THE EFFECT OF MOBILE MONEY ON BANKING SECTOR STABILITY IN KENYA

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Abstract

The objective of this study is to examine the effect of mobile money payment service on banking stability in Kenya. Employing data spanning 2007m03 to 2018m06, the study builds a model using the generalised method of moment estimation approach of bank stability incorporating its diverse measures - capital adequacy, asset quality, profitability, and liquidity conditions - as a function of the value transacted via mobile money service as well as other market and macroeconomic control variables. Findings show that growth in the value of mobile money transactions reduces capital adequacy and liquidity ratios of banks, and increases non-performing loans ratio to total loans. Despite these findings, mobile money supports commercial banks' profitability by increasing returns on assets and return on equity. The divergent implications of technology-based mobile money innovation on bank stability throws some caution on banks that, before these innovations are adopted, there is need to carefully consider their beneficial effects on profitability against the adverse consequences on capital adequacy, liquidity conditions and quality of assets.

I. Introduction

Technological innovations particularly those that leverage on advancement in Information Communication Technology (ICT) have been associated with adjustments in transaction costs, information asymmetry in the banking sector, adoption of new business models, applications, processes or products that subsequently affect the financial markets, institutions or the production of financial services (Basel Committee on Banking Supervision, 2019). Adoption of technology in finance ('FinTech') has the potential of 'unbundling' and 'restructuring' the existing financial services by 'globalizing' basic financial services, thereby enhancing financial inclusion particularly in developing countries through an improvement in financial access. Most importantly, the innovations can open up new funding opportunities for segments such as the Small- and Medium-Sized Enterprises (SMEs), which are widely known not to have easy access to bank credit and capital markets (Wilson & Testoni, 2014).

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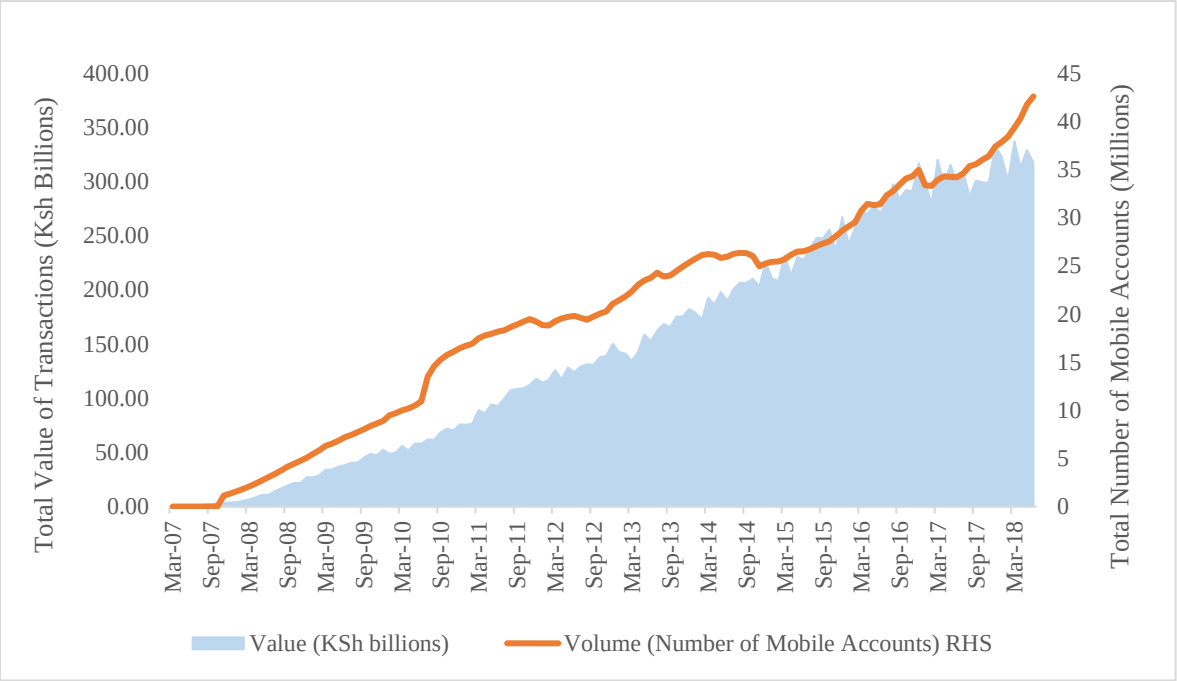
Kenya's mobile money innovation has opened up the possibility of providing basic financial services through new products that leverage on the mobile money technology. The products created by banks in Kenya that leverage on mobile money (such as *M-kesho* and *M-shwari*)[2] have driven change in banks' business models and shifted focus increasingly towards the lower income consumers (Cook & McKay, 2017). Essentially, the products substituted the need for brick & mortar type of banking infrastructure and automated teller machines in the provision of financial services (Wilson & Testoni, 2014). Today, an increasing number of bank clients do not necessarily need to physically visit a financial institution to deposit money, receive a loan, make a payment or transfer funds, or buy financial products/ services such as insurance. Consequently, the traditional financial instruments' role continues to decrease dramatically. It is recognised that the mobile phone technology and its adoption in the banking sector in Kenya has provided a platform to leapfrog access to financial services (Muthiora, 2015).

