THE EFFECT OF FINANCIAL INNOVATIONS ON MONEY VELOCITY: EVIDENCE FROM KENYA.

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DECLARATION

STUDENT'S DECLARATION

This is my original work and has not been submitted to any other examining body, university or institution.

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SUPERVISOR'S DECLARATION

This project has been submitted for examination purposes with supervisor's approval.

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DEDICATION

I dedicate this work to my loving parents and siblings. They have been extremely helpful throughout my academic career and I hope they live long enough to see my success.

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I take this opportunity to thank all those who assisted me in one way or the other in the course of my studies at the University of Nairobi. I thank the lecturers at the Department of Economics and Development Studies. Dr. Peter Muriu, my professor and supervisor, deserves special thanks for his patience, concern and corrections throughout this academic research endeavor. His genuine encouragement and input aided in the completion of this endeavor, for which I am grateful.

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ABSTRACT

Money velocity is a key aspect in the short-run implementation of monetary policy. The study investigated the effect of financial innovation on money velocity in Kenya. It analyzed the effect of opportunity cost variables which include: T-bill rate, commercial banks' lending rate and inflation rate on money velocity in addition to exchange rate and real GDP which were intervening variables. Time series data collected from KNBS and the CBK from Q4 2009 – Q4 2019 was used. The Augmented Dickey Fuller test showed all variables in model were stationary at their first difference. The bound co-integration test found a conditional long-run relationship existed. The short-run and long-run relationships for money velocity function was estimated using the Autoregressive Distributed Lag Model. The diagnostic tests which include: Breusch-Godfrey, ARCH, Ramsey RESET and Jarque Bera confirmed that the ARDL model suited the data adequately. From CUSUMSQ statistic, money velocity has not been constant in Kenya as it experienced instability at certain periods. The study found that 1-unit increase in measure of financial innovations (ratio of mobile money transactions to nominal GDP) made velocity of money in circulation to fall. The study also established that in the short-run, 1 percent increase of T-bill rate was significantly related with an increase in money velocity. In the long-run, real GDP, exchange rate depreciation, and opportunity cost variables which include: the inflation rate and lending rate positively and significantly affected money velocity. On policy recommendations, CBK should monitor financial sector development and enact policies to make money velocity and money multiplier stable, and thus ensuring the money demand function in Kenya remains predictable.

LIST OF ACRONYMS AND ABBREVIATIONS

AFC	Agricultural Finance Corporation
ASCAs	Accumulating Savings and Credit Associations
ATM	Automated Teller Machines
CBK	Central Bank of Kenya
CGAP	Consultative Group to Assist the Poor
CMA	Capital Markets Authority
CUSUM	Cumulative Sum of Recursive Residuals
CUSUMSQ	Cumulative Sum of Squares of Recursive Residuals
FSD Kenya	Financial Sector Deepening Kenya
GDP	Gross Domestic Product
HELB	Higher Education Loans Board
ICDC	Industrial and Commercial Development Corporation
IRA	Insurance Regulatory Authority
JLB	Joint Loans Board
KIE	Kenya Industrial Estate
KNBS	Kenya National Bureau of Statistics
MMT/ NGDP	Mobile Money Transactions to Nominal GDP
M1	Narrow Money
M2	Quasi Money
M3	Broad Money
MSME	Micro, Small, and Medium-Sized Enterprises
NHIF	National Hospital Insurance Fund
NSSF	National Social Security Fund
POS	Point of Sale
Q2	Quarter 2
Q3	Quarter 3
Q4	Quarter 4
RBA	Retirement Benefits Authority
RoSCAs	Rotating Savings and Credit Associations
SACCO	Savings and Credit Cooperative Organizations

SASRA	Sacco Society Regulatory Authority
SDGs	Sustainable Development Goals
T-bill rate	Treasury Bill Rate
VAR	Vector Autoregressive

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CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The development and innovations of Kenya's financial services have transformed monetary aggregates. Key policy measures bolstered economic and financial development, which prompted: firstly, the economy to grow at faster rates; secondly, the inflation rate to stabilize at lower levels; thirdly, the balance of trade to become surplus; and fourthly, the expansion of the shares of private sector credit to GDP and M3 (Killick & Mwega, 1990). The contribution of financial services to GDP is observed to go up as access to financial services increases. In contrast to 2006, when financial services made for 4 percent of GDP, they in 2019 accounted for 6.4 percent of GDP (KNBS, 2011, 2021).

Financial services consist of formal and informal providers. Prudential, non-prudential, and registered providers make up the formal providers. One, prudential, include: deposit-taking Sacco and specified Sacco that do not take deposits, all in accordance with SASRA regulations; pensions regulated by the RBA; insurance governed by the IRA; capital markets regulated by the CMA; and commercial banks, microfinance banks and mortgage finance companies are all regulated by the CBK. Two, non-prudential, are overseen by relevant government ministries or agencies with a mandate to enforce the law. They comprise of: mobile money; Youth Fund, ICDC, Women Fund, HELB, AFC, JLB and KIE; Kenya Post Office Savings Bank; NSSF; Credit Only Microfinance Institutions; and NHIF. Three, registered are legal entities and include: non-specified deposit taking Sacco, hire purchase companies and digital or mobile money apps. Conversely, informal providers have a well-defined organizational structure despite not being registered. These consist of: chamas, RoSCAs, ASCAs; shopkeepers, supermarkets, supply chain credit facilities; employers; moneylenders or shylocks; and online forex dealers, online payment modes, cryptocurrency dealers (CBK;KNBS;FSD-Kenya, 2021a).

Rosen (2013) observed that there are various innovative solutions in finance that have immensely changed services. The launch of mobile phone financial services in 2007 pinpointed technological progress that was taking place. Bhan (2014) mobile money e.g. M-Pesa, MTN etc. have thrived in

Africa. Telecommunications companies are taking advantage of technological advancements to unveil brand new services as well as modify business models, thus expediting developing economies, especially in Africa, to the prospect of going cashless in the near future. The current regulations continue to evolve and competition for retail deposits are seemingly driving down the transaction costs especially for banks. Banks around the world have invested heavily in creating enterprise solutions such as online banking services through mobile phones for customers and in retrospect reducing operating costs.

The SDGs and inclusive economic growth, both of which benefit all participants, depend critically on financial innovations. Around 1.7 billion adults worldwide inextricably from developing countries are unbanked and are unable to obtain financial services in any way, shape, or form (Demirguc-Kunt et al., 2017). Mugo and Kilonzo (2017) improving financial access supports a culture of savings and investment. The outcomes culminate into capital accumulation and asset creation, which reduces vulnerability to poverty. Visco (2007), Misati et al., (2010) and Resina (2004) stated as a result of financial development; financial market institutions and players expand, leading to better market integration and efficient allocation of resources. Thus, risks are diversified and transaction costs are reduced. Inadvertently, structural changes affect how stable the financial system will be, how monetary policy will work, and may unexpectedly trigger new risks.

Nyamongo and Ndirangu (2013) in their study concluded financial innovations can have an effect on how the Kenyan economy responds to monetary policy as well as key indicators that the CBK frequently monitor to determine policy direction. Noyer (2007) noted that financial innovation introduces new products and intermediaries that modify financial behavior of economic agents, which can contribute to instability in money demand. For example, within the Euro zone, demand for M3 and its velocity have been volatile since 2001, with an unpredicted velocity pattern as liquidity steadily increased. Ho (2006) argued that financial innovations influence how financial markets are structured, how economic agents make financial decisions and the variety of products in financial markets. In this regard, financial innovations influence the entire mechanism of monetary transmission and, therefore, can create uncertainty in the central bank's monetary functioning.

1.2 Financial innovations

Financial innovations involve introduction of new services, such as new ways of paying, savings, lending and investing. Digital technologies are revolutionizing the way we pay, save, borrow, and invest (Frost et al., 2021). Demirguc-Kunt et al., (2017) found that between 2014 and 2017, an additional 515 million adults banked globally. This translated to 69 percent of adult worldwide using bank or mobile money in 2017, up from 62 percent in 2014. New technologies are considered the engine of this progress.

Digital financial services rely on digital technologies such as fintech to deliver services to customers and thus leverage on lower costs, increased speed, greater transparency, enhanced security and greater convenience. Digital platforms are highly scalable as they help to match different group of users and improve risk assessment, especially for insurance, investing and lending. Innovations are capable of gathering information and reaching users at a reasonable cost (Goldfarb & Tucker, 2019).

Digital financial services help overcome, first, supply-side factors that hinder persons from accessing financial services, including: exorbitantly high operating costs, few players, thus less competition and innovation. Second, demand side hindrances include: small and unstable incomes of low-income earners, lack of national identity cards, low literacy and trust levels, informality and lack of documentation, and geographic barriers (Pazarbasioglu et al., 2020). Thus, Triki and Faye (2013) technological advances become an avenue for financial inclusion by providing much needed, affordable and accessible financing to disadvantaged households.

Current examples of financial innovations in Kenya are branchless banking and mobile money services. Branchless banking services include: one, agent banking, i.e. agents serving the bank's customers. Second, electronic banking, i.e. where you can bank online using the internet and you can also use a POS terminal and an ATM. Third, is the use of mobile phones to make financial transactions, mobile banking.

Mobile money services have evolved to provide firstly, mobile transfers via M-Pesa, Airtel Money or T-Kash which enable customers to transfer money (P2P) both within and across Kenya’s borders without purchasing goods or services. Secondly, Lipa na M-Pesa or Pay Bill for paying

goods and services. Thirdly, financial services examples are M-Shwari and Stawi from NCBA bank, KCB-MPesa from KCB bank, MCoop cash from Co-op bank, Eazzy from Equity Bank, Timiza from ABSA bank, HF Whizz from Housing Finance, and M-Fanisi from Maisha Microfinance Bank. The digital credit market has become competitive even as banks seek to offer alternative sources of financing in a bid to expand access to customers (FSD, 2015, 2019; Okiro & Ndungu, 2013).

Mobile money providers also provide savings through mobile banking as part of their mobile financial services. Subscribers can also access micro finance, insurance, etc. on their mobile phones, for example Fuliza offered by Safaricom. Ndung'u (2018, 2019) commercial banks employ digital technologies to manage new account openings, raise deposits, and reach out to the unbanked customers.

In Kenya, mobile money increased the savings in female-headed households by more than a fifth, enabling 185,000 more women to start businesses and helping to trim down extreme poverty by 22 percent (Suri & Jack, 2016). Mobile money mitigates risk for those living in far flung areas as friends, family and even the government can send them money in times of need. According to Jack and Suri (2014), when incomes unexpectedly fall, mobile money subscriber households do not shrink their spending, whereas non-subscriber households lowered their spending by 7-10 percentage points. CBK;KNBS;FSD-Kenya (2021a) formal access to finance in 2021 was 83.7 percent, an improvement from 82.9 percent in 2019. Advancements in mobile money and mobile banking can help explain the trajectory.

1.2.1 Electronic banking

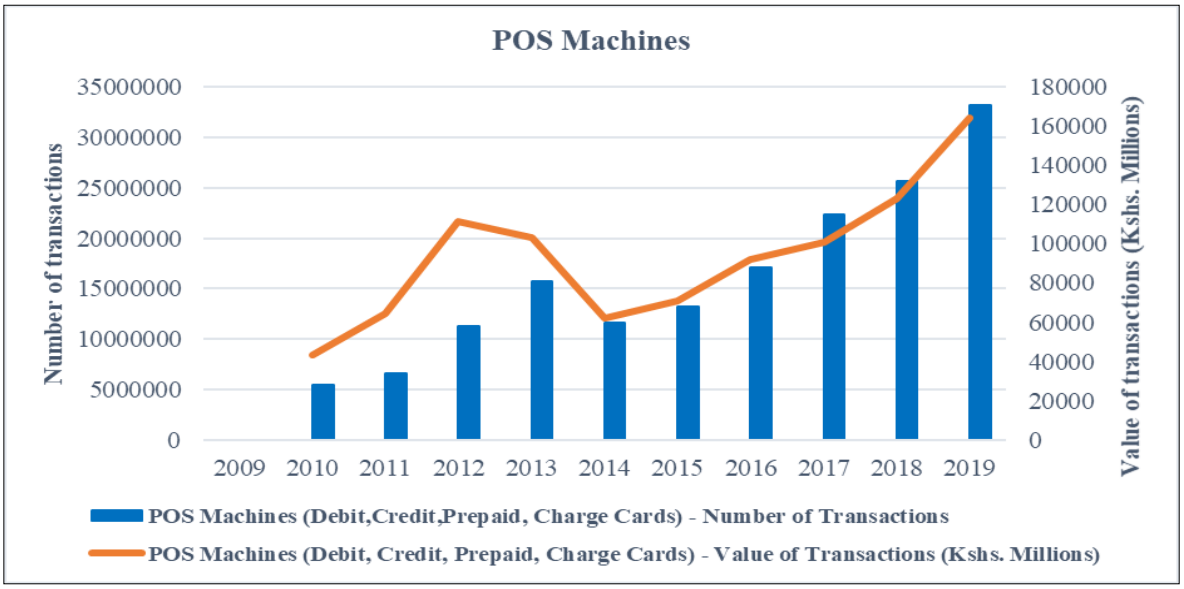
Table 1 displays ATMs increased from 1,717 in 2009 to 2,459 in 2019. During the same period, credit card usage increased from 108,456 to 263,255 and debit card usage from 3,700,646 to 10,597,465, while POS machines also rose tremendously from 15,871 to 42,846 (CBK, 2022).

