Relationship between Financial Innovations Adoption and Financial Deepening Of Commercial Banks in Kenya

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Abstract
Technological innovation has conceived digital financial products which has enhanced access to financial banking services. These financial innovations have altered traditional banking services and its ultimate value addition to financial services cannot be ignored. Consequently, the current study was undertaken with the general objective as establishing relationship between financial innovations adoptions and financial deepening of commercial banks in Kenya. Mainly, the study explored the relationship between mobile banking, ATM banking, online banking and internet banking and commercial banks financial deepening. In addition, moderating effect of bank size on the relationship between financial innovations adoption and commercial banking financial deepening was examined. The study was anchored on innovation diffusion, technology acceptance model, agency and constraints induced innovation theory. Target population comprised of 41 commercial banks licensed and operational in Kenya. Panel secondary data was collected through use of document check index. Inferential and descriptive statistics were adopted for data analysis. Positive significant relationship between mobile phone banking, automated teller machine, online banking, agency banking and financial deepening were reported. Bank size had positive moderating effect on financial deepening of Commercial banks in Kenya. It was recommended that government ought to develop polices geared towards adoption of financial innovation to amplify access to financial services. There is need to invest on internal controls and security management to mitigate against risk exposure due to alternative service provision strategies.
Key words: Financial deepening, Financial innovations, Agency banking, ATM banking, Online banking, Mobile banking.

Date of Submission: 28-09-2020   Date of Acceptance: 10-10-2020

I.   Introduction
Recently business environment has become very turbulent owing to influx of technology in decision making and ease of transferring information amongst stakeholders. Consequently, there is decreased information access costs and development of strategic business solutions which are customized to addressing unique customer needs. Banking sector have not lagged behind and has persistently incorporated information communication technology, thus altering tradition banking operations (Adewoye, 2013). Business competition has too intensified and can be deemed too complicated due to globalization. Hence, demand for banking services to match recent trends is unavoidable otherwise commercial banks has to shrink and ultimately close down (Aker, 2010).

Commercial banking financial innovations have adopted hierarchical approach from ATM, online banking, mobile banking and agency banking (Adunda & Kalunda, 2012). Although, these efforts are geared towards enhancing commercial banks performance their contribution in financial deepening cannot be overlooked due to alteration on banking loans and savings. According to Central Bank of Kenya (CBK), these innovations have been achieved courtesy of technological development in hardware, software and telecommunications. It is worth noting synchronization of commercial banking services has amplified financial deepening since customers can open and operate their accounts without physical banking visits (CBK, 2014).

According to Kithuka (2012) financial innovations have endeavored to match information and communication technology advancement. It is worth noting that financial innovations have deployed hierarchical approach on incorporation and introduction of new financial products such as ATM, internet banking, agency banking and mobile banks. Due to these changes commercial banks has persistently reduced their operational costs and amplified their profit capacity. Mwangi (2013) attributed these changes to continued liberalization in the financial sectors for example National Payments Systems Act 2011 enabled commercial banks to interlink their services with point of sale systems and mobile payments platforms. This has escalated

contribution of innovation on commercial banking service provision and its paramount to note that ATM growth and penetration in Kenya is overwhelming to 2381 in 2013 from 100 in 2000 (Okoro, 2014).

Statement of the Problem

Commercial banks are not immune of competition from other stakeholders in financial system. Hence, the wave of financial innovation CBK (2014), banks in Kenya are now facing exorbitant operational costs, management inefficiencies and liquidity difficulties characterized by mergers, restructuring, acquisitions and closure of banks in a span of nine months among them; Imperial bank, Chase bank, Dubai bank.

There is no empirical coherence on the influence of financial innovations on financial deepening of commercial banks for example Gennaioli, Shleifer and Vishny (2012) did a study on neglected risks, financial innovation and financial fragility found that the benefits of financial innovation promote greater efficiency and facilitates the smooth consumptions and investment decisions with considerable benefits to clients. Lerner and Tufano (2011) attributed it to escalation on transactions and ease of information management and they recommended need for subsequent enquiry to authenticate its contribution on financial access more so with emergence of technology driven products. In Kenyan context (Ngumi, 2014; Mwangi, 2013) relied on primary data and found that innovations had significant contribution on profitability. There was no consensus between theoretical and empirical findings since some were positive, negative, significant or non-significant.

It is paramount to note that despite of these studies being carried out there are glaring methodological challenges attributes to subjective sampling procedure, fitting regression model with no classical regression results. It is against this backdrop this paper examined relationship between financial banking innovations adoption and financial deepening of commercial banks in Kenya.

General Objective

The main objective of the study was to examine the relationship between financial banking innovations adoption and financial deepening of commercial banks in Kenya.

Specific Objectives

Specifically, the following objectives guided the study:
  i. To determine the relationship between mobile phone banking and financial deepening of commercial banks in Kenya.
 ii. To examine the relationship between ATM banking and financial deepening of commercial banks in Kenya.
iii. To establish the relationship between online banking and financial deepening of commercial banks in Kenya.
 iv. To find out the relationship between agency banking and financial deepening of commercial banks in Kenya.
  v. To determine the moderating effect of bank size on the relationship between financial innovations adoption and financial deepening of commercial banks in Kenya.

Research Hypotheses

The following hypotheses were adopted in the study:

Ho_1: There is no significant relationship between mobile phone banking and financial deepening of commercial banks in Kenya.

Ho_2: There is no significant relationship between ATM and financial deepening of commercial banks in Kenya.

Ho_3: There is no significant relationship between online banking and financial deepening of commercial banks in Kenya.

Ho_4: There is no significant relationship between agency banking and financial deepening of commercial banks in Kenya.

Ho_5: There is no significant moderating effecting of bank size on the relationship between financial innovation and financial deepening of commercial banks in Kenya.