Figure 1: Mobile Money Development in Kenya



Source: Central Bank of Kenya

As shown in Figure 1, since its introduction in March 2007, the value transacted through mobile money has grown steadily from Ksh 16.3 billion in 2007 (or about 0.8% of GDP) to a total of Ksh 3,747.3 billion in the 12 months to June 2018 (equivalent to about 36.9% of GDP or about 153% of total bank loans to private sector). The number of mobile money accounts has surpassed 40 million, with every adult Kenyan on average holding at least one mobile money account (CBK, 2019)[3].

Utilization of mobile money financial services is estimated to have increased to 79.4 percent in 2019 from 27.9 percent in 2009, and immensely contributed to the reduction in the proportion of the population accessing informal and those completely from financial services

[2] These mobile money based products are savings mobilization and loan products for small scale loans associated with Equity Bank and Commercial Bank of Africa, respectively.
[3] https://www.centralbank.go.ke/national-payments-system/mobile-payments/

to 6.1 percent and 11.0 percent from 26.8 percent and 32.7 percent in 2009, respectively. As banks moved in to leverage on this service as a means to increasing its reach to customers, mobile banking products have emerged. As a result, mobile bank account utilization increased to 25.3 percent by 2019 from 17.5 percent in 2016 as use of traditional bank account reduced to 29.6 percent from 31.7 percent over the same period (FinAccess, 2019). Synergies have been developed between mobile service providers and banks that, by 2014, accounted for about 42 percent of the financial services through the mobile phones (KBA, 2014).[4]

As adoption of mobile banking products continues to spread[5], mobile money as a payment service can affect banking sector operations. All mobile money transactions are backed by bank deposits in trust accounts. However, due to fungibility of money, this potentially affects how banks allocate funds thereby influencing their loan books and liquidity conditions which have implications on bank stability. From literature, developments in ICT and their adoption in the banking sector are argued to have strong influence on the structure and operations of the sector; from allowing transactions to be conducted more efficiently, to supporting banks to market their products more effectively. However, arguments for or against adoption of technology in the banking sector continue to develop. Those for adoption of technology argue that technology enables banks build up sophisticated databases and information sets about their customers, and based on these datasets are able to target and steer their commercial efforts more precisely, apply credit-scoring techniques to processing of consumer credits, mortgages and /or prescribe limits on credit cards. As a result of technology adoption, products or services that were previously highly dependent on the bank's evaluation of its customers become less cumbersome to process and more standardized (ECB, 1999).

On the contrary, Dabrowski (2017) argued that the application of ICT does not eliminate the problems of information asymmetry and adverse selection inherently present in financial intermediation. In addition, with promotion and increased adoption of technology in the provision of financial services, particularly by institutions outside the purview of banking regulations (or those insufficiently regulated), this may create institutions that are victims of business failure, abuse and fraud. It may also lead to systemic financial crisis if these institutions provide financial services in large scale. As unregulated institutions adopt ICT in the provision of financial services, this increases competition to the regulated institutions and as a result, the latter institutions would have to change their business models, including getting into partnerships with large and established technological or information partners (BigTech) to offer financial services (Arnold, 2017)[6]. The World Bank (2016)[7] acknowledged that while these innovations could result in stronger, more resilient financial systems, they however, may have the potential to make the system less stable and / or sometimes even trigger or catalyse a

[4] https://www.kba.co.ke/downloads/Mobile%20Banking%20Survey.pdf

[5] Mobile money utilization has spread across the economy. For instance, utility companies see it as an efficient way of collecting dues, and banks use it as a good avenue way to mobilise deposits, disburse loans and receive loan repayments. The Government uses it as an effective instrument for disbursing benefits and other social payments (Muthiora, 2015)

[6] Arnold (2017) also acknowledges that increased adoption of technological innovations in the financial sector, especially by players other than banks - such as investment funds, insurance schemes and pension funds-, has also been associated with disintermediation where banks lose their share of the intermediation to these other financial sector players.

7 The World Bank (see http://www.worldbank.org/en/publication/gfdr/gfdr-2016/background/financial-stability) defines financial stability as the absence of system-wide episodes in which the financial system fails to function (crises) or simply, resilience of financial systems to stress.

financial crisis. Such was the case with the 2007-09 global financial crisis where subprime products were introduced and their widespread adoption and trading was supported by technological development.