Table 1: ATMs, POS machines and Digital cards

Year	Total Number of ATMs	Total Number of POS Machines	Number of Digital Cards				
			Prepaid	Charge	Credit	Debit	Total Number of Digital Cards
2009	1717	15871	16749	1682	108456	3700646	3827533
2010	1979	18179	18750	725	113192	6191792	6324459
2011	2130	16604	22405	1339	122212	8548390	8694346
2012	2306	18478	27558	2095	138011	9063905	9231569
2013	2417	21089	73395	750	158612	9543204	9775961
2014	2514	17511	419258	68	208352	10552312	11179990
2015	2579	22230	2047340	873	252178	10673090	12973481
2016	2615	30133	1503715	826	233752	12903875	14642168
2017	2564	35466	1357372	700	236392	13616645	15211109
2018	2529	44874	1261985	695	239484	16167386	17669550
2019	2459	42846	635039	541	263255	10597465	11496300

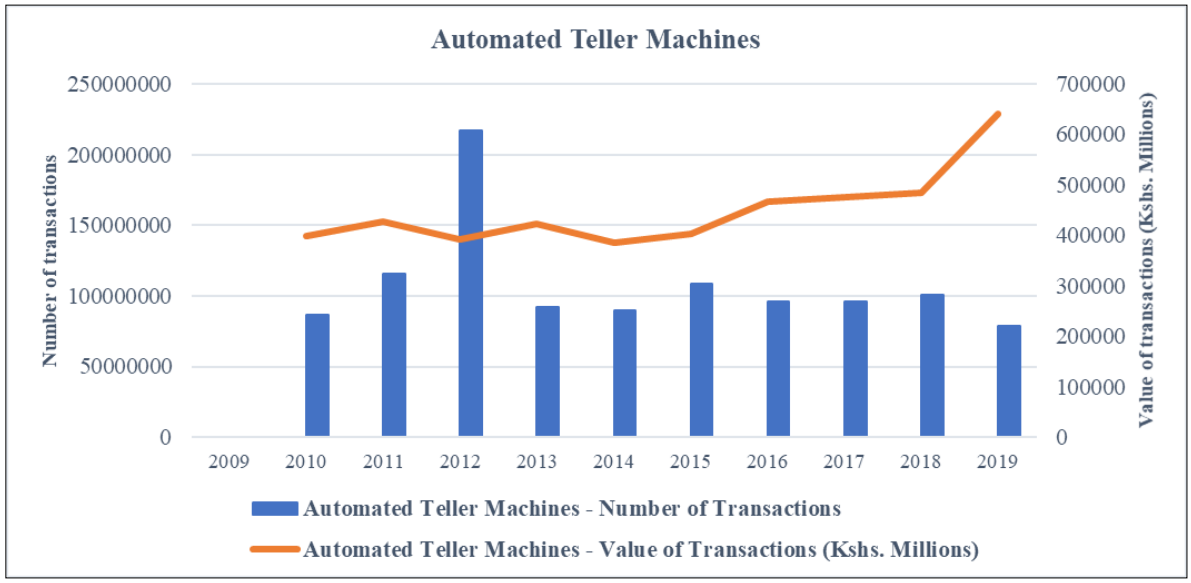
Source: CBK (2022)

Figure 1: Trends in POS Machines



Source: CBK (2022)

Figure 2: Trends in ATMs



Source: CBK (2022)

1.2.2 Mobile money

Mobile money services pushed Kenya towards a cashless economy. According to Table 2, the agents climbed from 23,012 in 2009 to 224,108 in 2019. Correspondingly, the accounts increased from 8.88258 to 58.3613 million and money transferred increased from 473.4115 to 4,345.764 billion Kenyan shillings (CBK, 2022).

Table 2: Agents, mobile money accounts and transaction value

Year	Total Number of Agents	Total Number of mobile money accounts in millions	Total transaction value by agents in Kenya shillings billions
2008	6104	5.08247	166.57132
2009	23012	8.88258	473.4115
2010	39449	16.4463	732.2199
2011	50471	19.191	1169.1502
2012	76912	21.06	1544.807
2013	113130	25.3263	1901.559
2014	123703	25.2492	2371.794
2015	143946	28.6447	2816.099
2016	165908	34.957	3355.105
2017	182472	37.3868	3638.474
2018	205745	47.6943	3984.37
2019	224108	58.3613	4345.764

Source: CBK (2022)

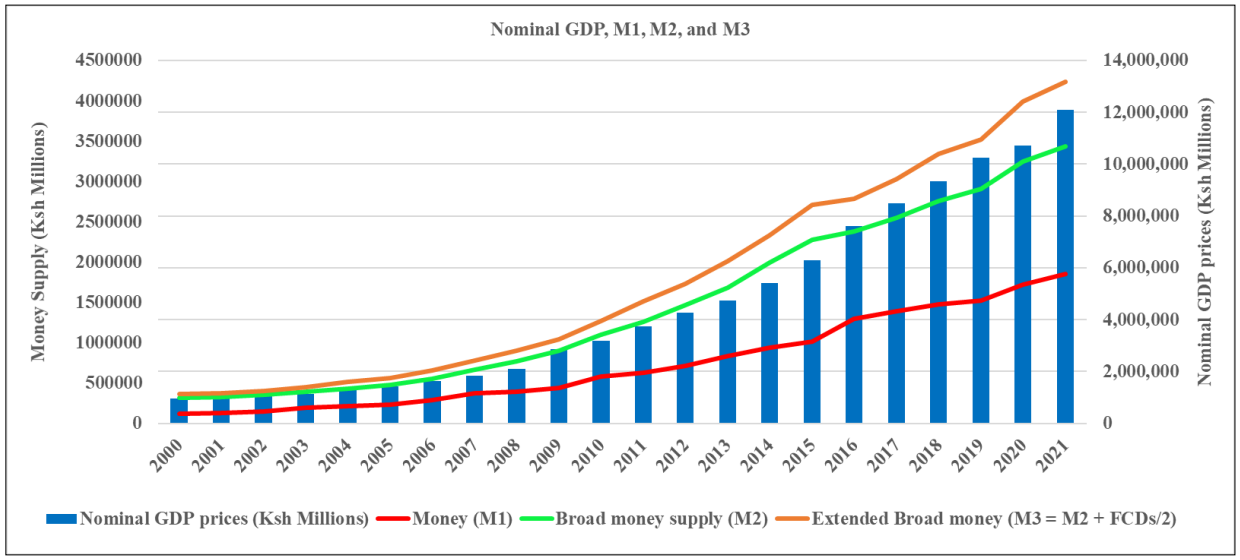
1.3 Money velocity

Money velocity refers to turnover, or the number of times one Kenyan shilling is traded for goods and services in a certain time period, such as a quarter or a year. Rami (2010) money velocity measures the ratio of nominal income to M3. Killick and Mwega (1990) emphasized that monetary aggregates are important in formulating monetary policy. Monetary aggregates influence macroeconomic pricing (inflation, exchange rates and interest rates), and investment, economic growth, etc. Okafor et al., (2013) argued that fluctuations in the money velocity can effectively nullify the results that monetary policy was intended to achieve.

In Kenya, since 2007, there has been an increase in the instability of monetary relations. This is evidenced by the trend of the money velocity to decline and the money multiplier to increase. These trends can be directly attributed to financial developments including mobile money innovations, which indicate greater financial depth. Weil et al., (2012) found that money velocity decreased considerably on a monthly basis from an average of 2.50 in 2006 to 2.09 in 2010, whereas money multiplier went up on a monthly basis from an average of 5.49 in 2006 to 5.96 in 2010.

Sichei and Kamau (2012) found that the demand for monetary aggregates was not stable between Q4 1997 and Q2 2011. Their paper attributed the volatility to financial market innovations. Nyamongo and Ndirangu (2013) established that in the periods before 2002 and between 2009 and 2010, money velocity was not stable. Similarly, the money multiplier has not been stable since 2007. This can be attributed to the innovations that coincided with introduction of mobile money in Kenya.

Figure 3: Trends in nominal GDP and monetary aggregates



Source: CBK;KNBS (2022)

1.4 Financial innovations and money velocity

Previous scholars have focused mostly on: estimating the money demand; establishing a link between commercial bank innovation and performance; determining what innovations imply about the transmission of monetary policy; determining what innovations mean for monetary policy transmission and whether a link exists between innovation, economic growth, and financial depth. These authors include: Sichei and Kamau (2012), Misati et al., (2010; 2021), Chipeta and Muthinja (2018), Ndung'u (1994), Ndirangu and Nyamongo (2015) and others.

Money velocity is considered a significant variable when estimating the money demand function. Variations in M3, according to Selden (1956), adjust the price and income based on velocity of money. Computing money velocity can help predict how aggregate spending changes over time (Friedman, 1959). Van den Ingh (2009) money velocity is an important factor in the short-run implementation of monetary policy. Kenya's economic environment is projected to be stabilized by monetary policy. This study looks at the effect of mobile money and innovations on money velocity. It takes cognizance of how Kenya can achieve optimal economic growth at given levels of money supply.

1.5 Problem statement

In order to develop successful monetary policy in the Kenyan context, the money demand ought to be stable so that monetary aggregates can reliably predict output, interest rates and price (Sriram, 2001). Developing countries like Kenya face a challenge of unstable money demand as a result of financial innovations and developments. CBK (2016) reported that money multiplier has been unstable, and the long-term trend of money velocity has been declining, affecting the projection of money demand. This was caused largely by innovations such as mobile phone platforms. In particular, in Q4 2016, the money multiplier was volatile, ranging from 6.7 to 7.1, while the velocity of money fluctuated between 2.4 and 2.5.

The CBK regulates players in the financial sector. The CBK controls the money supply and ensures sufficient liquidity, solvency, a market-based financial system that works, and ensures the domestic currency stability, thus helping to maintain stable general prices towards the realization of the stipulated growth rates.

Money demand is volatile and uncertain, such as, it increases during the peak period but decreases during the recession. Hypothetically, in the long run, the money supply varies with nominal GNP. Therefore, the CBK has no direct control over inflation, as a result, it embarks to employ either reserve money or interest rates on short-term loans are employed as policy tools. Every now and then, the CBK has to decide the targeting tool that is most preferred. Such a scenario leads to uncertainty and instability in the function that determines money demand in Kenya. In particular, mobile money can cause variations in the monetary aggregates targeted by policy, which distorts the outcomes. Jack et al., (2010) when the money supply expands, private credit offered through mobile money can cause price swings and instability in production.

According to the research problem statement, the study attempts to answer the following research questions:

i. What is the effect of financial innovations on money velocity in Kenya?
ii. What are the control effects of T-bill rate, commercial banks' lending rate, inflation rate, exchange rate and real GDP on money velocity in Kenya?
iii. What policy recommendations can be made based on the research findings?

1.6 Study objectives

The main objective of the study is:

i. Investigate the effect of financial innovations on money velocity in Kenya.

The study also controlled for the effects of:

ii. T-bill rate, commercial banks' lending rate, inflation rate, exchange rate and real GDP on money velocity in Kenya.

iii. Based on research findings, make policy recommendations.

1.7 Significance of the study

The study used recent data to shed light on how financial innovations have affected money velocity in Kenya. The study's findings helped to inform effective monetary policies to be put in place by monetary regulators, i.e. the CBK, during a phase of rapid growth of financial services and innovations that make the velocity of money and money multiplier unstable, which affects monetary aggregates.

The study would also be invaluable to entities offering financial services, such as commercial banks, who wish to learn more about the potential effect of technology on the provision of services and products to their customers. It was evident that the existing literature focusing on financial services in Kenya, specifically innovations such as mobile money, electronic banking etc., was scanty. The study contributed to the existing literature on how mobile money services and other financial technologies affect money velocity, and explaining their relationships in Kenya. The study has additionally gone a long way to build on the existing literature on the overarching role played by the fintechs and telecommunication companies in financial innovations in Kenya that have ultimately improved the levels of financial inclusion and made financial services competitive.

1.8 Layout of the study

Chapter 2 covered the literature review. The study methodology was presented in Chapter 3. Chapter 4 presented empirical findings. Chapter 5 summarized the findings.