II. Empirical and Theoretical Review

Theoretical Review

Innovation Diffusion Theory

Innovation diffusion theory was stipulated by (Rogers, 1962). Theory argues that any institutions aiming to achieve growth must be willing to undertake innovations. This theory posits that there are five key attributes of innovations; improvement of current modes operandi, consistent approach to performance, pre-testing capacity and ease to observe any shortcoming (Frame & Scott, 2001). Institutions have capacity to gain competitive advantage and minimize operational costs courtesy of innovations. Further, institutions would easily penetrate new markets and discover alternative means of serving their customers. Gardachew (2010) argued that

they innovation benefits are not void of challenges such as exposure to security threats, resistances from management and customers, complex approach to current situations and need for drastic replacements due to dynamic and sporadic technological changes.

There is need for commercial banks innovation to be enhanced by mobile phone penetration. Mobile phone penetration would minimize commercial banks performance and eradicate the need for opening of bank branches. It would be economical for commercial banks to incorporate innovative services to minimize service time and amplify penetration of financial services.

Agency Theory

Agency theory was put forth by (Jensen & Meckling, 1976). The theory argued that there is need for separation of ownership and management of an institution. Adoption of this management approach will lead to increased operational costs due to monitoring and agency costs. This may escalate conflict between relevant stakeholders and ultimately minimize gains to be accrued from an investment. This will discourage investment and mutate agency conflicts. Commercial banks are propelled by desire to maximize shareholder's wealth and profitability. This can be achieved through reduction in operational costs and enhancement in access of banking and financial services incorporate technological innovations to enhance quality of service provision.

The theory is relevant for the study since there is need for commercial banks to amplify financial services access. Through internet and online banking services banking customers will not only access financial services faster but also efficiently. The biggest threat is risk exposure they would face especially when coerced to execute transactions against their wish. Further, though online there is reduced paperwork and accounting opening process is shorted and this ultimately enhances quality of services accorded to customers who would ultimately spread positive news which may end up fostering customer's recruitment drives.

Empirical Review

Too, Ayuma and Kemboi (2016) examined role of financial innovation and performance in Kapsabet. Descriptive research design was applied and primary data gathered using semi structured questionnaires. Quantitative data was analyzed through inferential and descriptive statistics. Classical regression and correlation revealed positive and significant effect of mobile banking loans, mobile banking funds transfer, mobile payments and commercial banks performance. It was concluded that there is need for commercial banks to develop measures to access unbanked population since this would enhance banking penetration. From the findings it can be deduced that commercial banking financial innovations has the capacity to include many on its platform courtesy of alternative products and services. Although, classical regression modelling was adopted none of classical regression assumption was tested and this would have created possibilities of drawing biased conclusions.

Abdullahi and Nyaoga (2017) investigated the effect of automated teller machines usage and operational performance of commercial banks in Nakuru County. Univariate and bivariate data analyzed the data. There was positive causal effect of ATMs usage on commercial banks operational performance in Nakuru county. It was observed that customers executed alternative banking transactions through their ATMs. Although, classical regression analysis was adopted in the study, it failed to report any classical regression assumption, this had likelihood of increasing possibilities of drawing biased findings.

Nyang'ate (2015) examined the effect of electronic banking technologies on commercial banking performance in Kenya. Panel correlation research design was adopted. Secondary data of 44 commercial banks was gathered for a five-year period. Classical regression modelling was adopted to analyze the data. It was found that ATM banking innovations had positive significant effect on commercial banks performance. It was concluded that banking penetration and inclusion could be achieved if commercial banks integrated their ATM platform to ease access of their services from their competitors. It was appropriate to carry out diagnostic tests associated with panel data so to minimize likelihood of fitting spurious regression models.

Mbugua and Omagwa (2017) investigated the effect of agency banking on financial performance of commercial banks in Embu County. Descriptive research design was adopted. Stratified sampling was adopted to select respondents from different levels of banking management. Primary data was collected through use of semi structured questionnaires. Inferential and descriptive statistics were adopted to analyze quantitative data. Positive and significant effect of agency banking on financial performance was reported.

Kingori and Gekara (2015) investigated the effect of agency banking on commercial bank performance in Thika municipality. Purposive sampling and cross-sectional research design were adopted. Primary data was collected using semi-structured questionnaires. Univariate and bivariate analysis was adopted. Regression analysis revealed positive and significant effect of agency banking on commercial banks performance. It was concluded that there was increased access to banking services especially amongst those working in the informal sector since they could easily access banking services within their areas of operations.

Conceptual Framework

Conceptual framework is diagrammatic presentation of relationship that exists between study variables (Kombo & Tromp, 2009). It was assumed that mobile phone banking, ATM banking, online banking and agency banking have relationship with financial deepening of commercial banks as shown in Figure 2.1. Firm size was hypothesed to have moderating effect on the relationship between financial banking innovation adoption and financial deepening of commercial banks in Kenya.
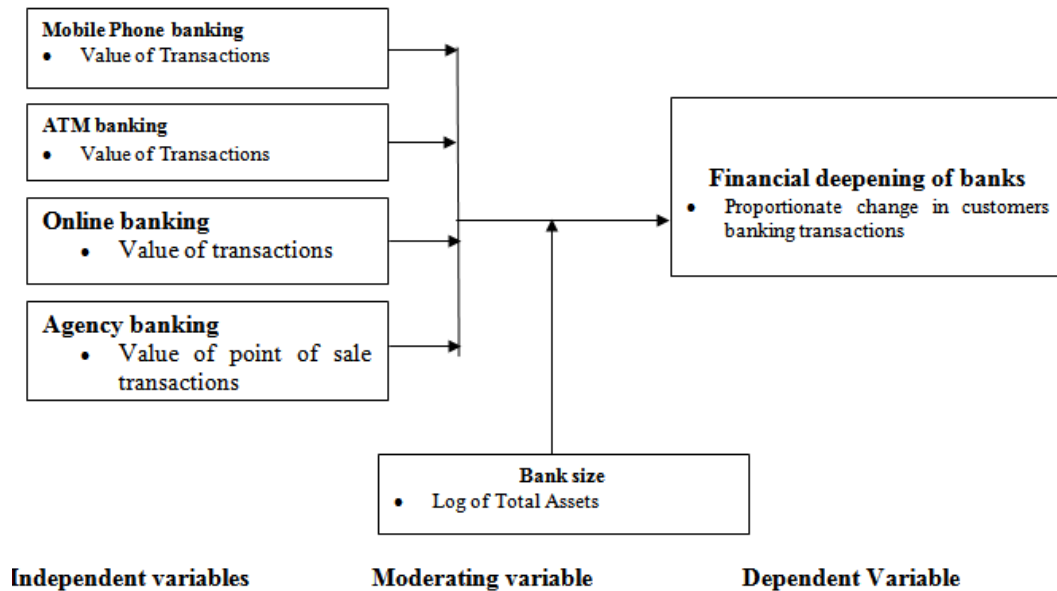
Figure 2.1 Conceptual Framework