The effect of financial innovations on banking sector stability has received varied views in literature. Muthiora (2015) argues that mobile money may not introduce systemic risk to the financial system owing to the fact that mobile money accounts for 6.59% of total national payment systems' throughput. However, high volumes transacted by large segments of the population may portend operational and liquidity risks to business continuity in the event of a hitch or collapse. While the development of the mobile money ecosystem continues to create many opportunities, there is growing need to ensure that the regulators are alert to these developments and that it is essential for regulatory frameworks to remain compatible with business models to preserve financial sector stability.

On the monetary policy front, it is argued that prior to the 2007-09 global financial crisis, emergence of financial innovations were considered neither important nor posing any significant risks to monetary policymaking (see arguments by Bernanke & Blinder, 1988; Arize, 1990; Friedman, 2000; Goodhart, 2000; Woodford, 2000). But in the aftermath of the crisis, discussion on the impact of financial innovations resurfaced, particularly focusing on their threats to financial stability if wrongly designed and regulated. While the innovations are noted to have triggered adjustments in some technical aspects of conducting monetary policy (such as monetary policy transmission mechanisms, forecasting models, ways of conducting open market operations, and definitions of monetary aggregates), they also posed real threat to financial stability (Mishra & Pradhan, 2008; Dabrowski, 2017).

Kipkemboi and Bahia (2019) argued mobile money when adopted by banks in their operations has both market and policy implications. On the market front, it has the potential to reduce transaction costs of both banks and its customers, can create investment opportunities for firms and enable them build capital buffers. On the policy side, it can increase money multiplier and reduce velocity of money thereby impeding the conduct of monetary policy particularly in quantity targeting regimes such as Kenya's. More specific to the banking sector, mobile money adoption can impact on the number of deposit accounts and the values mobilised through these accounts, support remittances flows, create new loan extension avenues, introduce new financial products and thus risks to the banking sector, and cause a recalibration of the payments systems. These have implications on market liquidity and commercial banks operations. Abugamea (2018) argues that changes in bank deposits can affect bank profitability (measured by ROA and ROE), even when changes in bank specific factors – such as bank size, capital and loans- and macroeconomic factors – economic growth and inflation are controlled for.

From theory, discussions of such macro-financial linkages borrows from the financial accelerator frame of thinking fronted by Bernanke and Gertler (1989), and extended by Kiyotaki and Moore (1997) and Bernanke *et al*. (1999). Based on this theory, two broad sets of drivers explain asset quality of banks, which is a critical component of bank stability. This includes both macroeconomic factors and bank –specific institutional factors. On the bank-specific factors, market developments that affect bank cost efficiency and changes in capital

can potentially affect risk appetite of banks and thus quality of loan underwriting with direct implications on NPLs (Berger and De Young, 1997; and Ghosh, 2015). Specifically, market developments that affect bank cost structure have a direct bearing on risk monitoring and thus profitability of banks. Additionally, developments that reduce bank capital tend to trigger banks to enrol riskier lending and thus worsen quality of assets, based on the 'moral hazard hypothesis' (Keeton and Morris, 1987).

From the foregoing, it is noted that technological innovations hold a great promise for the provision of financial services, with potential to enhance financial inclusion, widen the range of product offerings, and introduce convenience while also lowering the costs to clients. At the same time, the entrance of Fintech mainly through BigTech firms could materially alter the universe of financial service providers. This in turn could affect the degree of concentration and contestability in financial services, with both potential benefits and risks. In particular, benefits on one hand range from greater competition to increased diversity in lending, trading, and to the means and costs of effecting payments. Risks on the other hand include reduced profitability that can trigger additional risk-taking among incumbents as they seek to maintain margins, and imported risks into the financial sector from increased dependencies on third party BigTech firms (Dabrowski, 2017).

This study examines the effect of technology-enabled mobile money financial service on financial stability of commercial banks in Kenya. Here, we hypothesize that as technology permits a further unbundling of bank operations and profitable services traditionally offered by banks, future profitability of such institutions may be affected. As bank operations are affected, critical ratios such as the capital adequacy, liquidity and NPLs ratios can potentially be impacted. In addition, the creation and growth of mobile money payments system as a financial service product has reduced the use of payment products offered by banks such as cheques and direct transfers thus reducing banks' profit margins.[8] In this regard, the study sought to answer one broad question, i.e. what is the effect of mobile money service on the four measures of banking sector stability -capital adequacy, asset quality, profitability, and liquidity conditions- in Kenya?

This study is important to varied stakeholders in the financial sector. First, to banks, it attempts to answer the question of whether banks should continue adopting technology-based products in the conduct of banking business. It helps banks identify the benefits and pitfalls technological developments with respect to stability as viewed from different perspectives. Second is to the regulator whose concern over emergence and widespread adoption of technology-based innovations would be system-wide stability. The study provides input in the design and prescription of appropriate measures to safeguard stability through such avenues as licensing of new digital products. In essence, the study shapes thinking in ensuring that the regulatory framework under which innovations are encouraged provides 'better regulation' as opposed to 'more regulation' as a response to technology-based innovations.[9]

[8] This is supported by a finding by KBA (2014) that while 64 percent of money transfers are through the mobile money platform, only 33 percent are via banks.

