of bank instability associated with poor ICT diffusion. The econometric model we adopt in this study is expressed as equation 1:

$$BS_{it} = \propto_0 + \propto_1 BS_{it-1} + \propto_2 ICT_{it} + \propto_3 RegQ_{it} + \propto_4 GDPper_{it} + \propto_5 Unemp_{it} + \propto_6 FD_{it} + \gamma_t + \mu_i + \varepsilon_i$$

Where BS_{it} refers to banking stability of a given country I (i=1,2,….45) at time t where t=2004-2021. BS_{it-1} is the lagged variable for banking stability. ICT_{it} is a vector of information and communication technology variables that alternatively enter in the regressions to avoid possible problems of multicollinearity. More specifically, this vector is represented by variable such as; internet penetration which is a percentage of internet users in relation to the population, mobile phone which represents the number of cellular subscriptions per 1000 inhabitants. The study also apply the use of control variables such as regulatory quality ($RegQ_{it}$), inflation

(Inf_{it}), gross domestic product per person employed (GDP_{it}), and financial development (FD_{it}). $\gamma_t + \mu_i + \varepsilon_{i,t}$ is the decomposition of the fixed effects of the error term with γ_t and μ_i representing time and the individual specific effects. ε_{it} is presumed to be uncorrelated with the initial condition and individual effects μ_i for all t.

3.2. Data Description

We used data in the current study gathered from the World Development Indicators that was published by the World Bank. The dataset contains yearly data from 2004 to 2021 on the banking industry of 45 African countries. This article adopts a panel data relating to ICT which has been available since the 1990s. Table 1 below gives a grid display of some descriptive statistics of the main variables that proxy banking stability and ICT diffusion. The study made use of mobile phone subscriptions, internet penetration rate as proxy variables for ICT which is the independent variable of the study. Bank stability was measured using the *ATM per 1000 people*. The study also made use of control variables such as regulatory quality, GDP per person employed, domestic credit and the rate of unemployment. We obtain 810 observations (N = 45 and T =18). The list of the 45 countries is reported in A1 in the Appendix.

Table 1 reports that on average, the rate of mobile phone subscription for our panel of 45 African countries over the period 2004 to 2021 was 62.60 for every 1000 inhabitants. Disparities observed for mobile phone subscription indicates that countries like Botswana, Guinea, Mali, Namibia, Togo, and Zimbabwe reported more than 100 subscriptions per 1000 inhabitants over this period. In terms of internet penetration rate which is a percentage of internet users in relation to the population, it can be seen that the average rate stood at 16.15% with Cape Verde, Morocco and Zimbabwe having the highest values for this variable of more than 40%. Regarding the of use of ATM, Table 1 indicates an average of 10.92 with countries like South Africa, Namibia and Mauritius having the highest values within the period of study.

Table 1: Summary statistics (2004-2021)

Variables	obs	Mean	Std.Dev.	min	max
ATM	810	10.92551	14.61293	.0195827	72.9469
Mobile_phone_subscription per 100 inhabitants	810	62.60237	43.61542	.2065496	185.5593
Internet_penetration_rate	810	16.15793	18.72063	.0310112	103.9746
Dom_Credit	810	23.96507	25.68244	1.095236	142.422
RegQuality	810	-.706760	.599353	-1.84905	1.056674
GDPpers	810	13291.23	17267.77	20.26153	113013.1
Unemploy	810	7.993085	6.494978	.32	28.77

Note: obs: Observations; Std.Dev: Standard deviation; Min: Minimum and Max: Maximum.

Source: Computed by authors using data from World Bank (WDI, 2022)

An analysis of domestic credits reveals an average of 23.96 over the period of 2004 to 2021 and countries like South Africa, Tunisia and Egypt recording high rates of domestic credits. Appraising the level of regulatory quality in the study area, we observe an average of -0.706 with countries like Angola, Chad and Burundi having very weak levels of regulatory quality. Concerning the other variables over the period under review, GDP per person employed recorded an average of 13291.32 and the average rate of unemployment stood at 7.99.

4. EMPIRICAL EVIDENCE AND DISCUSSION

In this section, we first compute correlation coefficients for the different variables in Table 2. Our initial findings suggest that ATM and the variables of bank stability are positively and significantly correlated. Prior to running the GMM estimates for the empirical models, we test whether the variables are stationary using the test elaborated by Im, Pesaran and Shin (2003). Preliminary results conclude that all the variables used in our analysis are stationary. We also comment on results using the system GMM and the two step GMM

4.1. Correlation results

Table 2 below shows the matrix of linear correlations that exists between the different variables of the study. Generally speaking, it can be noticed that all the independent variables have a significant and positive relationship with the banking stability. This is seen on the table below.

Table 2: Correlation Matrix

Variables	ATM	Mobile_phone_subscription	Internet_pen_rate	Dom_Credit	RegQuality	GDPpers	Unemploy_Rate
ATM	1.0000						
Mobile_phone_subscription	0.1441	1.0000					
Internet_pen_rate	0.5345	0.3679	1.0000				
Dom_Credit	0.8095	0.0730	0.5028	1.0000			
RegQuality	0.6324	-0.0697	0.3336	0.6648	1.0000		
GDPpers	0.4043	-0.0158	0.3031	0.3809	0.1395	1.0000	
Unemploy_Rate	0.6028	-0.0639	0.3437	0.4333	0.3835	0.4858	1.0000

Source: Computed by authors using data from World Bank (WDI, 2022)

A closer look at the table shows that shows that there exists a positive linear correlation that exists between the different variables of the study. Table 2 shows that mobile phone subscription and internet penetration which are proxies of ICT are positively correlated with banking stability (ATM). It is equally seen that domestic credit is the most highly correlated variable with ATM. This is closely followed by regulatory quality and GDP per person employed.