CHAPTER TWO
LITERATURE REVIEW

Introduction

The chapter outlined prior studies on the effect of mobile money and innovations on money velocity both in other countries and in Kenya. It reviewed the key theories and empirical literature applied in the research process.

2.1 Theoretical Review

2.1.1 The classical perspective of quantity theory of money

Fisher (1911) developed an equation of exchange that connects transaction volume and pricing level to total monetary value of transactions. The transactional demand for money received significant attention from classical economists.

$$MV = PT \ldots eq.1$$

Where:

M – total amount of money in circulation, V – frequency with which money is exchanged, P – the average pricing range, and T – the total volume of products and services available for sale. In general, MV represents the cash payments made by businesses to buy finished goods, whereas PT represents the money businesses make from selling their products and services.

This identity is used to calculate the price level under the following assumptions: first, the monetary authorities control money supply. Second, in the short run, the number of transactions is fixed based on the classical premise that the economy runs at full employment and is always near to the natural level of real GDP. Third, because it is heavily influenced by institutional considerations, such as whether workers are paid weekly or monthly, and in the short-run, the velocity is fixed.

People find that they have more money in their possession than they need for current transactions when the monetary authorities expand the money supply, so they try to spend the extra. Given full employment and a constant volume of transactions, it is the added cost that causes the pricing level to rise. Because conducting a transaction gets more expensive as prices rise, the demand for money rises. Changes in the money supply have a commensurate effect on the price level.

Conclusively, inflation will come from any growth in the money supply that exceeds the economy's capability. In contrast, when output is increasing and the velocity of circulation is constant, to avoid deflation, the money supply must be increased in proportion. When the economy is expanding, monetary authorities should permit considerable growth in the money supply without allowing it to spiral out of control.

2.1.2 Cash balance theory of money demand – Cambridge version

Quantity theory of money by Fisher was refined by Marshall (1923), who developed the Cambridge version. The Cambridge theory of cash balance accentuated on individual choice and regarded money as a store of worth, in other words, holding money was the purchasing power of a person with time. In contrast, Fisher assigned weight to the quantity of money a person had when he wants to make a transaction. Pigou (1917) asserted that the desire to hold money does not depend on the rate of interest, but depends on a person's nominal income.

The current rate of interest, personal wealth, expectations of future prices, and the future rate of interest are all elements that affect an individual's desire to store money in the form of cash, according to Marshall and Pigou. However, changes in these factors either remain constant or change in proportion to a person's income. Money demand as cash balances is thus proportionate to a person's nominal income, according to the Cambridge version.

$$M^d = \frac{1}{V}(PY) = \frac{1}{V}GDP = kGDP \ldots eq.\ 2$$

Where: M^d – the demand for money, Y – the output, P – the pricing level of currently manufactures products and services, V – the velocity of money, and PY – the nominal GDP, and if we let $\frac{1}{V}$ be equal to k, then k – the proportionality constant of nominal income that people want to hold as cash balances.

k varies from time to time, because money is viewed as a store of worth. Because the income and price elasticity of demand for money are both equal to unity, any change in either will result in an equal and proportionate change in the demand for money. Lower money velocity is associated with higher nominal income holdings, i.e. k and vice versa. The Cambridge economists claimed that, when taking the interest rate in the economy into account, holding money depends on profitability and expected return on investment, making it a store of value.

2.1.3 Keynes' liquidity preference theory of interest rate determination

Keynes (1936) outlined how savings and investments can differ briefly as well as how the liquidity preference affects interest rates in an economy. People prefer money rather than wealth for three reasons, according to research. First, the motive of transactions—that is, households require money to pay for necessities—and the volume of transactions are influenced by an individual's income and frequency of money transactions. As a result, the need for money in transactions rises as income does. Second, there is the precautionary motive, which refers to holding money to cover unforeseen expenses like illness, accidents, or robberies. This motive may be based on the person's income level. Although the effect of the interest rate is relatively minimal in comparison to income, it is also a rising function of income. Third, the speculative motive, which refers to holding money to take advantage of profitable opportunities that may arise from time to time, such as bonds and Treasury bills. Everyone anticipates what the normal interest rate will be, according to Keynes' theory. When the rate is low, people speculate. For instance, when people predict that future interest rates will decline, this means that future bond prices would increase, indicating capital gain for bondholders. According to the hypothesis, when interest rates are unusually high, there will be a large demand for bonds and, as a result, more people will trade money for bonds, which will decrease the demand for bonds for speculative purposes.

According to Keynes, people hold wealth in the form of money or bonds, and their choice for one over the other is determined by the interest rates. The interest rates and speculative demand for money are inversely related.

The three reasons for holding money, which cause demand for real money balance, are added up to get the total demand for money. It is influenced by: one, the interest rates denoted by i, and two, the income denoted by Y.

$$\frac{M^d}{P} = f(Y, i) \dots \text{eq. } 3, \qquad M^d = P[f(Y, i)] \dots \text{eq. } 4$$

Where:

Y is a person's income so that $f'(.) > 0$ with respect to Y.
i is a person's income so that $f'(.) < 0$ with respect to i

Velocity is given by: $V = \frac{GDP}{M^d} = \frac{PY}{M^d} = \frac{PY}{P[f(Y,i)]} = \frac{Y}{f(Y,i)} \ldots eq.5$

Where: M^d – the demand for money, Y – the real income, and P – the average price level

Liquidity preference theory states that the rate of interest influences velocity, which causes it to fluctuate constantly. He presupposed that because the money supply is fixed by the government, it is perfectly inelastic. He also argued that a rise in the money supply would lead interest rates to fall while simultaneously lowering private investment as people would be forced to hold idle money. This, in turn, will lower the velocity of money. The investment is influenced by technological advancements, confidence and business expectations.

Monetary policy actions like increasing the supply of money, will be minimal on GDP because it will be offset by a decrease in the velocity of circulation, leaving average prices and real income unaffected. According to Keynes, the money velocity is positively correlated with interest rates, meaning that it continually fluctuates in response to the interest rates prevailing in the market.

2.1.4 Baumol-Tobin theory of demand for money

Keynes' demand for money model was expounded by Tobin (1956), and Baumol (1952), respectively. They consider money to be an inventory asset that is kept to be used for transactions only and pays no interest. According to Mishkin (2004), a person was assumed to only receive payments once during a specific time period and to spend it during that period. An individual must make a decision. If he or she chooses to hold extremely tiny money balances, he can earn interest on keeping interest-bearing bonds, but he will pay more in transaction costs. In the event of a high interest rate, he will hold more bonds and fewer money balances since the benefits of owning bonds outweigh the transaction costs. However, if the interest rate is low, he would be better off holding more money balances and fewer bonds because doing so may result in transaction costs that outweigh interest income.

According to Tobin (1969), the demand for money decreases as more transfers occur between money and securities. The additional interest a person earns from investing in additional securities and smaller cash balances represents the marginal revenue generated by each brokerage transaction. The marginal revenue from each transfer declines as the number of transfers rises. Transaction charges, such as brokerage fees, that are charged when money is transferred from one

security to another make up marginal cost. The cost accounts for the time and effort required to move between money and securities. Because the marginal cost curve is perfectly inelastic, each transfer has a fixed marginal cost. The point where marginal revenue and marginal cost are equal is where the optimal number of transfers is established. The amount of money demanded depends on the number of transfers.

According to Baumol's analysis, the demand for transaction balances is influenced by opportunity cost of deposits as well as brokerage fees. Baumol makes the assumption that a person pays a brokerage fee each time they purchase or sell a bond. The interest forgone by holding wealth in money as opposed to securities is known as the opportunity cost (Yamden, 2011).

$$\text{Total costs} = \text{Brokerage costs} + \text{Opportunity costs} \ldots \text{eq. } 6$$

$$TC = b\left(\frac{Y}{T}\right) + (i - r_D)M^d \ldots \text{where } M^d = \frac{T}{2} \ldots \text{eq. } 7$$

Where: Y – the income, b – fee paid to the broker, T – transactions volume, r_D – the deposit rate, i – the rate of interest and $\frac{Y}{T}$ – the number of transfers.

To minimize total costs, the investor decides how much money will be converted from bonds to cash at each withdrawal. Investors decide on the amount of T that will minimize the total cost. The following results are obtained by:

Differentiate TC with respect to T

Set the derivative to zero, and solve for T:

$$T = \sqrt{2bY/(i - r_D)} \ldots \text{eq. } 8, \quad M_d = \frac{1}{2}\sqrt{2bY/(i - r_D)} \ldots \text{eq. } 9$$

eq. 8 determines the optimal T. eq. 9 calculates the demand for money.

The benefit that one gets from keeping money is that the transaction fees are avoided whereas the cost forgone for keeping money is the interest revenues. People tend to keep less money with a rise in the opportunity cost. In other words, bond investments will be profitable as opportunity costs rise and the optimal cash balance will decline (Yamden, 2011).

When interest rates rise, less money balances will be held for transactions, which will result in an increase in velocity. The connotation is that the level of interest rates has a negative link with transactional money demand. They discovered that, in addition to speculative demand in the Keynesian liquidity preference theory, transactional demand for money is responsive to interest rates.

People can adjust their money holdings so that as interest rates rise, the expected return on a different asset—such as bonds—also rises, lowering the relative expected return on keeping cash and reducing its demand (Mishkin, 2004).

Similar to this, when interest rates increase, holding precautionary balances has a higher opportunity cost, which results in a decrease in money balances. As a result, interest rates are negatively related with the need for money for precaution (Mishkin, 2004).

2.1.5 Monetarists' approach to demand for money theory

Friedman (1956) explained that real money balances depend on three aspects in accordance with the modern quantity theory of money demand: first, total wealth; second, the price and return of different types of wealth; and third, the tastes and preferences of wealth owners. In contrast to Keynes, who believed in the liquidity preference theory, Friedman viewed money as an asset. All sources of income were included in the total wealth. Money, bonds, stocks, tangible non-human products, equity, and human capital are all examples of ways to hold wealth. Accordingly, when faced with uncertainty, economic agents, including people, businesses, and the government, tend to hold wealth as money more so than they would otherwise.

$$\frac{M^d}{P} = f(Y_p, (\pi^e - r_m), (r_b - r_m), (r_e - r_m)) \dots \text{eq. } 10$$

Where:

M^d – demand for money, P – average price, r_b – rates of return that are expected on holding bonds, r_e – rates of return that are expected on holding equities, r_m – rates of return that are expected on holding money and π^e – expected inflation or a proxy for expected return on non-financial goods.

eq. 10 above demonstrates how the desire for having real money balances is dependent on: one, permanent income Y_p or present discounted value of all incomes expected to be earned in future.

Two, the cost that is forgone when one holds money, which is represented by nominal rates of expected return on: bonds, $(r_b - r_m)$, equities $(r_e - r_m)$, and money $(\pi^e - r_m)$.

According to Friedman, who postulated that the desire for having real money balances is positively related to permanent income. In real terms economic agents hold more money as their income becomes permanently higher. A decrease in the rate of expected return on financial investments in comparison to the rate of expected return on money, on the other hand, will cause economic agents to hold more money because the cost of opportunity forgone on holding money is lower. In other words, the cost of opportunity forgone on keeping money decreases as the desire for having real money balances increases. An increase in expected inflation diminishes money's purchasing power, ceteris paribus, thus economic agents will demand more nominal balances, such as bonds, equities, and commodities to maintain their real money balances at a steady level (Friedman, 1956, 1970).

Monetarists assumed that the private sector remained stable, prices are flexible, and the velocity of circulation was stable and could be predicted by expected nominal rates on various financial and physical assets. Since bonds, stocks, and commodities can all be directly exchanged for money, the demand for other assets will increase as the money supply rises. If we assume that the overall economic production is fixed, then when the money supply expands, prices rise. Monetarists and classical economists both came to the same conclusion—that rising money supply would result in rising prices. Monetarists contented that increasing the money supply would improve output and, as a result, employment in the short run.

However, Friedman (1959) emphasized on the economy's supply-side long-run properties. Unless there is more long-term growth in the economy, a rise in the supply of money will be reflected in an increase in prices in the long run. Friedman (1985) suggested that when it come to the long-run, the money growth rate influences prices but has little effect on economic growth, meaning that inflation will occur at the point when the money growth rate exceeds the economic growth rate.

2.2 Empirical Review

2.2.1 Determinants of money velocity

After the work of Bordo and Jonung (1987; 1981), who used an institutional approach for the period 1880 to 1986 and found that velocity was on a trend that was declining downward across 5 countries namely: Norway, Canada, Sweden, United States and United Kingdom, from the late nineteenth until World War II in 1945, the existence of the u-shaped long-run velocity behavior observed in the 1900s was widely acknowledged. After World War II, velocity started to accelerate following an upward trend.