III. Research Methodology

Research Design

Research design is perceived as the logical flow of how the study will be executed (Nachmias & Nachmias, 2004). Expo facto research fits those studies which endeavor to find causality between independent and dependent variables. It was adopted to describe financial innovations carried out by commercial banks and show how they influence financial deepening in Kenya.

Target Population

Target population for a study emanates from consolidation of all elements under consideration (Kombo & Tromp, 2009). Currently, the target population comprised of 41 commercial banks licensed and operating in Kenya as at 31/12/2017. Amongst 41 commercial banks, one was mortgage based, 30 locally owned, three publicly owned, 26 were private and 13 foreign based. Further, classification showed that 11 were listed in Nairobi securities exchange and the rest none listed. Moreover, eight banks were in tier one, 20 in tier two and 15 in tier three. Census of 41 commercial banks was adopted.

Data Collection Instruments

Secondary data was used in the study. Annual banking report by CBK was the main source document for secondary data. Data collection was applied for data collections and this was in line with past studies such as Githira and Nasieku (2015) and Tarus and Omandi (2013) who adopted similar approach to consolidate secondary data for their analysis.

Data Collection Procedure

The researcher obtained a letter from the Department of Economics, Commerce and Accounting, JKUAT to enable the researcher to seek a research permit from the National Council for Science, Technology and Innovations. Secondary data was gathered from annual banking reports prepared by central bank of Kenya and where information was missing respective annual statements of banks was considered as data source document.

Data Processing and Analysis
Data gathered was cleaned, coded, entered into computer and analyzed. Descriptive statistics included mean, standard deviation, minimum, maximum, kurtosis and skewness. Inferential statistics had Pearson correlation and regression analysis. The multiple regression model for the study were:

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \varepsilon_{it}$$ .... Equation 3.1

Model   with   moderation

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 Z_{it} + \beta_6 X_{1it} Z_{it} + \beta_7 X_{2it} Z_{it} + \beta_8 X_{3it} Z_{it} + \beta_9 X_{4it} Z_{it} + \varepsilon_{it}$$

Where; Y_{it} represent Financial Deepening of Commercial banks
X_{1it} represent Mobile phone banking (MB) for bank i in period t;
X_{2it} represent ATM banking (ATMB) for bank i in period t;
X_{3it} represent Online banking for bank i in period t;
X_{4it} represent Agency banking for bank i in period t;
Z_{it} represent Bank size for bank i in period t
$X_{it}*Z_{it}$ represent interaction between respective independent variable with bank size for bank i in period t.

Before fitting regression model, it was necessary to carry out diagnostic tests to minimize likelihood of fitting spurious regression model. Unit root was tested using inverse chi squared, inverse normal, inverse logit and modified inverse chi-squared. Multicollinearity was tested using variance inflation factors and tolerance limits, heteroskedasticty was tested through use of Breusch-Pagan test, serial correlation was tested using Woodridge test and Hausman test was applied to ease choice between random and fixed effects model.

IV. Findings and Discussion
4.1 Descriptive Statistics for Commercial Banks in Kenya
Descriptive statistics adopted in the study included measures of central tendency and dispersion. Study findings in Table 4.1 revealed that average financial deepening was 13.39, with an average deviation of 13.72. There was wider variation in average financial deepening amongst banks as accounted by minimum of -28.58 and maximum of 60. It was not normally distributed since p value for Jarque Berra test was less than 0.05, which presented enough evidence to warrant rejection of the null hypothesis at 5 percent which indicated that data was normally distributed.

The average mobile banking innovation was 13.89 with minimum of 1.24 and maximum of 30.30, there was minimal variations on mobile banking innovations across banks as accounted for 5.07, this may be attributed by increased penetration of mobile telecommunication hence it can be easily incorporated as tool for provision of banking services. On average ATM banking innovation was 16.26, there was skewed adoption of ATM banking innovation across banks with large banks executing their banking services through ATM as compared to small ones. This was confirmed by non-normality of its adoption. The average online banking innovation was 17.87, with minimum of 1.54 and maximum of 34.45, further, it was not normally distributed as depicted by Jarque Berra p value less than 0.05. On average agency banking was 17.17 with maximum of 40.58 and minimum of 1.17. Amongst banking agency banking innovation had the highest standard deviation of 7.11, which manifested non-uniformity of agency banking transactions amongst commercial banks in Kenya.

These results concurred with Adreniran and Junaidu (2014), Adetoi (2011), Akram and Allam (2010) who reported commercial banks had incorporated financial innovations to aid in provision of banking services, minimize operational costs and diversify their portfolio of banking services. This is in line with Vision 2030 which calls for provision of the highest portion of non-banked population. Commendable development is notable through decline in non-banked over the last ten years though telecommunication is credited to it.