4.2. Presentation of Baseline Results

Table 3 shows the baseline results obtained from the estimation. The study made use of the Fixed effects, Random effects as well as the system GMM.

Table 3: Estimation Results

Dependent Variable: ATM			
Variables	**FE**	**RE**	**System GMM**
ATM_L1			0.5056522***
			(0.892203)
Mobile_phone_subscription	0.0388345***	0.0298685***	0.0189659***
	(0 .0088053)	(0.0081079)	(0.0037807)
Internet_penetration_rate	0.1149793***	0.106651***	0.151508*
	(0 .0207781)	(0.0200135)	(0.0090551)
Dom_Credit	0.1458817 ***	0.2990059***	0.2060610***
	(0 .0386949)	(0 .0280911)	(-0.336237)
RegQuality	-0.1433365	2.52833**	1.495639***
	(1.223787)	(0.9769702)	(0.2827920)
GDP_per_person	0.0000384	0.0000662*	9.55e-06**
	(0 .0000522)	(0 .0000357)	(5.71e-06)
Unemployment_Rate	0.0779459	0.4144073***	0.2803054***
	(0.1491671)	(0 .1048232)	(0.0446678)
Constant	1.576363 ***	-1.743944 ***	-1.714992***
	(1.696631)	(1.448421)	(0.4353866)
sigma_u	9.5420369	4.2739501	
sigma_e	4.598323	4.598323	
Rho	0.81153736	0.46348851	

Note: Standard errors in parentheses: ***p<0.01 ; ** p<0.05, * p<0.1. Abbreviation: FE fixed effect: RE random effect and System GMM: system generalized method of moments

Source: Computed by authors

From the results of the study above, it can be seen that the main variables of the study which are mobile phone subscription internet penetration and domestic credits have a positive and significant effect on banking stability. The results are consistent depending on the model used in running the regression be it FE, RE or SGMM. All the variables are significant at 1% level. Table 3 also reports that the lagged value for ATM relates positively and significantly with all the variables of the study. This shows that higher ICT diffusion positively impacts banking stability. These results are consistent with Ben Ali (2022) who equally found similar results on the subject matter.

4.3. Robustness Results

To ensure that the results of the study are reliable, we run a robustness test using the 2 step GMM model to confirm the aforementioned results in table 4.

Dependent Variable: ATM			
Method: 2 Step GMM			
Variables	**Coeff.**	**SE**	**Z-Stat**
ATM_L1	0.8017203***	0.1263576	6.34
Mobile_phone_subscription	0.0122454**	0.005251	2.33
Internet_penetration_rate	-0.0451699*	0.0266572	-1.69
Dom_Credit	0.0894550	0.409366	2.19
RegQuality	1.044219*	-0.5104837	2.05
GDP_per_person	0.0000155**	7.36e-06	2.10
Unemployment_Rate	0.1461815**	0.633449	2.31
Constant	-0.2696054	0.5227919	-0.52

Note: ***p<0.01 ; ** p<0.05, * p<0.1. Abbreviation: Coeff: Coefficient; SE: Standard error
Source: Authors' computation, 2023

The results of the model in table 4 above show that the sign and significance of the coefficient of our independent variables are the same for as the results in table 3. However, it can be seen that internet penetration has a negative effect on ATM. This phenomenon can be explained by the fact that an increase in internet services has led to the institution of mobile banking and other methods of banking which do not necessitate the use of ATM. The results show that mobile subscription, GDP per person and Unemployment have significant levels of 1%, internet penetration and regulatory quality are significant at 5% levels. This therefore goes to verify our hypothesis that ICT diffusion has a positive effect on Banking stability in Africa.

5. Conclusion

Although technological innovation is usually seen to act as a booster for an economy as a whole, the effects and the relative importance of IT, precisely in the banking sector, there still exists a divide in the literature concerning this issue. The role of ICT diffusion in improving banking stability has been attentively treated in already existing literature (e.g., Hasan et al., 2012, Casolaro and Gobbi, 2007, Berger, 2003 a, b), although compounding evidence on its influence as a booster to banks' profits and lowering their risk profiles is relatively scarce and, in some cases, shows divergent results.

The aim of this paper is to investigate whether ICT diffusion acts as a panacea in the regulation of the banking industry in Africa using a panel of 45 countries over the period of 2004 to 2021. In a precise manner, we test whether ICT affects the ATM of the banking industry by boosting performance or enhancing the dissemination of information. We first run a FE, RE and a system GMM method between ICT and banking stability. Secondly, we run a robustness check using the two step GMM. We find evidence that the use of ICT through internet penetration and mobile phones increases banking stability in Africa. The findings imply that changes in ICT improves the performance of the banking industry in relation to the ATM services accorded which improves the level of banking activities and thus improves banking stability. Our results are consistent with existing literature.

Based on the aforementioned results, we suggest that the banking sector should do more of staff downsizing and staff retraining so as to combat the numerous difficulties faced by banks as a result of the modernization of the IT structure. Also, by virtue of the fact that the banking sector is subject to strict and stiff regulations, policy makers should propose flexible regulations to this heavily regulated sector in view of incorporating technological changes. Thus, possible policies that can be drawn from this manuscript and aimed at improving ICT diffusion for the stability of banks in Africa is value addition.

Future studies should take into account studying the effect of ICT on banking stability while taking into account certain mediating or moderating variables like institutions and ethnicity or cultural diversity. Also, the scope of the study can equally be widened to the world at large making a differentiation between developing and developed countries.

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