Increased monetization, which led to velocity declining as holdings of transaction balance expanded faster than income, is what the 2 authors, Bordo and Jonung, blamed for the declining trend of velocity in circulation. Monetization was estimated by the ratio of currency/money. The upward trend was analogous to financial innovation and deregulation, as economic agents economized on their cash holdings. This resulted from the development of the capital and money markets, particularly expansion of the banking system, different stages of the financial sector's development in various nations, and adjustments in the decision-making process for fiscal and monetary policy.

Gordon et al., (1997) established velocity behavior using Ramsey–Cass–Koopmans model and quarterly data in the United States spanning the years from 1960 to 1997. They calibrated a general equilibrium model to determine the nominal expected return on assets in proportion to the real expected return on assets. Policy expectations will have an effect on the portfolio decisions made by economic actors, such as the decision to substitute nominal assets with real assets, which will subsequently lead to changes in velocity. They hypothesized that, whilst expansionary fiscal policy will cut real taxes and draw economic agents to real assets, which will be taxed less comparatively, fiscal policy that is contractionary will raise real taxes and, as a result, encourage economic agents to hold nominal assets like money. Due to economic actors' shift to real assets in latter, which implies higher velocity values, there is a decrease in money demand on the short-run. In contrast, monetary policy that is expansionary will boost real money balances, which will result in a greater opportunity cost of keeping money. As a result, economic agents will be more likely to exchange real assets for money, increasing short-term velocity values.

Duczynski (2004) studied the factors that affected money velocity in developed and Latin-American nations between 1975 and 2000 with rates of interest as an independent variable. They discovered that the money velocity experienced instability in the long run, since it fluctuated in both regions. In the long run, they found that the velocity of money was unstable (not constant) as it continued to vary in both regions. In actuality, the interest rates from the first lag were more significant than those from the current period. Interest rates had a greater influence on money velocity in Latin American nations than developed nations.

A number of other researchers have previously studied velocity of money in Kenya. Killick and Mwega (1990) found that past demand for money was a major determinant of velocity. Interest rates and inflation significantly affected M3 as well. The results were consistent with earlier research by Darrat (1985) and Kanga (1985).

King'ori (2003) investigated the relationship between money velocity and expected inflation rate, real per capita income, real exchange rate, and financial innovations in Kenya between 1992 and 2002 using the ARDL model and an error correction model. The analysis found that while the real interest rate had a smaller but still significant impact, financial innovation and the foreign exchange market had a stronger influence on short-run money velocity. The rate of inflation had no influence on the velocity of money. Money velocity was inversely related to real per capita income. Broad money velocity function was stable.

Anyanwu (1994) studied the M1 velocity in Nigeria between 1960 and 1992 and found that financial deregulation, interest rates, inflation rates, real GDP, and exchange rates all had an effect on the income velocity of money. Akinlo (2012), did a study utilizing co-integration and error correction mechanisms, which revealed velocity and income growth had a positive relationship. This means Nigeria's economy is nearing its peak in terms of economic expansion. In contrast, the exchange rate's short-run relationship with income velocity was negative. In the short run, interest rates and predicted inflation rates, both of which are opportunity cost variables, were insignificant. The author demonstrated that the deployment of money substitutes has a favorable influence on the demand deposit/time deposit ratio (financial development variable). As a result, any effort by the government to increase money printing will trigger a spike in inflation.

Ndanshau (1996) showed, using data from 1967 to 1994, that the expected rate of inflation in Tanzania was inversely proportional to the velocity, albeit weakly, while the real interest rate was also significant. Adam et al., (2010) studied the importance of income velocity in monetary targeting framework forecasting in Tanzania. Their findings demonstrated that VAR model outperformed alternative methods on coming up with the structural equation for money demand. They concluded that VAR-based forecasting can be useful in the formulation of monetary programs since a co-integrating relationship was stable between the velocity and other factors influencing money demand.

Rami (2010) examined the velocity of money in the India from 1972 to 2004. He developed a model with share of monetary assets, short-term interest rates, real income, extend of monetization, bank population and money stock as independent variables whereas the money velocity as a dependent variable. The research showed that the M3 velocity was very predictable. Institutional variables such as monetization and the total number of banks were discovered to be significant in M3 velocity, whereas monetization was found not to be significant in M1 velocity.

The study by Gill (2010) employed the Johansen co-integration technique to show the factors influencing the money velocity in Pakistan during a 33-year period, from 1973 to 2006. The velocity of money was found to be positively related with interest rate, real income proxied by real GDP per capita and financial development proxied by time deposits to currency ratio and consumer price index (inflation). Making successful and credible monetary policies, however, requires consideration of the fact that the money velocity has not been constant.

Mukisa (1998) did a study on the factors influencing velocity in Uganda between 1980 and 1997. The velocity of M3 turned out to be stable. Significant factors that play a vital role in determining velocity were financial innovations, past nominal rate of interest and level of inflation. Findings showed that the velocity of broad money has a negative income elasticity. Altayee and Adam (2012) investigated the velocity of money in Sudan. Their findings depicted that in the mid-1900s, the velocity of M1 fluctuated and was persistent, but post-2000 it was more stable and predictable.

Leão (2005) suggested that the pro-cyclicality of velocity was due to erratic total expenditures during economic crises and business expansions in the United States. He distinguished between expenditures on capital goods, exports, and consumer durables as well as expenditures on nondurable products and services. As economic agents match their expenditures on consumer durables, exports, and investment goods when liquid capital becomes available, money engaged in these expenditures has higher velocity values than expenditures related to nondurable products and services. Consumer durables, exports, and investment goods make up a larger share of total expenditure during expansions than they do during recessions. Using quarterly data from 1982 to 2003, he developed a short-run error correction model and a long-run semi-log specification to analyze velocity behavior. The independent variables were: first, the share of consumer durables, exports and investment goods in aggregate expenditures. Second, in accordance with Friedman (1984) idea that M1 volatility means uncertainty that would force people towards money balances and decrease velocity values, M1 volatility was proxied by the M1 standard deviation, which had a negative sign. Third, transactions of non-real GDP represented the ratio of M3/M1. Growth of transactions of non-real GDP will lead people out of demanding M3 into demanding M1, bearing in mind that lower values of M3/M1 ratio are consequently accompanied by lower V1 values. In the short-run only the M1 volatility was significant, whereas the co-integrating relationship in the long-run revealed other independent variables to be significant with the expected signs.

The conclusions of Leão (2005) are in agreement with those of Barros et al., (2007), who also developed a model in line with the expenditure composition hypothesis. The study used VAR model to investigate the variables influencing the both M1 and M3 velocity in the US from 1964 to 2005. They discovered that increasing the proportion of investment and consumer durable goods in total expenditure increases both M1 and M3 velocity. Additionally, in light of this, they proposed the hypothesis that economic growth will become more unstable and volatile the greater the decision by the central bank on interest rate is influenced by money growth.

2.2.2 Financial innovations and monetary aggregates

Weil et al., (2012) assessed how East African monetary policy is affected by mobile money systems. They concluded that there was a structural break in monetary aggregates after 2007, insinuating that the 2007 emergence of mobile payment systems like M-Pesa may have contributed to some changes in the macroeconomic environment. They calculated the M-Pesa velocity, or the

average speed of financial transactions, using Safaricom's aggregate data. They discovered that the M-Pesa velocity is rising with time, indicating that more subscribers are using mobile money systems to conduct transactions. The value of transfers made by each customer has steadily increased, outpacing the average balance of e-money held by customers, thus increasing M-Pesa's velocity. The researchers also found that velocity of M-Pesa's is not as high as that of other monetary aggregates, such as cash velocity or other monetary components, and that its monetary repercussions in Kenya were small. This alludes that both in Tanzania and Uganda, the financial effects will be equally minimal.

Misati et al., (2010) investigated the interest rate channel, which the CBK uses to carry out monetary policy. They examined how financial innovations affected Kenya's monetary policy transmission using data from 1996 to 2007 on a monthly basis, and the two-stage least squares approach. They arrived to the conclusion that financial innovation stifles the mechanism for communicating monetary policy via the interest rate channel. Monetary policy efficacy can be increased by continuously revising policy tools, targeting frameworks, and operating methods, according to their findings. Nyamongo and Ndirangu (2013), on the other hand, investigated the effects of financial innovations on mechanism for transmitting monetary policy in Kenya from 1998 to 2012. According to the findings, financial innovations led to favorable outcomes via the channel for interest rate, and accelerating financial deepening.

Ndirangu and Nyamongo (2015) looked at how financial innovations affected Kenya's monetary policy between 1998 and 2013 using an ARDL approach. They were looking to see how financial innovations influence long-run stability of money demand. They found, Kenya's rapid developments of financial service have not led to fundamental changes in M3. M3 was stable in the long-run, from error correction estimates and a test of M1′s stability using the CUSUM. The broad money demand was determined to be co-integrated and consequently stable for the M3, even though the CUSUM showed some moments of instability. Since M3 was a realistic goal for the CBK during the research period, monetary targeting was a viable strategy for Kenya's government.

Sichei and Kamau (2012) previously assessed money demand in Kenya using quarterly data from Q4 1997 to Q2 2011. Their findings conflict with from those of Ndirangu and Nyamongo (2015).

They used co-integrated VAR analysis in their investigation. According to their research, the demand for monetary aggregates was unstable and fluctuated in response to variations in real GDP, and nominal terms of rates of T-bill, rates of foreign interest and rates of exchange. This was in line with research by Killick and Mwega (1990) and Kisingu et al., (2004). First and foremost, a significant number of financial markets innovations that brought forth quasi-money products are to blame for money demand becoming unstable. Second, after helping to stabilize the money multiplier and the demand for money during the 1980s, regulations on capital and finance were lifted during the 1990s. The demand for money was not predictable during the period under review.

Sichei and Kamau (2012) revealed that elasticity of income for M3 is 1.459 using quarterly data from Q4 1997 to Q2 2011. Their finding is supported by Ndele (1991) and Njuguna (1994) found elasticities of income for M3 were 1.7 and 1.92, respectively. In contrast, research by and Killick and Mwega (1990) and Kisungu et al., (2004) indicated that income elasticity was 0.56 and 0.977 respectively.

According to Ndung'u (1994), Sichei and Kamau (2012), Killick and Mwega (1990) and Kisungu et al., (2004) the T-bill rates elasticity for M3 is significantly negative at -1.97, -2.737, -0.250 and -0.01 correspondingly. This suggests that, Ceteris Paribus, when the yield on the 91-day T-bill is higher, people will substitute money for T-bill.

Sichei and Kamau (2012) found that the demand for M3 at 7.085 had a positive relationship with nominal deposit rate. This suggests that the greater the nominal deposit rate, the less assets one holds as a substitute for money. It was discovered that the M3 demand was negatively affected by the nominal rate of interbank lending and the rate of foreign interest which was adjusted for depreciation. This can be construed to mean that a rise in rates of foreign interest could lead to domestic people owning more foreign assets, which they finance by holding less domestic money. Since the expected depreciation suggests that the expected returns on holding foreign currency increases, agents will substitute domestic currency for foreign currency. It was discovered that M3 demand was unaffected by financial innovation, which was measured by the number of ATMs.

Cho and Miles (2007) estimated the long-run demand for M2 in Korea using the Engle-Granger approach from Q4 1976 to Q3 1998. The co-integration test results showed stability. The coefficient on output, or real GDP, was greater than one, meaning that money, in general, has a greater influence on transactions in the Korean economy. But Lee and Chung (1995) found that M2′s income elasticity was just 0.602 percent. It has been proven by several writers, including Kim (1992) and Lee and Hwang (1998), M2 velocity has been decreasing over time. It was expected that as payment systems advanced and cash management got better, the velocity would rise over time in many countries. Nevertheless, despite improved financial liberalization in Korea, the rise in the propensity to keep M2 as earnings rise will generally tend to move velocity in the opposite way. Similar findings on velocity were made in the United States between 1982 and 1983, when it drastically decreased following years of consistent rise, as reported by Cho and Miles (2007). The ability to earn interest on checking and other deposits, which was not possible in earlier years, contributed to the drop by encouraging people keep cash for extended periods of time.

Rao and Kumar (2009) recently looked at the annual long-run demand for M1 from 1960 to 2008. To more accurately represent the opportunity costs of retaining money, their model was semi-log and had a unit income elasticity and added variables for inflation and exchange rates, with expected negative sign. The variable with a trend was also added to account for improvements in payment technology, which was anticipated to have a negative sign. In the projected long-term model, variables had predicted signs and were significant. Long-run co-integrating relationships were found using single structural break tests, although there was a structural shift or break in 1998. In order to explain the break, they used a short-run money demand model with a low R2.

Kipkemboi and Bahia (2019) explored how mobile money affected the stability of monetary aggregates in sub-Saharan African countries. Their findings demonstrated that mobile money moved assets and currency into the financial system, improved financial deepening and how the monetary policy operates. Mobile money made the money multiplier to increase, implying that the amount of money produced by the monetary base increases. Up until it reaches stability, the multiplier grows at a decreasing rate. They advocated a viewpoint similar to Ndirangu and Nyamongo (2015) that mobile money made velocity to decrease, or rather that financial

innovations leads to a fall in the exchange of cash. It lessened the money demand in transactions and raised bank deposits.