Table 4.1 Overall Descriptive Statistics for Commercial Banks in Kenya

	Financial Deepening	Mobile Banking	ATM Banking	Online Banking	Agency Banking	Bank Size
Mean	13.39	13.89	16.26	17.87	17.17	17.61
Median	12.25	13.04	17.35	21.24	19.35	17.37
Maximum	60.00	30.30	30.68	34.45	40.58	36.96
Minimum	-28.58	1.24	1.05	1.54	1.17	9.77
Std. Dev.	13.72	5.07	5.82	6.66	7.11	3.81
Skewness	0.52	0.51	-0.52	-0.83	-0.19	1.94
Kurtosis	4.77	4.27	3.87	2.98	3.95	10.61
Jarque-Bera	38.08	23.82	16.39	24.52	9.28	657.34

Probability	0.00	0.00	0.00	0.00	0.01	0.00
Sum	2891.74	2999.34	3512.49	3860.71	3707.64	3803.17
Sum Sq. Dev.	40479.39	5536.97	7270.09	9529.78	10874.15	3121.51
Observations	216	216	216	216	216	216

4.1.1 Trend Analysis for Commercial Banks in Kenya

Graphical presentation in figure 4.1, examined trend analysis of financial deepening, mobile banking, ATM banking, online banking and agency banking. Financial deepening revealed irregular trends amongst banks between 2012 to 2017, there were upwards and downward cycles with some banks recording random patterns. Mobile banking innovation amongst banks was not constant with some banks recording increased adoption levels as compared to others, though some had downward trend in some periods which may be an indication of low market uptake which may be associated with banks customers' response.

ATM banking innovations amongst commercial banks had irregular patterns across banks within period under examination, the patterns were not consistent, this may be inferred that ATM banking was incorporated as per banking requirements which may have impacted its use amongst customers. Trend for agency banking and online banking were almost similar though agency banking was not dominant amongst some commercial banks as compared to others. Banking size differed amongst banks within period under examination with some banks being equivalent to several combined banks on asset base.
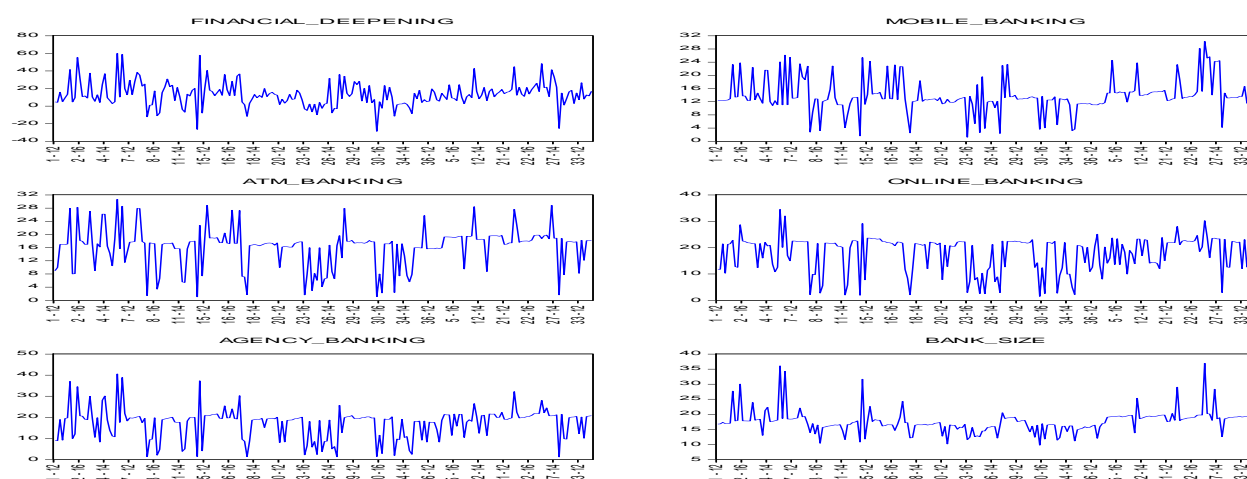

Figure 4.1 Trend Analysis for Commercial Banks in Kenya 4.2 Panel Diagnostic Tests

4.2.1 Panel Unit Root for Commercial Banks in Kenya

The null hypothesis for unit roots stated that there was unit root (the data was not stationary). Study findings in Table 4.2 revealed that there was enough evidence to warrant rejection of the null hypothesis at 5 percent level of significance since all p values were less than 0.05. Thus, we conclude that financial deepening, mobile banking, ATM banking, online banking, agency banking and bank size of commercial banks in Kenya were stationary at levels. Consequently, regression modelling without lagging was fitted with no likelihood of fitting spurious model. These findings are in tandem with Githira, Muturi & Nasieku, (2019b) and Muchiri, (2016) who found stationarity at levels while examining influence of firm financial characteristics and financial structure in EASE respectively.

Table 4.2 Panel Unit Root for Commercial Banks in Kenya

Variable	Test	Statistic	P value
Financial deepening	Inverse Chi-squared	256.487	0.0000
	Inverse Normal	-7.9537	0.0000
	Inverse logit	-10.058	0.0000
	Modified Inverse chi-squared	15.3739	0.0000
Mobile banking	Inverse Chi-squared	345.0278	0.0000
	Inverse Normal	-6.6734	0.0000
	Inverse logit	-12.9071	0.0000

	Modified Inverse chi-squared	22.7523	0.0000
ATM banking	Inverse Chi-squared	343.7775	0.0000
	Inverse Normal	-7.9477	0.0000
	Inverse logit	-14.2693	0.0000
	Modified Inverse chi-squared	22.6481	0.0000
Online banking	Inverse Chi-squared	409.3941	0.0000
	Inverse Normal	-8.112	0.0000
	Inverse logit	-16.3711	0.0000
	Modified Inverse chi-squared	28.1162	0.0000
Agency banking	Inverse Chi-squared	373.6859	0.0000
	Inverse Normal	-7.6865	0.0000
	Inverse logit	-14.6215	0.0000
	Modified Inverse chi-squared	25.1405	0.0000
Bank size	Inverse Chi-squared	403.088	0.0000
	Inverse Normal	-8.1924	0.0000
	Inverse logit	-16.1729	0.0000
	Modified Inverse chi-squared	27.5907	0.0000

4.2.2 Multicollinearity Test for Commercial Banks in Kenya

Classical modelling assumes none of independent variable is highly correlated with each other. Variance inflation factors (VIFs) and tolerance were adopted to test for multicollinearity. According to Woodridge (2012) independent variables are not collinear if none of its tolerance exceed 10 or tolerance limit is less than 0.1. As shown in Table 4.3, none of VIFs exceeded 10 or tolerance limits was less than 0.1. Consequently, there was no collinearity amongst independent variables and mobile banking, ATM banking, online banking and agency banking were jointly fitted to examine their relationship with financial deepening of commercial banks in Kenya.