[9] In the words of Sir Andrew Crockett after the global financial crisis ' to prevent a repetition of the economic and human costs of the crisis, there would be a natural desire for ' more regulation', but what was needed was 'better regulation'

Methodology

The study builds a bank stability model consistent with the "financial soundness indicators" of Čihák & Schaeck (2010) that are widely adopted by central banks globally. These measures include capital adequacy, asset quality, profitability, and liquidity conditions. While capital adequacy is measured by capital adequacy ratio[10], asset quality is measured by ratio of non-performing loans to total gross loans, average ROA and average ROE measure bank profitability, and liquidity conditions are captured by the average liquidity ratio[11].

We consider a simple banking stability model specified as:

$$Bankstab_{it} = \alpha_{it} + \beta_{it} Mobile_t + \phi_{it} MACRO_t + \varepsilon_{it} \quad (1)$$

Where $Bankstab_{it}$ is a vector of four measures of bank stability, based on capital adequacy, profitability (ROA/ ROE), asset quality and liquidity ratio; and $Mobile_t$ is the total value of mobile money transactions through the payment system in time *t*. The term $MACRO_t$ is a vector of macroeconomic control variables that capture cyclical and economy-wide developments that affect bank stability, such as inflation and economic growth. The subscripts $_{it}$ capture specific measures of bank stability (*i*) at time (*t*). It must be noted that mobile money transactions and macroeconomic variables do not vary across measures of bank stability. The term ε_{it} is the disturbance term assumed to be normally distributed with a mean of zero and constant variance.

Model (1) represents a set of equations that is estimated using the Generalised Method of Moments (GMM) technique, pioneered by Hansen (1982). The method requires that a certain number of moment conditions be specified for the model.[12] The GMM method then minimizes a certain norm of the sample averages of the moment conditions particularly in cases where endogeneity needs to be minimized. This approach was adopted for its desirable properties of generating consistent, asymptotically normal, and efficient estimates of all semi parametric estimators, which is known effectively to solve potential endogeneity problems associated with economy-wide time series models. The approach does not use any extra information aside from that contained in the moment conditions.

GMM primarily seeks to find unbiased estimates of parameter vector ρ that would satisfy the following moment conditions:

$$E[m(y_t, \rho)] = 0 \quad (2)$$

where y_t is a vector of observable variables at time *t*, and ρ is the unique value of a set of parameters that makes the expectation of the function equal to zero. Equation (2) is assumed to satisfy orthogonality conditions between a set of instrumental variables z_t and the residuals of model (1), that is, $\varepsilon_t(\rho) = \varepsilon(y_t, x_t, \rho)$, as follows:

[10] Computed as the ratio of regulatory capital to risk-weighted assets.
[11] Computed as the ratio of short term liquid assets to short term liabilities (usually less than 30 days to maturity)
[12] Moment conditions are functions of the model parameters and the data, such that their expectation is zero at the parameters' true values.

$$E[z_t \varepsilon_t(\rho)] = 0 \quad (3)$$

where x_t is a vector of all explanatory variables in model (1) observed at time *t.* By replacing the moment conditions (equation 2) by respective sample analogue, the following method of moments estimator is generated:

$$m_T(\rho) = \frac{1}{T}\sum_{t=1}^{T} z_t \varepsilon_t(\rho) = \frac{1}{T} Z' \varepsilon_t(\rho) = 0 \quad (4)$$

where T is the sample size. Generating unique estimates of the parameters would require a fully identified case, i.e. where the number of moment conditions (L) exactly equals the number of parameters (K). However, a more common case is an over-identified one where L>K, thus justifying the use of GMM (Mitterhammer *et al*., 2000). GMM seeks to reformulate the problem by seeking ρ that makes the sample moments as close to zero as possible, by introducing weights, using the following quadratic representation.

$$J(\rho, W_T) = T m_T(\rho)' W_T^{-1} m_t(\rho) = \frac{1}{T} \varepsilon(\rho)' z W_T^{-1} z' \varepsilon(\rho)$$

where W_T is a positive definite weighting matrix of dimension (*mxm*) that minimizes the weighted distance between the actual and theoretical values. In essence, GMM involves obtaining values of the parameters that ensure that the sample moments (weighted) are as close to zero as possible.

This study estimates five equations specified in model (1) corresponding to the five different measures of stability based on capital adequacy, liquidity risk (ratio), profitability (ROA and ROE) and asset quality (NPLs ratio). The plausibility of dynamic specifications of the models is considered, thus inviting the Arellano & Bond (1991) GMM modelling approach that addresses the resultant endogeneity.