Resina (2004) noted that advances in technology have revitalized many countries, making them surpass traditional stages of development. Frost et al., (2021) technology has enabled what would have taken a half-century using traditional development processes conceivable in a decade. CBK;KNBS;FSD-Kenya (2021b) financial innovations supported businesses, especially during the period when COVID-19 was declared a pandemic, when curfews and restrictions on travel in and out of Kenyan cities were imposed. MSMEs are adopting mobile money to conduct business more than ever, a trend that began long before the COVID-19 outbreak. The constantly shifting financial landscape will inevitably have significant implications on monetary policy. A literature review by Resina (2004) concluded that monetary policy will endure despite the dynamic changes brought about by IT advancements. Greenspan (1993) the successful implementation of monetary policy entails a dynamic process that requires learning and adaptation to capital market innovations.

Visco (2007) found that emerging market economies are catching up at a faster pace with advanced economies in terms of financial development. The trend is supported by: First, the financial system is deepening, as seen by the rapid rise of bond and equities markets and robust credit expansion. Second, there has been a shift toward more market-based financial systems, such as the development of local currency bond markets, which has increased the diversification of both investor portfolios and funding sources. Third, increasing international integration, as exemplified by the involvement of foreign banks and foreign investors in domestic financial systems. Rapid changes affect how monetary policy is communicated to the economy for example, one is that, given the significance of the interest rate channel, transmission may increasingly take place through market prices as opposed to quantity changes. Two, as a result of better macroeconomic fundamentals and stable inflation expectations, the transmission of monetary policy may be more predictable. Three, financial liberalization may, however, make it more challenging to attain dual goals, such as inflation and exchange rate.

Adam and Walker (2015) discovered that as monetary policy shifts from reserve money targeting to inflation targeting, mobile money enhances macroeconomic stability, facilitates wider adoption,

and poses no threat to its efficacy. Noyer (2007) financial innovations alter the channels through which monetary policy operates. Financial innovation also frequently makes it easier to use arbitrage, hedging, financing, and investing strategies. It also helps financial markets swiftly incorporate new information into their pricing, lower transaction costs, and increase financial assets. Similar to this, improved local and international financial market integration strengthens the exchange rate channel. Financial innovations, however, weaken the credit channel by increasing enterprises' access to the securities market, reducing information asymmetries, and reducing the liquidity constraints on banks through securities. In concurrence, Bharadwaj et al., (2019) used survey and administrative data from Kenya, to investigate the uptake and consequences of the M-Shwari loan. In developing countries such as Kenya, financial institutions are using fintech techniques to provide digital loans for mobile devices. The study found that 34 percent of people who are eligible for an M-Shwari loan choose to take one, but it does not substitute other forms of financing. Instead, the M-Shwari loan tends to improve both credit availability and resilience to financial shocks, because negative shocks make households 6.3 percentage points less inclined to cut back on spending. They came to the conclusion that digital loans are not a fix for more serious credit market flaws.

Rotich et al., (2007) examined the CBK's monetary policy actions and rule-based behavior from 1997 to 2006. According to empirical results, since 1997, the CBK was targeting M3 when deciding on monetary policy. The inflation gap (-4.23), at 5 percent level, was statistically significant implying that the CBK had successfully controlled inflation. The CBK would slow the expansion of M3 by 4.23 percent in response to a 1 percent rise in expected annual inflation. In a similar vein, the inflation gap (2.41), at 5 percent level, was statistically significant implying that the CBK would raise the repo rate by roughly 2.41 percentage points for every 1 percent increase in predicted annual inflation. When the predicted inflation is held constant, the real GDP (-0.15), at 5 percent level, was not statistically significant, meaning that a 1 percentage point increase in GDP growth would prompt the CBK to drop the nominal repo rate by 15 basis points. The study came to the conclusion that the CBK increased the repo interest rate whenever inflation was high to reduce excess liquidity with some allowance to stabilize output.

Njuguna (2011) additional difficulties in Kenya's financial sector's structural transformation and dynamics include how to delicately establish a compromise between financial inclusion goals on one hand and efficiency, stability, and integrity goals on the other.

2.3 Overview of the literature

Gordon et al., (1997) the velocity of money has been at the epicenter of prolix discourse on the implications of macroeconomic policies. Classical theory states that the money velocity is constant. The greater the share of nominal revenue held, according to the Cambridge version, the lower the velocity. Keynes believes that money velocity fluctuates in response to market interest rates. Baumol and Tobin's analyses show that as interest rates rise, money balances held for transactions decrease, implying that the money velocity will increase. Milton Friedman's monetarist theory posits that the velocity of circulation is a function of expected nominal rates on various financial and physical assets, and that it is stable and predictable. However, Milton Friedman's monetarist approach to modern quantity theory uses the classical identity equation to calculate the money velocity. This approach estimates real money balances for both developed and developing countries using scale variable: national income or gross domestic product at current market prices; opportunity cost variables: exchange rate, deposit rate, inflation rate and Treasury bill rate. Other determinants include wealth, the stock market, brokerage fees, payment habits, and financial innovations.

Empirical literature from various studies disagree on the results and significance of the variables that determine the money velocity. These variations can possibly be attributed to different measures taken for the same factor; the nature of the studied area or region; methodologies used; and the development of the financial system of the country, etc. Yamden (2011) for developing countries, the variables affecting the level of income are more significant in varying liquidity and determining the demand for money balances.

Mankiw (1997) partly blamed the large, unexpected and unexplained decline in velocity for the economic recession experienced by the United States in 1982. This meant that considerable uncertainty about the secular movements in the money velocity could neither be accounted for nor explained. In the early 1980s, economists suggested that the increase in money velocity was as a result of financial sector innovations and improved technology. In contrast, in recent times, the

velocity of money in Kenya has declined since 2007 as a result of financial developments brought about by mobile money such as M-Pesa.

Kenya has experienced remarkable changes in the financial sector, which necessitated an assessment of the extent to which scale variables, variables that represent the opportunity that is forgone, and money supply variables affect the velocity of money. The study addressed this gap by incorporating measure of innovations variable into the money velocity function and ascertaining whether the function was stable. The study complemented the existing literature.

CHAPTER THREE

METHODOLOGY

Introduction

The conceptual framework, empirical model, data processing and analysis were covered in this chapter. The chapter outlined the approach used to measure the effect of innovations on money velocity in Kenya.

3.1 Research design

The applicability of explanatory variables in terms of how significant they were in describing the behavior of money velocity was assessed using descriptive and econometric methods.

3.2 Conceptual framework

The World Bank has recognized financial inclusion as a factor in achieving 7 of the 17 SDGs and that financial inclusion can help reduce extreme poverty and increase shared prosperity. Winn and Koker (2013) financial inclusion is a feasible and very inexpensive means of reaching out to the unbanked, particularly in remote and rural locations. Financial inclusion entails providing individuals and businesses with affordable access to transactions, payments, credit, insurance and savings. Providing financial services to the underprivileged benefits individuals and the nation as a whole.

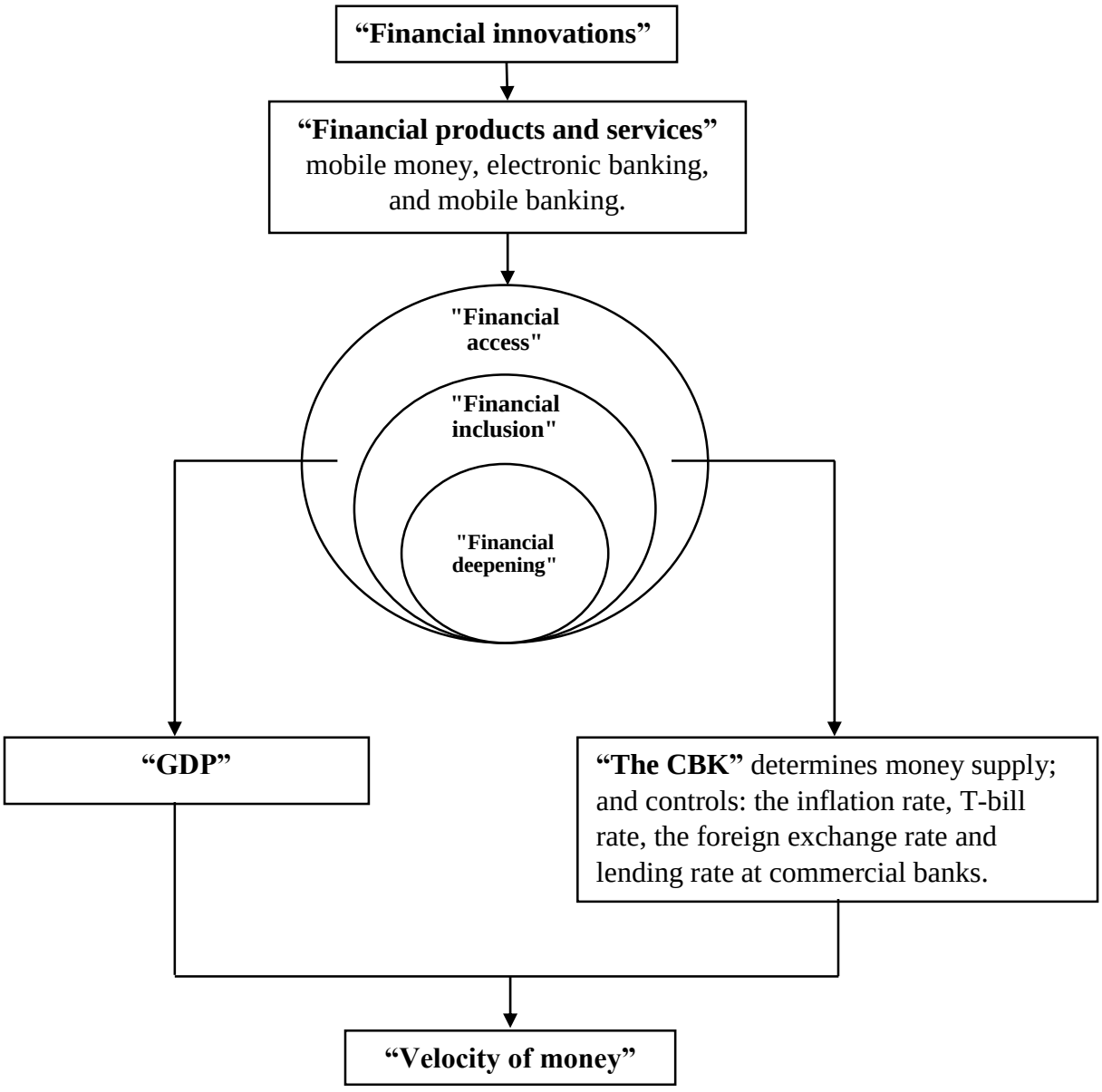
Mobile money is one form of electronic money issued by telecommunications companies, such as M-Pesa, which is offered by Safaricom. Mobile money increases financial inclusion by utilizing a phone to withdraw, deposit, and transfer funds. Cards, such as credit, debit, prepaid, and charge cards, are another type of electronic money, which use payment technology from companies such as VISA and MasterCard for transactions at ATMs and POS machines. Zhou and Xu (2011) electronic money can be converted into any financial assets, such as savings and long-term investments, and it is primarily either M1, because it is received in exchange for deposits that can be demanded at any time, or M0, because it is liquid.

Sun et al., (2010) electronic money in circulation has a significant impact on the macroeconomics when it exceeds 10 percent of the traditional money supply. Zhou (2007) argued using the Fisher equation that, other factors remaining constant, ceteris paribus, the use of electronic money raises the demand for money.

Financial inclusion is considered as a determinant of financial depth (Aduda & Kalunda, 2012). By providing a wide range of market tools and extending financial access, therefore mobile money has contributed to financial deepening.

Financial innovations – velocity of money channel

Figure 4: Conceptual framework



3.3 Empirical model

Friedman (1959) in the modern quantity theory approach, adopted the classical equation for velocity of money in circulation which was represented as:

$$V = \frac{PY}{M^s} = \frac{\text{GDP at market prices (Nominal GDP)}}{M^s} \dots \text{eq. } 11$$

Where: M^S – money supply, Y – real GDP, P – price level, PY represents nominal GDP,
Real money balances:

$$\frac{M^d}{P} = k * f(\ln EXC_t, \pi_t^e, TBR_t, LEND_t, \ln Y_t, MMT/NGDP_t) \dots \text{eq. } 12$$

Where k was the constant of proportionality of how much people wished to hold for each shilling of income they earned.