Table 4.3 Multicollinearity Test for Commercial Banks in Kenya

	Collinearity Statistics	
	Tolerance	VIF
Mobile Banking	0.415	2.410
ATM Banking	0.247	4.050
Online banking	0.213	4.697
Agency Banking	0.133	7.533

4.2.3 Correlation Analysis for Commercial Banks in Kenya

Product Moment Pearson correlation coefficient was fitted to examine the strength of relationship between financial innovations and financial deepening of commercial banks in Kenya. Results shown in Table 4.4, depicted strong positive significant relationship between financial deepening and mobile banking in Kenya (rho = 0.7871, p value <0.05). Secondly, there was strong positive significant relationship between ATM banking and financial deepening of commercial banks in Kenya (rho = 0.8002, p value <0.05). Thirdly, there was strong positive significant relationship between online banking and financial deepening (rho = 0.7795, p value <0.05). Fourthly, there was strong positive significant relationship between agency banking and financial deepening (rho = 0.8506, p value <0.05). Fifthly, there was strong positive significant relationship between bank size and financial deepening (rho = 0.7772, p value <0.05).

These findings agreed with Adenerian and Junaidu, (2013) who reported strong positive relationship between mobile banking and financial inclusion in Malaysia. Also, they agreed with Too et al., (2016) who reported positive effect of financial innovation on financial access in Kapsabet. Moreover, the study concurred with Hasan et al., (2012) reported positive contribution of internet banking on banking market penetration in Italy.

Table 4.4 Correlation Analysis for Commercial Banks in Kenya

	Financial Deepening	Mobile Banking	ATM Banking	Online Banking	Agency Banking	Bank size
Financial Deepening	1					
Mobile Banking	0.7871	1				
	0.0000	-----				
ATM Banking	0.8002	0.2058	1			
	0.0000	0.0000	-----			
Online Banking	0.7795	0.2643	0.3787	1		
	0.0000	0.0000	0.0000	-----		
Agency Banking	0.8506	0.3784	0.5389	0.4882	1	
	0.0000	0.0000	0.0000	0.0000	-----	
Bank Size	0.7772	0.0726	0.4630	0.5975	0.3732	1
	0.0000	0.0000	0.0000	0.0000	0.0000	-----

4.2.4 Panel Heteroskedasticity for Commercial Banks in Kenya

Classical modelling assumes uniformity of error terms amongst variables under examination (Baltagi, 2005). Even if failure to meet this condition has no likelihood of yielding biased findings, they have tendency to increase likelihood of rejecting null hypothesis due to decreased t statistics and increased standard errors. Breusch Pagan was applied to test for heteroskedasticty. In this test, null hypothesis stated that there is uniform variance across error term. Results in Table 4.5 had p value < 0.05, for non-moderated and moderated models respectively revealed that there was enough evidence to warrant rejection of the null hypothesis and conclusion that the data was not homoscedastic. This was solved through use of robust standard errors (Githira, et al., 2019a).

Table 4.5 Panel Heteroskedasticty for Commercial Banks in Kenya

Model	χ^2–Value	P value
Without Moderation	313.71	0.00
With Moderation	1117.91	0.00

4.2.5 Panel Serial Correlation for Commercial Banks in Kenya

Classical modelling also assumes that error terms are not serially correlated. This was examined through Woodridge test. The null hypothesis is depicted through high coefficient of determinations and small standard errors. According to Woodridge (2012) presence of first order serial correlation is managed through use of fixed generalized least squares. As shown in Table 4.6, p values for moderated and non-moderated models were greater than 0.05, which depicted first order serial correlation was absent.

Table 4.6 Panel Serial Correlation for Commercial Banks in Kenya

Model	F–Value	P value
Without Moderation	0.312	0.562
With Moderation	0.526	0.239

4.2.6 Panel Granger Causality Test for Commercial Banks in Kenya

Granger causality was applied to evaluate causality between banking financial innovations and financial deepening of commercial banks in Kenya. Results shown in Table 4.7, indicated that there was no causality between mobile banking and financial deepening, ATM banking and financial deepening, online banking and financial deepening, agency banking and financial deepening. Further there was no causality between mobile banking, ATM banking, online banking and agency banking respectively. Moreover, bank size had no causality with financial deepening. These findings concurred with Muchiri et al., (2016) who reported no causality between financial structure and financial performance. They refuted Githira et al., (2019b) who reported causality between some firm financial characteristics and stock return of listed companies in Nairobi securities exchange.

Table 4.7 Panel Granger Causality Test for Commercial Banks in Kenya

Null Hypothesis:	F-Statistic	Prob.
Mobile banking does not Granger Cause financial deepening	0.24215	0.7853
Financial deepening does not Granger Cause mobile banking	1.09972	0.3358
ATM banking does not Granger Cause financial deepening	0.34995	0.7053
Financial deepening does not Granger Cause ATM banking	0.69474	0.5009
Online banking does not Granger Cause financial deepening	1.02138	0.3628
Financial Deepening does not Granger Cause online banking	0.00183	0.9982
Agency banking does not Granger cause financial deepening	0.00741	0.9926
Financial deepening does not Granger Cause agency banking	0.39346	0.6755
Bank size does not Granger Cause financial deepening	1.94023	0.1475
Financial deepening does not Granger Cause bank size	1.11063	0.3323
ATM banking does not Granger Cause mobile banking	0.99986	0.3706
Mobile banking does not Granger Cause ATM banking	0.27055	0.7634
Online banking does not Granger Cause mobile banking	3.08106	0.0491
Mobile banking does not Granger Cause online banking	0.09863	0.9061
Agency banking does not Granger Cause mobile banking	1.9578	0.145
Mobile banking does not Granger Cause agency banking	0.22402	0.7996
Bank size does not Granger Cause mobile banking	5.95866	0.0033
Mobile banking does not Granger Cause bank size	0.36554	0.6945
Online banking does not Granger Cause ATM banking	1.77281	0.1737
ATM banking does not Granger Cause online banking	1.20486	0.3028
Agency banking does not Granger Cause ATM banking	1.81136	0.1673
ATM banking does not Granger Cause agency banking	2.14022	0.1215
Bank size does not Granger Cause ATM banking	1.71425	0.1839
ATM banking does not Granger Cause bank size	0.09546	0.909
Agency banking does not Granger Cause online banking	0.50507	0.6046
Online banking does not Granger Cause agency banking	3.211	0.0433
Bank size does not Granger Cause online banking	0.78817	0.4567
Online banking does not Granger Cause bank size	0.68042	0.5081
Bank size does not Granger Cause agency banking	2.21932	0.1125
Agency banking does not Granger Cause bank size	0.20013	0.8189