Data, Sources and Description

The study focused on the period 2007m3-2018m6; period limited by availability of consistent dataset on key variables of interest. Data on capital adequacy ratios, profitability indicators such as ROA and ROE, ratio of NPLs to gross loans, liquidity ratio, total banking sector assets and value of mobile money transactions was obtained from the Central Bank of Kenya. Data on the macroeconomic control variables, such as inflation and economic growth, was collected from publications of the Kenya National Bureau of Statistics publications. Table A1 in the appendix presents the data measurement and description, while Table A2 depicts the descriptive statistics.

Estimation Results

This section presents the model estimation results. However, a brief discussion on the time series characteristics of the data is done first. This includes a brief review of the descriptive statistics, an assessment of the trend analyses, and the orders of integration of the variables. Based on descriptive statistics presented in Table A2 in the appendix, the banking sector over the period, however, remained sound and stable as indicated by all the relevant ratios, such as the capital adequacy ratios and the liquidity ratios, being at favourable rates against statutory

limits. For instance, the capital adequacy ratio averaged 24.8% but varied by 18.0 percent over the sample period with a statutory minimum of 10.0%, implying that the sector was well capitalised when compared to the risk-weighted assets.

The quality of assets as measured by the ratio of gross non-performing loans to total gross loans averaged 10.4%, having declined from 19.1% in the period before 2007 to 6.4% in late 2015 before rising steadily to 11.9% by June 2018. The recent increase in NPLs relative to gross loans was attributed largely to delayed government payments to suppliers as well as slowdown in private sector credit due to the interest rate capping law that constrained effective pricing of risk by banks. Against a statutory minimum of 20%, the liquidity ratio ranged between 33.0% and 60.6% and averaged 41.0%. The high liquidity ratio largely reflected banks' increased investment in government securities particularly after interest rate caps was instituted. Profitability of the banking sector, as measured by return on assets (ROA) and return on equity (ROE) remained strong averaging 3.3% and 28.3%, respectively over the study period. However, these profitability measures maintained a gradual downward trend over the sample period. The macroeconomic developments was depicted by more stability in prices after 2012 compared to the period before, reflecting lower food and fuel prices in the latter period, and a strong steady growth in the economy.

The unit root characteristics of the time series considered for this study were ascertained using the Augmented Dickey Fuller (Dickey and Fuller, 1979; and Mackinnon 1991 and 1996) and Phillips-Perron (1988) tests. The results for these tests are posted in Table A3 in the appendix. It is evident that all variables of interest based on the tests conducted are stationary at levels, except for NPLs ratio and the logarithm of total assets, which are stationary at first difference. In this regard, relevant considerations are made on the specific ways, through which the variables enter the respective bank stability models, to avoid spurious results and inferences.

Model estimation results based on GMM are posted in Table 1. Since GMM is an instrumental variable approach, it is acknowledged that results may be sensitive to the set of instruments used in the analysis and the weighting matrix adopted for analysis. As considered in common practice, one lag of the respective regressors in each of the models were used as instruments due to their assumed strong relations to the variables they were instrumenting (mostly macro-variables) and minimal covariance with the random disturbance term. The number of instruments used were equal to the number of variables being instrumented, a necessary condition for full model identification process, as justified by strongly significant *j-statistics*. The *regressor endogeneity test* statistics are significant (at least at 10% level of significance) across all the five models; indicating the relevance of the choice of GMM estimation for this exercise. It is also established, through the *Wald Chi-square* test, that all the regressors in all the models are jointly significant, and that the models depict strong goodness of fit (based on the adjusted R-squared measures).The study adopted a *white weighting matrix* that is a heteroskedasticity consistent estimator of the long-run covariance matrix $[z_t \varepsilon_t(\rho)]$ based on an initial estimate of ρ.

Bank stability models depicted strong inertia effects of more than 64 percent, showing less influence of extraneous factors on bank stability. The influence of economic growth on banking sector stability indicators was consistent with *apriori* expectations. For instance, increase in

economic activity supports banks' ability to build capital buffers against extended loans (the capital adequacy ratio), enhance commercial banks liquidity conditions, and support earnings on assets and equity, but reduce non-performing loans. The focus of this study is to establish the effect of mobile money on bank stability – as measured by its indicators. A 1% growth in mobile money significantly reduces capital adequacy ratio by 0.0021 (or about 1 percent). This implies that mobile money transfer service that is increasingly being adopted by banks for customer deposits and withdrawals as well as extension of loans, has had a significant impact in supporting build-up in the total risk-weighted assets more than it has supported their capital build-up. This reduces the capital adequacy ratio. A similar change in mobile money reduces banks' overall liquidity ratio by 0.0071 (or about 2%), implying that mobile money has increased short-term liabilities –particularly the build-up in bank deposits) - relative to the growth in banks short-term assets. This supports the narrative that mobile money service adoption by banks has aided mobilisation of savings and financial inclusion.