The function for money demand was given as:

$$M^d = P[f(k, \ln EXC_t, \pi_t^e, TBR_t, LEND_t, \ln Y_t\ MMT/NGDP_t,)] \dots \text{eq. } 13$$

Assuming that equilibrium exists in the money market:

$$M^d = M^s \dots \text{eq. } 14$$

From eq. 11

$$V = \frac{PY}{M^s} = \frac{PY}{M^d} = \frac{PY}{P[f(k, \ln EXC_t, \pi_t^e, TBR_t, LEND_t, \ln Y_t, MMT/NGDP_t)]} \dots \text{eq. } 15$$

Empirical model:

$$V_t = \beta_0 + \beta_1 \ln EXC_t + \beta_2 TBR_t + \beta_2 \pi_t^e + \beta_3 LEND_t + \beta_4 \ln Y_t + \beta_5 MMT/NGDP_t + \varepsilon_t \dots \text{eq. } 16$$

Where: k or β_0 – the intercept, ε_t – error term, V_t – velocity of money, real GDP is denoted by $\ln Y_t$, exchange rate is denoted by $\ln EXC_t$, T-bill rate is denoted by TBR_t, commercial banks' lending rate is denoted by $LEND_t$, expected inflation is denoted by π_t^e and $MMT/NGDP_t$ is a measure of financial innovations (ratio of mobile money transactions to nominal GDP), and ln denotes natural logarithm and t at time t.

Bordo and Jonung (1987) identified the proxies for measuring money supply as: one, the ratio of currency in circulation/money; two, the ratio of total non-bank financial assets/total financial assets; three, the ratio of time deposits/currency in circulation; four, the time deposit/demand deposit ratio. Kipsang (2013) and Arrau et al., (1991) the $M2/M1_t$ ratio implies that the bigger the diversity of money alternatives, as demonstrated by $M2$, the lower the demand for $M1$.

The study used the ratio of $MMT/NGDP$ as financial innovation variable. The T-bill rate, commercial banks' lending rate, and inflation rate were the opportunity cost variables. Real income and exchange rate were intervening variables.

3.4 Sources of data

Data was collected from KNBS and the CBK from Q4 2009 to Q4 2019.

Table 3: Description of variables

Variables	**Measurement**	**Expected sign of independent variables of the coefficient and explanation from other studies.**
Dependent Variable		
Money velocity	It is the ratio of nominal income/ money supply.	
Independent Variables		
Real GDP	It is an estimate of a country's final goods for a specific year or quarter that has been adjusted for inflation or deflation by comparing and converting prices to the prices of a base year. It is expressed in Kenya Shilling millions.	Negative relationship in developing countries. Anyanwu (1994), Friedman (1984), Fry (1988) and Nampewo and Opolot (2016).
T-bill rate (91-day)	Return rates for alternative financial assets.	Positive relationship. When the T-bill rate rises, consumers substitute money for other financial assets, increasing money velocity Nampewo and Opolot (2016).
Expected inflation rate	Return rates on alternative physical assets.	Positive relationship. When the expected rate of inflation rises, consumers swap money for other tangible assets, increasing money velocity. Nampewo and Opolot (2016).

Exchange rate	The average rate at which the Kenyan Shilling is exchanged for 1 US Dollar.	Positive relationship. A depreciation of the exchange rate increases money velocity. Nampewo and Opolot (2016).
Commercial banks' lending rate	It is the cost of commercial bank loans.	Positive relationship. A high interest rate on a loan discourages borrowing, reducing money demand. The velocity of money rises. Gill (2010).
Financial innovations	The ratio of mobile money transactions/nominal GDP.	Negative relationship. Mobile money services have a negative effect on the velocity of money in circulation. Berensten (1997) and Ndirangu and Nyamongo (2015).

3.5 Estimation method

The study used STATA 15 software to estimate the model.

3.5.1 Stationarity

The Augmented Dickey Fuller test was done to determine whether the variables were non-stationary i.e. had a unit root or not.

$$\Delta y_t = \alpha + \delta t + \beta y_{t-1} + \tau_1 \Delta y_{t-1} \dots \dots . + \tau_k \Delta y_{t-k} + \varepsilon_t \dots \text{eq. } 18$$

Where:

Δ – the difference operator, y_t – the variable, t – the time trend, α – the drift term, δ – the time trend term, β is the coefficient before differencing, τ_k are the coefficients after differencing, and ε_t – white noise error term

$H_0: \beta = 0$ is equivalent to $\rho_1 = 1$; $H_\alpha: \beta < 0$ is equivalent to $\rho_1 < 1$

Where:

H_0: null hypothesis; H_α: alternative hypothesis.

3.5.2 ARDL bounds' co-integration technique

If the variables are non-stationary, a co-integration test is performed using ARDL bound test. Co-integration occurs when a linear combination of two series $I(1)$ becomes stationary or $I(0)$. If the test discovers at least one co-integration relationship, the short-run and long-run relationships between the variables are modeled using an error correction model. Selection of the lag was estimated using SBIC criteria.

Pesaran et al., (2001) the null hypothesis was no co-integration between the variables in the model.

$H_0: \gamma_1 \dots \dots \dots = \gamma_k$; $H_A: \gamma_1 \dots \dots \dots \neq \gamma_k$

Where:

H_0: null hypothesis; H_α: alternative hypothesis.

Pesaran et al., (2001), the asymptotic lower bound and upper bound values are calculated depending on the number of regressors, the order of integration, and the deterministic model. Kripfganz and Schneider (2016) first, do not reject if the F-statistic was below than the lower bound critical value, respectively. Second, reject if the F-statistic was above the upper bound critical value, respectively. When both critical values for lower and upper bounds are rejected it confirms the conditional long-run relationship.

3.5.3 Autoregressive Distributed Lag Model

The ARDL model's error correction allows for both short-run modifications and long-run relationships, including adjustments to achieve co-integration between velocity of money and financial innovation variable, opportunity cost variables, real GDP and exchange rate (Hill et al., 2018)

$$\Delta V_t = \alpha_0 + \alpha_1 \sum_0^k \Delta V_{t-1} + \alpha_2 \sum_0^k \Delta \ln EXCH_{t-1} + \alpha_3 \sum_0^k \Delta \pi_{t-1}^e + \alpha_4 \sum_0^k \Delta TBR_{t-1} + \alpha_5 \sum_0^k \Delta LEND_{t-1} + \alpha_6 \sum_0^k \Delta \ln Y_{t-1} + \alpha_7 \sum_0^k \Delta MMT/NGDP_{t-1} + \theta EC_{t-1} + \varepsilon_t$$

Where: $\alpha_1, \dots\dots, \alpha_7$ are short-run coefficients of the ARDL model, α_0 – a constant, θ – a term for speed of adjustment (it corrects ΔV_t to the error), EC is an expression for error correction,

ε_t denotes the stochastic error term, k denotes the length of the lags and ln denotes natural logarithms, V_{t-1} – the velocity of money, $EXCH_{t-1}$ – the exchange rate, π^e_{t-1} – the expected inflation rate, TBR_{t-1} – 91-day treasury bill rate, $LEND_{t-1}$ – commercial banks' lending rate, Y_{t-1} – real GDP, and $MMT/NGDP_{t-1}$ – financial innovations variable and the difference operator is denoted by **Δ.**

The long-run relationship using ARDL was specified as:

$$V_t = \alpha_0 + \alpha_1 \sum_0^k \Delta V_{t-1} + \alpha_2 \sum_0^k \Delta \ln EXCH_{t-1} + \alpha_3 \sum_0^k \Delta \pi^e_{t-1} + \alpha_4 \sum_0^k \Delta TBR_{t-1} + \alpha_5 \sum_0^k \Delta LEND_{t-1} + \alpha_6 \sum_0^k \Delta \ln Y_{t-1} + \alpha_7 \sum_0^k \Delta MMT/NGDP_{t-1} + \varepsilon_t$$

3.6 Diagnostic tests

i. Jarque-Bera test was done to confirm the residuals were normally distributed.
ii. Ramsey Reset test was done to confirm there were no omitted variables and that the model was accurately specified.
iii. Breusch-Godfrey LM test was done to confirm the residuals were not serially correlated.
iv. Autoregressive conditional heteroscedasticity LM test was done to confirm the error term was homoscedastic.
v. CUSUM and CUSUMSQ was done to determine whether the ARDL model was stable (Brown et al., 1975).
vi. VAR Granger causality test was conducted to confirm whether the endogenous variables granger cause money velocity (Engle & Granger, 1987).

CHAPTER FOUR

EMPIRICAL FINDINGS

Introduction

This chapter discussed empirical results concerning the effects of mobile money and other innovations on money velocity. The variables were described in the summary statistics and correlation was done to determine the associations. ARDL model was employed to, first, model the equation of velocity. Secondly, realize 3 objectives that were stipulated earlier in the study, and thirdly, determine whether the model was stable. Bi-directional causality between independent variables and money velocity in the model was done using granger causality Wald tests.

4.1 Descriptive statistics

4.1.1 Variables

Table 4: Summary statistics

Variables	N	Mean	Median	Std. Dev.	Min	Max	Skewness	Kurtosis
Velocity	41	2.51	2.485	0.14	2.284	2.764	0.23	1.92
Log of exchange rate	41	4.527	4.533	0.102	4.319	4.659	-.302	1.721
Inflation rate	41	7.054	6.180	3.645	3.333	19.187	1.897	6.102
Log of nominal GDP	41	14.163	14.125	.378	13.507	14.735	-0.101	1.769
91-day T-bill rate	41	8.489	8.313	3.232	1.823	19.353	0.896	5.738
Commercial banks' lending rate	41	15.449	14.973	2.268	12.35	20.213	0.457	2.189
Log of real GDP	41	13.796	13.798	0.164	13.469	14.068	-0.049	1.906
Mobile money transactions/ nominal GDP	41	0.397	0.422	0.086	0.192	0.539	-0.881	2.996

Table 4 showed that the mean or average velocity of money was 2.51. The standard deviation was 0.14. Skewness was 0.23, thus a positively skewed distribution. Kurtosis was 1.92, thus platykurtic. It meant that there were more observations in the time series with lower values below the average and the distribution was almost symmetric around the average.

The mean or average exchange rate was 4.527. The standard deviation was 0.102. Skewness was 0.302, thus a positively skewed distribution. Kurtosis was 1.721, thus platykurtic. It meant that

there were more observations in the time series with lower values below the average and the distribution was asymmetric around the average.

The inflation rate had a mean value or average of 7.054. Standard deviation was 3.645. Skewness was 1.897, thus a positively skewed distribution. Kurtosis was 6.102, thus leptokurtic. It meant that there were more observations in the time series with higher values above the average and the distribution was asymmetric around the average.

Nominal GDP had a mean value or average of 14.163. Standard deviation was 0.378 from the mean value. Skewness was -0.101, thus a negatively skewed distribution. Kurtosis was 1.769, thus platykurtic. It meant that there were more observations in the time series with lower values below the average and the distribution was almost symmetric around the average.

91-day T-bill rate had a mean value or average of 8.489. The standard deviation was 3.232. Skewness was 0.896, thus a positively skewed distribution. Kurtosis was 5.738, thus leptokurtic. It meant that there were more observations in the time series with higher values above the average and the distribution was asymmetric around the average.

Commercial banks' lending rate had a mean value or average of 15.449. Standard deviation was 2.268. Skewness was 0.457, thus a positively skewed distribution. Kurtosis was 2.189, thus platykurtic. It meant that there were more observations in the time series with lower values below the average and the distribution was asymmetric around the average.

Real GDP has a mean value or average of 13.796. Standard deviation is 0.164. Skewness was 0.166, thus a negatively skewed distribution. Kurtosis was 1.89, thus platykurtic. It meant that there were more observations in the time series with lower values below the average and the distribution was almost symmetric around the average.

The mean or average ratio of mobile money transactions to nominal GDP was 0.397. The standard deviation was 0.086. Skewness was -0.881, thus a negatively skewed distribution. Kurtosis was 0.996, thus platykurtic. It meant that there were more observations in the time series with lower values below the average and the distribution was asymmetric around the average.

4.2 Pairwise correlations of the variables

Correlation measures the overall strength of the relationship between the variables.