4.2.7 Panel Hausman Test for Commercial Banks in Kenya

Fixed effects and random effects modelling choice is guided by findings of Hausman test. This test assumes that the most appropriate model to fit is fixed effects against an alternative use of random effects. As shown in Table 4.8, Chi square statistics was 2.25 and p value of 0.694 which was greater than 0.05. Consequently, there was enough evidence to warrant rejection of the null hypothesis and conclusion that the most appropriate model to examine relationship between banking financial innovations and financial deepening of banks in Kenya was random effects. These findings differed with Githira and Nasieku (2015) who fitted fixed effects on firms listed in East Africa securities exchanges and they concurred with Ndili and Muturi (2015) who fitted fixed effects on their examination on role of financing decision on financial performance of listed companies in NSE.

Table 4.8 Panel Hausman Test for Commercial Banks in Kenya

Test Summary		Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
		2.225	4	0.694
Variable	Fixed	Random	Var (Diff.)	Prob.
Mobile Banking	0.895	0.890	0.005	0.953

ATM Banking	0.392	0.345	0.005	0.488
Online Banking	0.223	0.306	0.008	0.353
Agency Banking	0.728	0.679	0.010	0.620

4.3 Relationship between Financial Innovations and Financial Deepening of Commercial Banks in Kenya

Multiple regression analysis revealed that financial innovations had significant relationship with financial deepening (F = 195.2354, p value < 0.05). An R squared of 0.7873, indicated that mobile banking, ATM banking, online banking and agency banking explained 78.73 percent of change in financial deepening can jointly be explained by banking financial innovations while the remaining percentage can be accounted by other attributes excluded in the model.

The first hypothesis stated that mobile banking had no significant relationship with financial deepening of commercial banks in Kenya. Results in Table 4.9 revealed positive and significant relationship between mobile banking and financial deepening of commercial banks in Kenya ($\beta = 0.8903$, p value <0.05). This implied that unit increase in mobile banking increased financial deepening by 0.8903 while holding constant ATM, online and agency banking.

The second hypothesis stated that ATM banking had no significant relationship with financial deepening of commercial banks in Kenya. It was found that ATM banking had positive significant relationship financial deepening of commercial banks in Kenya ($\beta = 0.3453$, p value <0.05). This implied that unit increase in ATM banking increased financial deepening by 0.3453 while holding constant mobile, online and agency banking.

The third hypothesis stated that online banking had no significant relationship with financial deepening. It was found that online banking had positive significant relationship with financial deepening of commercial banks in Kenya ($\beta = 0.3058$, p value <0.05). This implied that unit increase in online banking increased financial deepening by 0.3053 while holding constant mobile, ATM and agency banking.

The fourth hypothesis stated that agency banking had no significant relationship with financial deepening of commercial banks in Kenya. It was found that online banking had positive significant relationship financial deepening of commercial banks in Kenya ($\beta = 0.6794$, p value <0.05). This implied that unit increase in agency banking increased financial deepening by 0.6794 while holding constant mobile, ATM and online banking.

These findings supported Kingori and Gekara (2015), Mbugua and Omagwa (2017), Chipeta and Muthinja (2018), Nyang'ate (2015) who reported that commercial banks provision of quality services, market penetration and its ability to recruit customers was anchored on organization ability to align its financial innovation on technologically supported service provision platforms. This would aid in minimization of operational costs and optimization of shareholder's wealth which will be in line with agency theory. Incorporation of technologically based financial products ought to put into consideration barriers associated with technology, language challenges due to heterogeneity of cultures in the country. Kathuo et al., (2015) argued that despite of technological innovations being beneficial caution ought to be examined since they may precipitate fraud amongst several sectors especially in situations where personal information may be eave dropped.

Financial Deepening = -21.7198 + 0.8903*Mobile Banking + 0.3453 * ATM banking + 0.3058*Online banking + 0.6794*Agency banking…………………………………..……4.1

Table 4.9 Relationship between Financial Innovations and Financial Deepening of Commercial Banks in Kenya

Variable	Coefficient	Robust Std. Error	t-Statistic	Prob.
C	-21.7198	1.4882	-14.5949	0.0000
Mobile banking	0.8903	0.1334	6.6765	0.0000
ATM banking	0.3453	0.1502	2.2986	0.0225
Online banking	0.3058	0.1425	2.1460	0.0330
Agency banking	0.6794	0.1686	4.0288	0.0001
R-squared	0.7873	Mean dependent variable		12.4543
Adjusted R-squared	0.7833	S.D. dependent variable		13.4484
S.E. of regression	6.2610	Sum squared residuals		8271.3380
F-statistic	195.2354	Durbin-Watson stat		2.1739

Prob (F-statistic)	0.0000	

4.4 Moderating Effect of Bank Size on Relationship between Banking Financial Innovations and Financial Deepening of Commercial Banks in Kenya

Regression results in Table 4.10, revealed that 93.10 percent of changes in financial deepening was accounted for by mobile, ATM, online, agency banking, bank size, moderated banking innovations while the remaining percentage was accounted for by other factors excluded in the model. R squared increased by 14.37 percent (0.9310-0.7873) after moderation which indicated banking size had moderating effect on the relationship between banking financial innovations and financial deepening of commercial banks in Kenya. Further, bank size had positive significant effect on financial deepening of commercial banks in Kenya (β = 0.5081, p value <0.05).