Bank stability as measured by profitability indicators- ROA and ROE- show that a 1% increase in the value transacted via mobile money improves banks ROA by 0.04% and ROE by 0.7%. Banks as earlier shown, have adopted mobile money-based platforms to support their banking business through mobilisation of savings and advancing customers with funds in withdrawals and loans. The fact that this platform reduces face-to-face encounters with customers helps reduce commercial banks operational costs of running branches and serving customers. This helps improve commercial banks net income as a ratio of average assets (ROA) and as a ratio of shareholders equity (ROE). However, a similar increase in the value of mobile money transactions contributes to a 0.0007 (or 0.05%) increase in the NPLs of the banking system relative to total loans. This is consistent with the fact that the mobile-based loans extended by banks in most of the months within the sample period depicted relatively higher NPLs-ratios compared to the loans via the conventional channels.[13]

Table 1: Model Estimation Results

	Model 1 CAR	Model 2 LIQ_ratio	Model 3 ROA	Model 4 ROE	Model 5 NPLs_ratio
Variable	*Coefficients [S.e]*				
CAR(-1)	0.8909*** [0.0417]				
LIQ_Ratio(-1)		0.6449*** [0.1378]			

[13] Data collected by the Central Bank shows that mobile-based loans NPLs ratio stood at 11.32% in April 2018 and 10.50% by June 2018, compared with overall NPLs ratio of 10.58% and 10.20% over the same periods, respectively.

ROA(-1)			-0.9869*** [0.0623]		
ROE(-1)				-0.9728*** [0.0850]	
NPLs_ratio(-1)					0.9642*** [0.0284]
LNGDP(-1)	0.0028** [0.0011]	0.0135*** [0.0052]	0.0018* [0.0009]	0.0210* [0.0120]	-0.0041* [0.0022]
LNMOBILE(-1)	-0.0021* [0.0012]	-0.0071** [0.0030]	0.0004 [0.0003]	0.0070 [0.0060]	0.0007 [0.0006]
SIZE			-0.0018* [0.0010]	-0.0230* [0.0140]	
SIZE(-1)					0.0034* [0.0021]
Adj. R-squared	0.74	0.65	0.59	0.65	0.97
J-stat. Probability	0.0000	0.0000	0.0000	0.0000	0.0000
Regressor Endogeneity test stat. (Probability)	5.9101 (0.0961)	7.7414 (0.1017)	10.6499 (0.0308)	10.9759 (0.0268)	9.3712 (0.0525)
Wald Chi-sq. test statistic. (Probability)	49007.10 (0.0000)	60077.92 (0.0000)	53341.85 (0.0000)	43988.61 (0.0000)	99860.15 (0.0000)

*Note: These results are based on GMM estimation, and the white estimation and covariance-weighting matrix. .Instruments used include one period lags of the respective regressors. The symbols: *, ** and *** respectively represent significance at 10%, 5% and 1%. Figures in block brackets are respective coefficient standard errors.*

Conclusion and Policy Implications

The objective of this study is to examine the effect of mobile money payment service on banking stability. The study draws on the divergent views in literature on the balance between benefits and risks that technology-based innovations may portend on financial stability, particularly at a time when the banking sector in Kenya continues to leverage on this payments technology to develop savings mobilization and loan products. The study assumes that as technology permits a further unbundling of banking operations and profitable services traditionally offered by banks, critical ratios, such as the capital adequacy, liquidity, NPLs ratios, and bank performance /profitability which are measures of bank stability, would be impacted. In particular, the study sought to establish the effect of mobile money service on the four measures of banking sector stability as proposed by Čihák & Schaeck (2010), namely capital adequacy, asset quality, profitability, and liquidity conditions in Kenya. Analyses was conducted based the GMM estimation that is well-known for its ability to generate consistent, asymptotically normal, and efficient estimates among all the semi parametric estimators, and can effectively solve potential endogeneity problems associated with economy-wide time series models.

Based on the estimation results obtained from the study, it was established that the continued increase in the value of transactions channelled via the mobile money has had a positive effect of supporting banking sector profitability as measured by return on assets and return on equity. In particular, it was observed that the increase in the use of mobile money that has also been reflected in its increased adoption by banks continues to support an increase in net incomes of

banks relative to their average assets and shareholders' equity. It appears mobilization of deposits through the mobile banking platform does not seem to impede bank profitability as argued by Abugamea (2018). Mobile money increase is also found to have also reduced commercial banks' liquidity ratio mainly by facilitating savings mobilisation by banks, thus increasing their liabilities. Mobile money growth also reduces commercial banks' capital adequacy ratio. Since capital adjustments are by nature less variable, the influence of mobile money on capital adequacy ratio is through an increase in the risk-weighted assets which are predominantly loans. This implies that mobile money continues to support commercial banks' loan extension; attributed to the argument that adoption of technological innovations may encourage lending by banks as the credit processing procedures become less cumbersome (ECB, 1999).