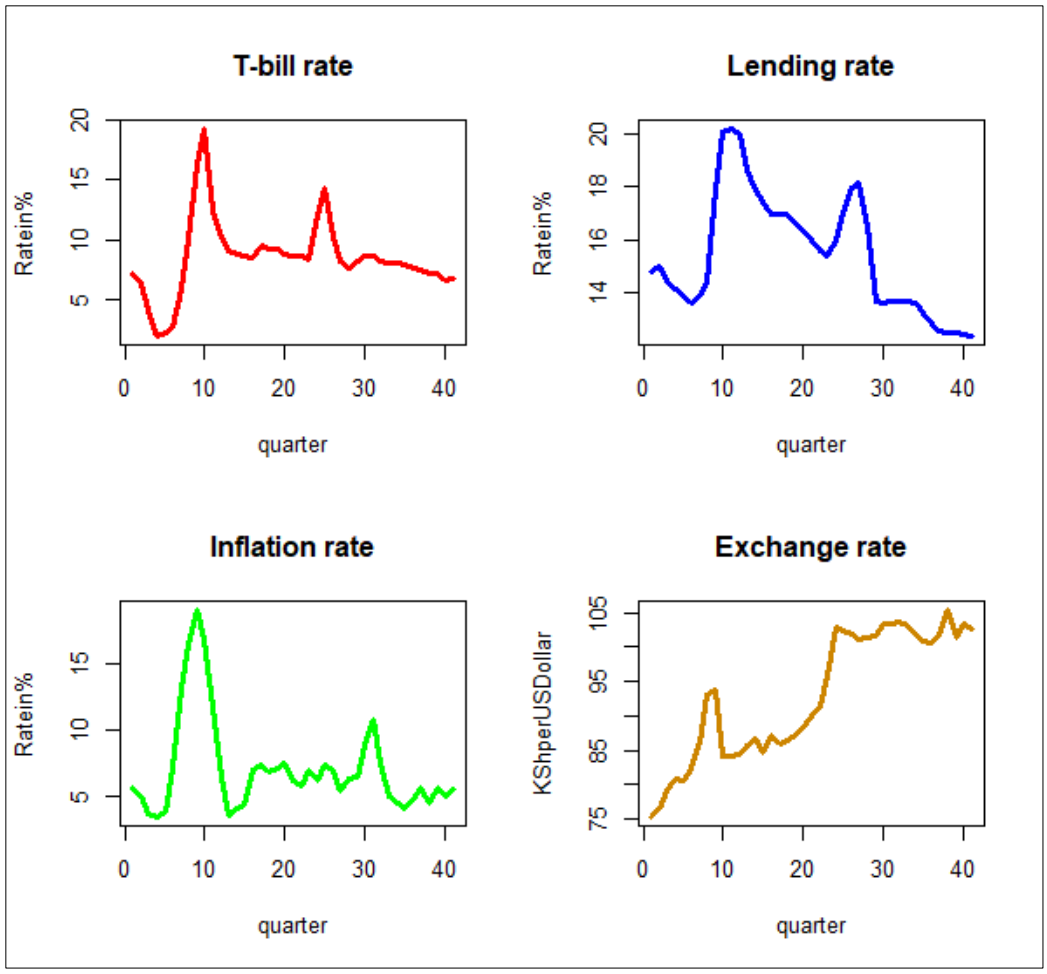
Table 5: Correlation

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Velocity	1.000						
(2) log of Exchange Rate	0.190 (0.235)	1.000					
(3) Inflation rate	-0.170 (0.287)	-0.019 (0.906)	1.000				
(4) log of Real GDP	0.326 (0.037)	0.888 (0.000)	-0.258 (0.103)	1.000			
(5) 91 day T – bill rate	-0.235 (0.139)	0.176 (0.271)	0.638 (0.000)	0.026 (0.871)	1.000		
(6) Commercial banks' lending rate	-0.566 (0.000)	-0.385 (0.013)	0.302 (0.055)	-0.446 (0.003)	0.620 (0.000)	1.000	
(7) ratio of MMT/NGDP	-0.118 (0.461)	0.810 (0.000)	-0.095 (0.556)	0.766 (0.000)	0.295 (0.061)	-0.075 (0.639)	1.000

Real GDP (0.326) was positively associated with money velocity. Exchange rate (0.190) was also positively associated with money velocity. Both inflation rate (-0.17) and 91-day T-bill rate (-0.235) were inversely associated with money velocity. The lending rate of commercial banks (-0.566) was also negatively linked to money velocity. The ratio of MMT/NGDP (-0.118) was negatively associated with the money velocity.

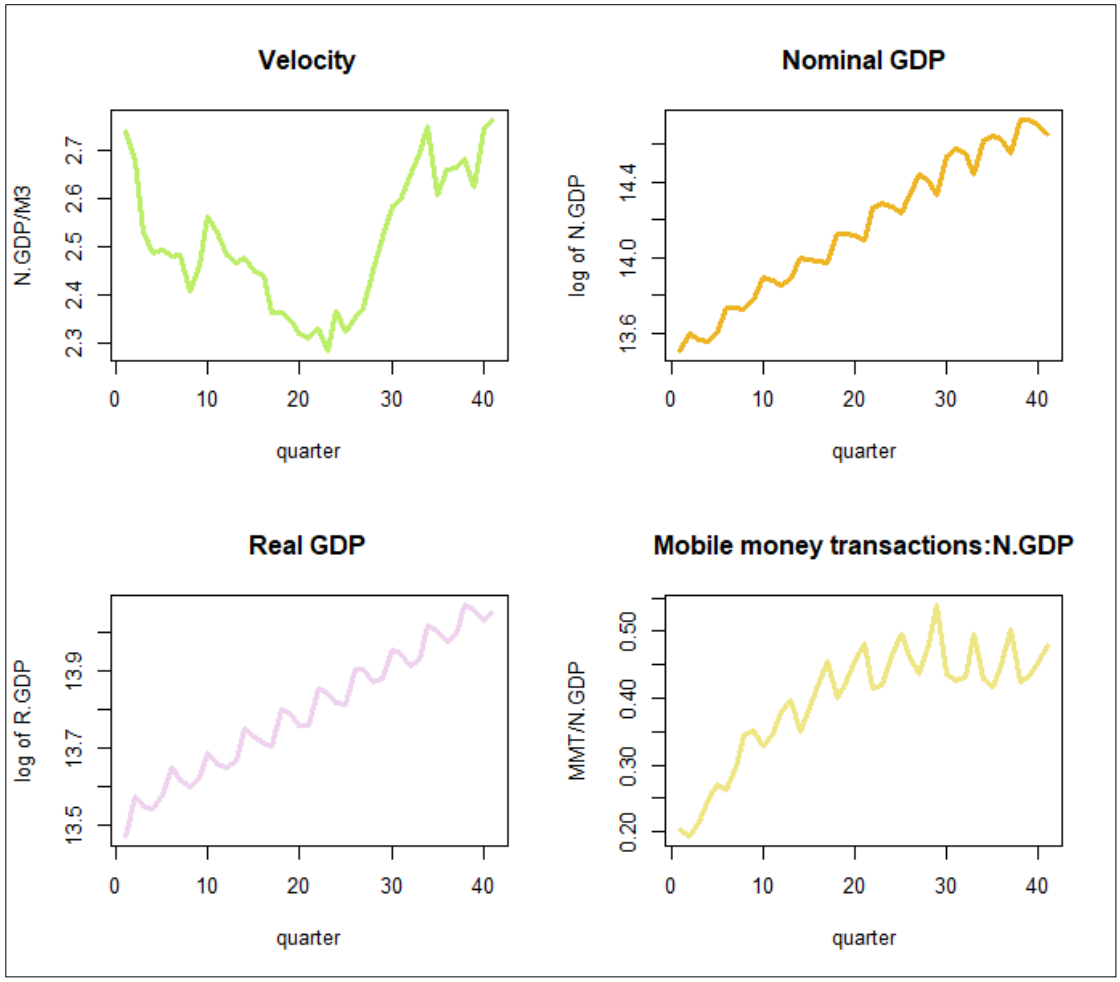
4.3 Graphical representation

Figure 5: Graphs of the T-bill rate, lending rate, inflation rate and exchange rate



T-bill rate had a minimum value in Q3 2010 (1.823 percent) and maximum value in Q1 2012 (19.353 percent). The commercial banks' lending rate had a minimum value in Q4 2019 (12.35 percent) and maximum value in Q2 2012 (20.213 percent). The expected inflation rate had a minimum value in Q4 2019 (3.333 per cent) and maximum value in Q2 2012 (19.187 percent). The exchange rate had a minimum value in Q4 2009 (75.138) and maximum value in Q1 2019 (105.513).

Figure 6: Graphs of the velocity, nominal GDP, real GDP and ratio of MMT/NGDP



Velocity of money had a minimum value in Q2 2015 (2.284) and maximum value in Q4 2019 (2.764). The log of nominal GDP had a minimum value in Q4 2009 (13.507) and maximum value in Q1 2019 (14.735). The log of Real GDP had a minimum value in Q4 2009 (13.469) and maximum value in Q1 2019 (14.068). The ratio of MMT/NGDP had a minimum value in Q1 2010 (0.196) and maximum value in Q4 2016 (0.539).

4.4 Stationarity

Stationarity allows the research make recommendations and project the future. The study employed Augmented Dickey Fuller to test whether the variables were stationarity. The null hypothesis was that of a unit root in the series.

Table 6: Augmented Dicker Fuller test

Variables in levels	Models with intercept only	Models with intercept and trend
	p-value for z(t)	p-value for z(t)
Velocity	0.6526	0.4923
Log of exchange rate	0.3535	0.4566
Inflation rate	0.3277	0.5589
T-bill rate	0.2159	0.5307
Lending rate	0.7717	0.7818
Log of Real GDP	0.5861	0.0000
Ratio of MMT/NGDP	0.1699	0.1571
Variables in first difference		
Velocity	0.0000	0.0000
Log of exchange rate	0.0000	0.0000
Inflation rate	0.0147	0.0707
T-bill rate	0.0011	0.0076
Lending rate	0.0121	0.0538
Log of Real GDP	0.0000	0.0000
Ratio of MMT/NGDP	0.0000	0.0000

Except for logarithm of real GDP, the null hypothesis of a unit root was not rejected for variables in the model with an intercept and variables in the model with both an intercept and a time trend. With one exception, this means that the majority of the variables were non-stationary.

To deal with stochastic trends with a unit root, the first difference of the variables was computed. At the first difference, all variables in models with an intercept and those with both an intercept and a time trend were stationary, indicating I(1).

4.5 ARDL bound co-integration test

Using SBIC method, the optimal lag order of 4 was selected for the model.

Table 7: ARDL Bound co-integration test

joint null hypothesis F-statistic	Critical values			
	1%		5%	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
11.387	3.15	4.43	2.45	3.61

In table 7, F-statistic (11.387) falls above the upper bound critical value (3.61) and also the lower bound critical value (2.45), thus the null hypothesis of no level effect was rejected at 1% and 5% level. There was a conditional long-run relationship.

4.6 Diagnostic tests

4.6.1 Serial correlation

Table 8: Breusch-Godfrey LM test

lags	F statistic	degrees of freedom	p-value
1	16.790	(1, 4)	0.015
2	10.673	(2, 3)	0.043
3	7.162	(3, 2)	0.125
4	9.132	(4, 1)	0.243

In table 8, the null hypothesis was not rejected at 5% from lag 1 to lag 4, thus not serially correlated.

Table 9: Durbin Watson

d-statistic (13, 37) = 3.171038

In table 9, d-statistic was above 2 suggesting a negative autocorrelation.

Table 10: Durbin's alternative test

lags	F statistic	degrees of freedom	p-value
1	3.323	(1, 4)	0.142
2	2.045	(2, 3)	0.275
3	0.923	(3, 2)	0.558
4	19.373	(4, 1)	0.169

In table 10, the null hypothesis was not rejected at 5% from lag 1 to lag 4, thus not serially correlated.

4.6.2 Homoscedascity of the residuals

Table 11: Autoregressive conditional heteroskedasticity LM test

lags	chi2	degrees of freedom	p-value
1	1.851	1	0.174
2	5.610	2	0.060
3	4.866	3	0.182
4	8.347	4	0.080

In table 11, the null hypothesis was not rejected from lag 1 to lag 4 at 5% level of significance, thus the errors were not autoregressive conditional heteroskedastic.

4.6.3 Functional form

Table 12: Ramsey RESET test

F statistic (3,21)	p-value
0.12	0.9409

In table 12, the null hypothesis was not rejected thus the model did not have omitted variables or specification errors.

4.6.4 Normality test of the residuals

The chi-square associated with adjusted Jarque Bera chi-square exceeded 5%, thus the residuals were normally distributed.

Table 13: Jarque Bera test

Skewness/Kurtosis tests		joint		Adjusted Jarque Bera chi square	p-value
Variable	N	Prob. (Skewness)	Prob. (Kurtosis)		
residual	37	0.2391	0.4612	2.06	0.3561

4.7 Results of ARDL model

Table 14: Model equation

Optimal lag length	Obs.	R-squared	Adj R-squared	Log-likelihood	Root MSE
ARDL(4,4,3,4,4,3,3)	37	0.9904	0.9306	141.54449	0.0144

In table 14, the strength of the relationship was strong as intervening and opportunity cost variables in the model account for 99.04 percent of the variations in money velocity.