After bank size moderation on mobile banking, MB*BS there was positive significant relationship with financial deepening (β = 0.0115, p value <0.05). Secondly, bank size had positive moderating effect on ATM banking, ATMB*BS (β = 0.0160, p value <0.05). Thirdly, online banking had positive and non-significant moderation on bank size (β = 0.0059, p value >0.05). Finally, bank size had positive significant moderating effect on agency bank, AB*BS (β = 0.0124, p value <0.05).

Financial Deepening = -18.9276 + 0.1602 * Mobile banking + 0.0900 * ATM banking+ 0.2843* Online banking + 0.0688*Agency banking + 0.5081 * Bank size + 0.0115*MB*BS + 0.0160 * ATMB*BS+0.0059*OB*BS+0.0124*AB*BS……………………..………….. (4.2)

Bank size moderating effect was confirmed through comparison of moderated and non-moderated coefficients with marginal change of banking financial innovations on financial deepening of commercial banks in Kenya. Bank size moderating effect will be present if marginalized coefficients will differ from non-moderated banking financial innovations coefficients. The following equations were adopted:

$\frac{\delta FDi,t}{\delta MBi,t} = \beta_1 + \beta_6 BS = 0.1602 + 0.0115 * 17.61 = 0.3627$

$\frac{\delta FDi,t}{\delta ATMBi,t} = \beta_2 + \beta_7 BS = 0.0900 + 0.0160 * 17.61 = 0.3718$

$\frac{\delta FDi,t}{\delta OBi,t} = \beta_3 + \beta_8 BS = 0.2843 + 0.0059 * 17.61 = 0.3882$

$\frac{\delta FDi,t}{\delta ABi,t} = \beta_4 + \beta_9 BS = 0.0688 + 0.0124 * 17.61 = 0.2872$

Comparison between marginalized coefficients and those in equation 4.21 (Financial Deepening = -21.7198 + 0.8903*Mobile Banking + 0.3453 * ATM banking + 0.3058*Online banking + 0.6794*Agency banking), these coefficients differed. Consequently, it can be concluded that bank size had moderating effect on relationship between banking financial innovations and financial deepening of commercial banks in Kenya. These results supported Hasan et al., (2012), Chipeta and Muthinja (2018), Mbugua and Omagwa (2017), Wabwoba (2012), Arif et al., (2013), Muhindi and Ngaba (2018) and Sreesha (2018) who reported significant relationship between financial innovation, bank size and financial access. Bank size contribution on banking performance and provision of services have significant effect amongst past scholars. Furthermore, moderating effect of bank size is in line with innovation diffusion theory which argues that to fully benefit from technology then institutions ought to have enough financial resources to acquire assets. This will be in line with Ndili and Muturi (2015) who argued that performance of listed companies is anchored on their ability to acquire and invest their finances.

Table 4.10 Moderating Effect of Bank Size on Relationship between Banking Financial Innovations and Financial Deepening Commercial Banks in Kenya

Variable	Coefficient	Robust Std. Error	t-Statistic	Prob.
C	-18.9276	2.3631	-8.0096	0.0000
Mobile banking	0.1602	0.1109	1.4437	0.1507
ATM banking	0.0900	0.1159	0.7759	0.4389
Online banking	0.2843	0.1200	2.3694	0.0189
Agency banking	0.0688	0.1392	0.4941	0.6219
Banking size	0.5081	0.1504	3.3784	0.0009
MB*BS	0.0115	0.0045	2.5615	0.0113
ATMB*BS	0.0160	0.0063	2.5628	0.0112

OB*BS	0.0059	0.0062	0.9515	0.3427
AB*BS	0.0124	0.0053	2.3218	0.0214
R-squared	0.9310	Mean dependent variable	13.3877
Adjusted R-squared	0.9132	S.D. dependent variable	13.7214
S.E. of regression	4.0422	Akaike info criterion	5.8145
Sum squared residuals	2793.9760	Schwarz criterion	6.5177
Log likelihood	-582.9645	Hannan-Quinn criterion.	6.0986
F-statistic	52.4197	Durbin-Watson stat	2.0663
Prob (F-statistic)	0.0000		

V. Conclusion and Recommendations

From the foregoing findings there is need for commercial banks to take advantage of mobile phone uptake to advent their products and services. There is need to increase mobile banking products to have alternative services accessed in favor of current lending, withdrawals, deposits. Mobile phone banking diversification would minimize cases of financial exclusion especially amongst unbanked population in Kenya.

Commercial banks should integrate their ATM banking so as to intensify access of banking services. Commendable use of ATM services was noted in listed and non-listed banks. Commercial banks ought to encourage of ATM plastic money to minimize cases associated with theft and loss of cash during transit. Thirdly, online banking services had strong significant relationship with financial deepening of commercial banks in Kenya. There is provision of online banking supportive services in different parts of the country. Provision of internet connection in geographically dispersed locations would aid in eradicating distances covered to access banking services. Banking online services ought to be blended to be easily accessible in those remote regions with limited internet access.

Further, it was found that agency banking service impacted positively on financial deepening. This calls for creative and diversified provision of financial services through agents. Beyond normal banking transactions such as opening of accounts there is need for provision of services such as financial advisory and recruitment of mortgage clients which will be in line achievement of big four agendas in Kenya. Finally, increased bank size improved financial deepening of commercial banks in Kenya. Bank size had positive moderating effect on financial deepening, mobile banking, ATM banking, online banking and agency banking. Hence, there is need for commercial banks to invest in tangible and intangible assets which would aid in adoption of banking financial innovation.