A concern, however, remains on the finding that mobile money growth increases the ratio of NPLs in commercial banks' total loans. This is against arguments that innovations can reduce NPLs (Ghosh, 2015) through an improvement in operational cost efficiency of institutions (see for instance: Wilson and Testoni, 2014; ECB, 1999 Mishra and Pradhan, 2008 and Dabrowski, 2017), but is consistent with the caution offered by the World Bank (2016) that such innovations can destabilise the system. The finding of reduced liquidity ratio and increasing NPLs is consistent with an assertion that banks with low liquidity conditions tend to face higher NPLs (Nikolaidou and Vogiazas, 2017). Increase in NPLs ratio amid expansion in lending implies that the innovation may have triggered excessive risk-taking by banks, which is consistent with arguments by Berger and De Young (1997).

These findings have some policy implications. Mobile money has implications on banking sector stability, but its implication varies in magnitude and direction of influence from one measure of stability to another. Mobile money adoption has supported banks' profitability, but moderated / reduced capital adequacy and liquidity ratios. A striking result is the finding that mobile money can be associated with the growth in NPLs in the banking sector. In this regard, the banks should exercise caution when considering the adoption of mobile money based services in their business models.

Appendix

Table A1. Variable measurement

Measure	Variable	Symbol	Measurement	Observed components
Stability (adequacy of capital)	Capital adequacy ratio	CAR	Ratio of total regulatory capital to risk weighted assets of the bank	a) Core Capital b) Total risk-weighted assets
Stability (quality of assets)	Asset quality	NPLS_RATIO	Ratio of gross non-performing loans (NPLs) to total loans	a) Gross NPLs b)Gross Loans
Stability (liquidity risk)	Liquidity ratio	LIQ_RATIO	Ratio of assets of maturity x to liabilities of maturity x (*x is usually 30 or fewer days*)	a) Assets of *x* maturity b) Liabilities of *x* maturity
Stability (earnings)	Return on assets	ROA	Net income as a ratio of average total assets	a) Net income b) Average total assets
Stability (earnings)	Return on equity	ROE	Net income as a ratio of Shareholders' equity	a) Net income b) Shareholders' equity
Mobile money technology	log(Mobile Money)	LNMOBILE	Value of mobile money transactions	Value of mobile money transactions
Macroeconomic growth performance	Log (Real GDP)	LNGDP	Logarithm of real GDP	Real GDP
Macroeconomic price risk	Overall Inflation	INFL	Month on Month percentage change in consumer price index	Inflation rate
Size of Banking sector	Banking sector size	SIZE	Logarithm of total assets	Total assets

Figure A1: Trends in the Key Variables

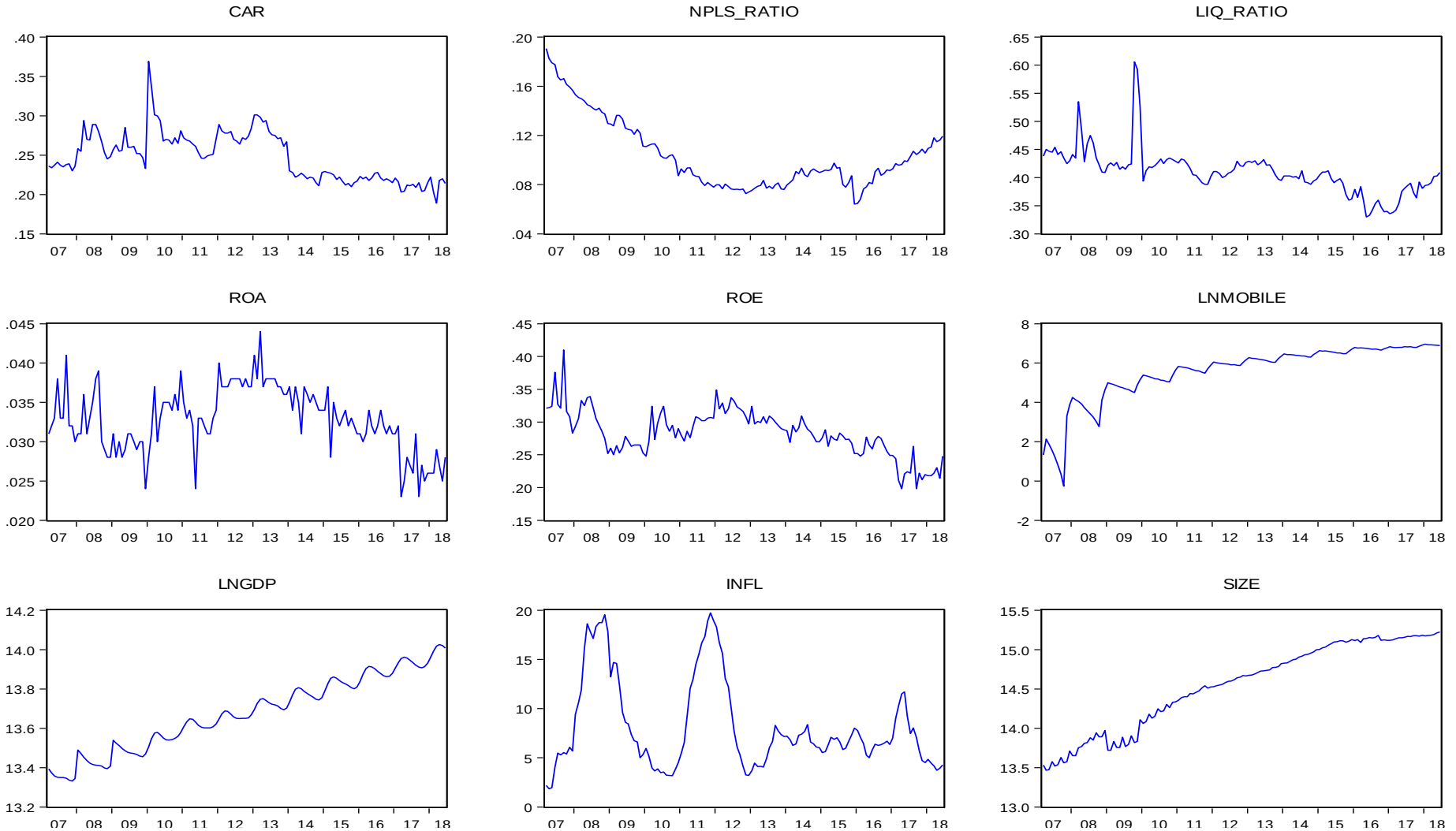


Table A2: Descriptive Statistics

	CAR	NPLS_RATIO	LIQ_RATIO	ROA	ROE	LNMOBILE	LNGDP	INFL	SIZE
Mean	0.248	0.104	0.410	0.033	0.283	5.558	13.677	8.159	14.542
Median	0.247	0.093	0.410	0.033	0.285	6.030	13.679	6.620	14.656
Maximum	0.369	0.191	0.606	0.044	0.410	6.961	14.025	19.720	15.222
Minimum	0.189	0.064	0.330	0.023	0.198	-0.263	13.332	1.850	13.466
Std. Dev.	0.031	0.028	0.040	0.004	0.035	1.482	0.189	4.592	0.550
Skewness	0.660	1.101	1.548	-0.148	0.017	-1.799	-0.084	1.163	-0.453
Kurtosis	3.589	3.438	9.462	2.730	3.710	6.165	1.949	3.268	1.841
Jarque-Bera	11.836	28.580	290.935	0.911	2.862	130.143	6.418	31.053	12.269
Probability	0.003	0.000	0.000	0.634	0.239	0.000	0.040	0.000	0.002
Sum	33.698	14.097	55.801	4.458	38.525	755.859	1860.069	1109.610	1977.757
Sum Sq. Dev.	0.128	0.108	0.221	0.002	0.168	296.324	4.843	2846.834	40.772
Observations	136	136	136	136	136	136	136	136	136

Table A3: Unit Root Test Results

	Augmented Dickey Fuller test (ADF)		Phillips Perron test (PP)		Conclusion
	Statistic (Prob.)	*Order of Integration*	*Statistic (Prob.)*	*Order of Integration*	
CAR	-2.9903**	I(0) (with intercept)	-2.6574*	I(0) (with intercept)	I(0)
NPLS_RATIO	-11.2387***	I(1) (No intercept/trend)	-112394***	I(1) (No intercept/trend)	I(1)
LIQ_RATIO	-3.7653**	I(0) (with intercept)	-3.5228***	I(0) (with intercept)	I(0)
ROA	-12.7798***	I(1) (No intercept/trend)	-5.0585***	I(0) (with intercept)	I(0)
ROE	-3.0659*	I(0) (with intercept, trend)	-3.1089**	I(0) (with intercept)	I(0)
LNMOBILE	-3.3428**	I(0) (with intercept)	-3.1725**	I(0) (with intercept)	I(0)
LNGDP	-4.3574***	I(1) (with intercept)	-4.1040***	I(0) (with intercept, trend)	I(0)
Inflation (INFL)	-1.6611*	I(0) (No intercept/trend)	-2.7879*	I(0) (with intercept)	I(0)
LN_ASSETS (SIZE)	-4.0974***	I(1) (No intercept/trend)	-14.5891***	I(1) (No intercept/trend)	I(1)

Note: The results based on the ADF Fuller test adopted the Schwarz information criterion for optimal lag selection with a maximum lag length of 12, while the PP test results reflect the Bartlett Kernel as the spectral estimation approach and the Newey-west bandwidth.

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