References

[1]. Abdullahi, H. M., & Nyaoga, R. B., (2017). Effect of Automated Teller Machines Usage on
[2]. Operational Performance of Commercial Banks in Nakuru County, Kenya. *International Journal of Economics, Finance and Management Sciences, 5*(3),162-167.
[3]. Adeniran, L. R. & Junaidu, A. S. (2014). An empirical study of automated teller machine (ATM) and user satisfaction in Nigeria: A study of united bank for Africa in Sokoto metropolis. *International Journal of Management Technology.2(3),* 1- 11.
[4]. Adeoti, J.A. (2011). Automated teller machine (ATM) frauds in Nigeria: The way out. *Journal of Social Sciences, 27*(1), 53-58.
[5]. Adewoye, J. O. (2013). Impact of mobile banking on service delivery in the Nigerian commercial banks. *International Review of Management and Business Research, 2(2),* 333-344.
[6]. Aduda, O. J., & Kalunda E. (2012). Financial Inclusion and Financial Sector Stability with Reference to Kenya: A Review of Literature. *Journal of Applied Finance & Banking, 2(6),*95-120.
[7]. Aker, J. C. (2010). Information from markets near and far: mobile phones and agricultural markets in Niger. *American Economic Journal: Applied Economics, 2(3),*46–59.
[8]. Baltagi, B.H. (2005). *Econometric analysis of panel data,* John Wiley & Sons.
[9]. Central Bank of Kenya, (2014). *Bank Annual Report, Kenya*, Government Press
[10]. Frame, W. & Scott, L., (2001). Empirical Studies of Financial Innovation: Lots of Talk, Little Action? *Journal of Financial Economics, 25*(12), 213-240.
[11]. Gennaioli, N., Shleifer, A. & Vishny, R. (2012). Neglected Risks, Financial Innovation and Financial Fragility, *Journal of Financial Economics, 10(4)*, 452-468.
[12]. Githira, C. W., & Nasieku, T., (2015). Capital Structure Determinants among Companies Quoted in Securities Exchange in East Africa. International Journal of Education and Research, 3 (5) 483-496.
[13]. Githira, C., Muturi, W., & Nasieku, T., (2019a). Influence of firm financial characteristics on stock return of listed companies in Nairobi securities Exchanges. *American Based Research Journal, 8*(3), 86-99.
[14]. Githira, C., Muturi, W., & Nasieku, T., (2019b). Influence of firm financial characteristics on stock return of non-financial listed companies in East Africa securities Exchanges. *American Based Research Journal, 8*(3), 100-113.
[15]. Jensen, M. C. & Meckiling, W. H., (1976). Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure. *Journal of Financial Economics, 3*(76),305-360.
[16]. Kingori, E. M., & Gekara, M., (2015). Effects of Agency Banking on The Performance of Bank Agents Business in Thika Municipality, Kenya. *The Strategic Journal of Business and Change Management, 2*(79), 940-972.
[17]. Kithuka, B. K. (2012). Factors influencing growth of agency banking in Kenya: the case of Equity Bank, Kwale county, Kenya. *Unpublished MA Thesis, University of Nairobi.*

[18]. Kombo, D. K., & Tromp, D. L. A. (2009). *Proposal and thesis writing: An Introduction.* Pauline Publications.
[19]. Kombo, D.K., & Tromp, D.L.A. (2009). *Proposal and Thesis Writing: An Introduction.* Pauline Publications.
[20]. Kothari, C. R. (2004). *Research Methodology: Methods and Techniques* (2nd Ed.). New Age Publications.
[21]. Mbugua, I. N.& Omagwa, J. (2017). Agency banking and financial performance of commercial banks in Embu County, Kenya. *International Academic Journal of Economics and Finance, 2*(3), 348-367.
[22]. Muchiri, M. J., Muturi, W. M., & Ngumi, P. M. (2016). Relationship between Financial Structure and Financial Performance of Firms Listed at East Africa Securities Exchanges. *Journal of Emerging Issues in Economics, Finance and Banking 5*(1), 1734-1755.
[23]. Mwangi, P. N. (2013) Effect of bank innovations on financial performance of commercial banks in Kenya. *Unpublished thesis,* Jomo Kenyatta University of Agriculture and Technology.
[24]. Nachmias, C., & Nachmias, D. (2004*). Research methods in the social sciences (5th ed)*
[25]. Ngumi, P. M. (2014). Effect of bank innovations on financial performance of commercial banks in Kenya (Doctoral dissertation), Unpublished Jomo Kenyatta University of Agriculture and Technology.
[26]. Nyang'ate, L. M., (2015). Relationship between Banking Technologies and Financial Performance of Commercial Banks in Kenya. *International Journal of Economics Commerce and Management, 3*(11), 784-815.
[27]. Okoro, A. S. (2014). Impact of electronic banking instruments on the intermediation efficiency of the Nigerian economy, *International Journal of Accounting Research, 1(6),*14-21.
[28]. Rogers, E. M (1983). The Diffusion of Innovations, Free Press, New York.
[29]. Sekaran, U. & Bougie, R. (2009). *Research Methods for Business:* A Skill-Building Approach.
[30]. Tarus, D. K., & Omandi, E. M. (2013). Business Case for Corporate Transparency: Evidence from Kenya. *European Journal of Business and Management*, *5* (3)113-125.
[31]. Too, V. K., Ayuma, C., & Kemboi, A., (2016). Effects of Mobile Banking on the Financial Performance of Commercial Banks in Kapsabet (Kenya): A Case of Selected Banks in Kapsabet Town. *Journal of Business and Management, 18*(10), 37-48.
[32]. Torruam, J. T. Chiawa, M. A. & Abur, C. C. (2013). Financial Deepening and Economic Growth in Nigeria: An Application of Cointegration and Causality Analysis. T*hird International Conference of Intelligent Computational Systems* (ICICS'2013), April 29-30, Singapore
[33]. Wanjau, B. M., Muturi, W., & Ngumi, P., (2018). Influence of Corporate Transparency Disclosures on Financial Performance of Listed Companies in East Africa. *Asian Journal of Finance & Accounting, 10* (3), 1-15.
[34]. Wooldridge, J. M. (2013). *Econometric analysis of cross section and panel data*. Cambridge, MA: MIT Press.