Table 15: Short-run coefficients

Regressor	coefficient	standard error	t statistic	p value
Velocity				
D (Velocity (-1))	-0.316	0.138	-2.290	0.070
D (Velocity (-2))	-0.429	0.155	-2.780	0.039
D (Velocity (-3))	-0.156	0.099	-1.570	0.178
exchange rate logarithm				
D (exchange rate logarithm (-1))	-2.073	0.349	-5.940	0.002
D (exchange rate logarithm (-2))	-2.189	0.374	-5.850	0.002
D (exchange rate logarithm (-3))	-2.076	0.497	-4.180	0.009
D (exchange rate logarithm (-4))	-1.324	0.574	-2.310	0.069
Inflation rate				
D (Inflation rate (-1))	-0.063	0.011	-5.660	0.002
D (Inflation rate (-2))	-0.058	0.011	-5.290	0.003
D (Inflation rate (-3))	-0.033	0.008	-4.110	0.009
T-bill rate				
D (T-bill rate (-1))	0.093	0.023	4.050	0.010
D (T-bill rate (-2))	0.080	0.022	3.620	0.015
D (T-bill rate (-3))	0.066	0.020	3.330	0.021
D (T-bill rate (-4))	0.017	0.008	2.050	0.096
Lending rate				
D (Lending rate (-1))	-0.137	0.035	-3.940	0.011
D (Lending rate (-2))	-0.086	0.024	-3.560	0.016
D (Lending rate (-3))	-0.100	0.014	-7.360	0.001
D (Lending rate (-4))	-0.089	0.023	-3.930	0.011
Log Real GDP				
D (Real GDP logarithm (-1))	-2.914	0.652	-4.470	0.007
D (Real GDP logarithm (-2))	-1.321	0.471	-2.800	0.038
D (Real GDP logarithm (-3))	-0.227	0.299	-0.760	0.483
Ratio of MMT/NGDP				
D (Ratio of MMT/NGDP (-1))	5.189	0.909	5.710	0.002
D (Ratio of MMT/NGDP (-2))	4.578	0.803	5.700	0.002
D (Ratio of MMT/NGDP (-3))	2.504	0.718	3.490	0.017
_cons	-54.254	9.654	-5.620	0.002

Short-run coefficients account for fluctuations in the short-run that do not result from deviations from long-run equilibrium. The short-run model, in table 9 showed that the exchange rate (-2.073), inflation rate (-0.063), commercial bank lending rates (-0.137), and real GDP (-2.914) all have a significant negative effect on money velocity.

In contrast, the ratio of MMT/NGDP (5.189) and T-bill rate (0.093) have a significant, positive effect on money velocity. For opportunity cost variables, in the short run, the T-bill rate had a favorable influence on money velocity, suggesting that, Ceteris Paribus, when the yield on the 91-day T-bill is higher, people substitute money for T-bill (Sichei & Kamau, 2012), leading to an increase in money velocity.

Table 16: Adjustment parameter and long-run coefficients

Regressor	coefficient	standard error	t statistic	p-value
ADJ Velocity L1.	-1.657	0.272	-6.090	0.002
long-run coefficients				
Log of exchange rate	1.209	0.149	8.110	0.000
Inflation rate	0.028	0.004	7.600	0.001
T-bill rate	-0.060	0.011	-5.560	0.003
Lending rate	0.088	0.014	6.310	0.001
Log of Real GDP	2.191	0.165	13.320	0.000
Ratio of MMT/NGDP	-3.797	0.196	-19.330	0.000

The negative, significant coefficient for speed of adjustment (-1.657) evaluates how strongly the dependent variable reacts to a deviation from the equilibrium relationship in 1 quarter or how quickly an equilibrium distortion like this was corrected. The findings validate the error correction approach framework's applicability, as well as its application together with the long-run relationship for enhanced policy implications.

The long-run coefficients represent the independent variables' equilibrium effect on the dependent variable. In table 10, at 1 percent level of significance, the long-run relationship showed that all variables, including the exchange rate, inflation rate, T-bill rate, commercial banks' lending rate, real GDP, and the ratio of MMT/NGDP have significant effects on the velocity of money.

1% increase in the exchange rate was significantly related with a 1.209-unit increase in the velocity of money. 1% increase of inflation rate was significantly related with 0.028-unit increase in

velocity of money. 1% increase of commercial banks' lending rate was significantly related with 0.088-unit increase in velocity of money. 1% increase of real GDP was significantly related with 2.191-unit increase in velocity of money. However, 1% increase of T-bill rate was significantly related with 0.060-unit decrease in velocity of money. Similarly, 1-unit rise of ratio of MMT/NGDP was significantly related with 3.797-unit fall in velocity of money.

The positive link between real GDP and money velocity suggested that Kenya was approaching advanced financial development stages (Fry, 1988). This was also consistent with Mawejje and Lakuma's (2019) findings, which revealed that mobile money balances increased productivity in Uganda by having a positive relationship with credit to the private sector and higher consumer price indices. As the exchange rate rises, so does money velocity. This indicated that when the Kenyan Shilling falls in value relative to the US dollar, money velocity increased. This could be explained by domestic portfolio holders readjusting their holdings in favor of international assets as the cost of holding domestic currency rises (Akinlo, 2012). Inflation increased money velocity, indicating that people substitute money for alternative assets of holding wealth when prices hike. Lowering commercial bank lending rates encouraged people to borrow, increasing money demand and consequently decreasing money velocity (Duczynski, 2004). When lending rates rise, so does the cost of holding money, and consumers swap money for alternative financial assets.

Financial developments such as mobile money have resulted in the ratio of MMT/RGDP increasing, and so demand deposits increase, causing velocity of money in circulation to fall. These findings are similar with Nampewo and Opolot (2016), Akinlo (2012) and Berentsen (1997). Furthermore, because mobile money is often used for transactions, it may reduce the demand for money in transactions while increasing bank deposits (Ndirangu & Nyamongo, 2015).

4.7.1 VAR granger causality

In the ARDL model, a conditional long-run relationship was established. To determine direction of causation, VAR Granger causality was done.

Table 17: Wald tests

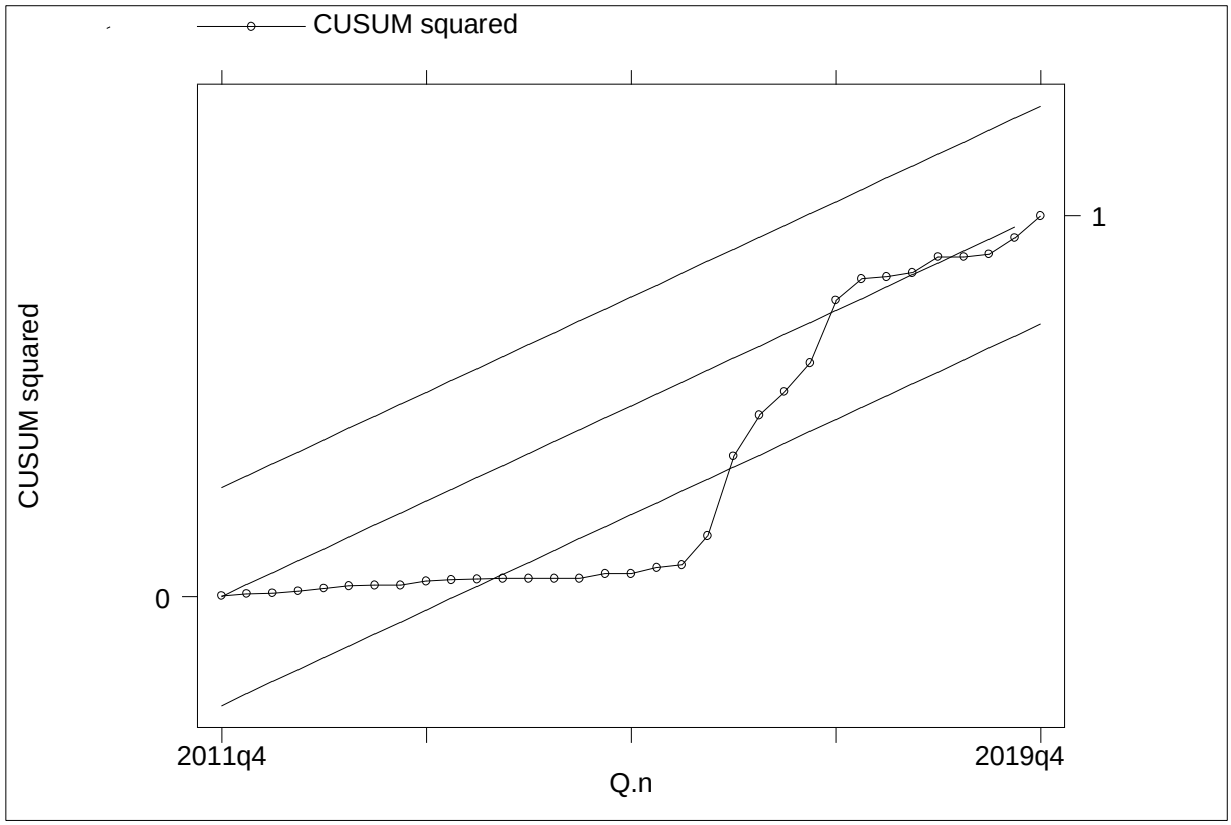
Equation	Endogenous variable (excluded)	chi2	degrees of freedom	p-value
Velocity	Log of exchange rate	134.840	4	0.000
Log exchange rate	Velocity	5.324	4	0.256
Velocity	Inflation rate	157.950	4	0.000
Inflation rate	Velocity	63.706	4	0.000
Velocity	T-bill rate	73.485	4	0.000
T-bill rate	Velocity	30.568	4	0.000
Velocity	Lending rate	192.230	4	0.000
Lending rate	Velocity	50.874	4	0.000
Velocity	Log of real GDP	64.809	4	0.000
Log of real GDP	Velocity	45.302	4	0.000
Velocity	ratio of $\mathrm{MMT/NGDP_t}$	142.170	4	0.000
ratio of $\mathrm{MMT/NGDP_t}$	Velocity	13.981	4	0.007

In table 17, comparing p-value with 5% level of significance, uni-directional granger causality was established between velocity of money and log of exchange rate.

Also this meant that there was a linkage between money velocity, and T-bill rate, inflation rate, lending rate, log of real GDP and ratio of $\mathrm{MMT/NGDP_t}$ in the model as bi-directional granger causality was found. The causation between money velocity and real income suggested that monetary policy interventions can help to reduce the severity of the business cycles and unobservable shocks. Money could also be one of the aspects considered while determining the causes of output changes. The observation of causality running from inflation to money velocity and considerable feedback in the other way appeared to favor monetarist viewpoint. The rate at which money grows influences prices but has little effect on economic growth in the long-run, and when the money growth rate exceeds the economic growth rate, there would be inflation (Friedman, 1985).

4.7.2 Stability test

Figure 7: Plot of CUSUMSQ statistic



The plot was not well within the critical bounds at certain periods, implying that the model was not stable in those periods.

CHAPTER FIVE

CONCLUSION

Introduction

This chapter presented a summary of the key findings from the study, policy implications, conclusion and areas for further research.

5.1 Summary of the key findings

The result of CUSUMSQ statistic showed money velocity experienced instability at certain periods which was in agreement with (CBK, 2016, 2021). ARDL model was used to estimate the money velocity function. In the short-run, 1% increase of T-bill rate was significantly related with 0.093-unit increase in velocity of money. After adjusting the model to the significant deviation from the equilibrium relationship from one quarter to another, in the long-run, real GDP, exchange rate depreciation, and opportunity cost variables which include: the inflation rate and lending rate positively affected velocity of money. However, 1-unit increase in measure of financial innovations (ratio of mobile money transactions to nominal GDP) made velocity of money in circulation to fall by 3.797 units. The finding suggest that Kenya was approaching advanced financial development stages (Fry, 1988). Bi-directional causality between money velocity, opportunity cost variables, exchange rate and real GDP highlighted the significance of the variables in predicting future money velocity.

5.2 Policy implications

From the findings, the CBK should monitor financial sector development and enact policies to make velocity of money and money multiplier stable, thus ensuring the money demand function in Kenya remains predictable. Particularly, the CBK should pay special attention to mobile money services, due to cheap transaction costs and high liquidity. This will help to strengthen the monetary targeting mechanism. Alternately, CBK should pursue an inflation-targeting monetary policy that guide market expectations by using interest rates and the expected inflation.

Currently, Kenya is a net importer of goods and services and therefore, a depreciation of the shilling has long-term implications for the velocity of money. Policies that regulate the money supply, control inflation rates, and increase output can contribute to exchange rate stability and reduce external shocks from potential capital flight. To prevent inflation, the CBK should regulate

mobile money by charging interest rates. Inflation can develop if the velocity of money increases without necessarily raising output. Economic growth should be pursued as the real GDP and money velocity depicted a positive relationship. This will facilitate more money for transaction purposes that can be used in economic activity.

5.3 Conclusion

This study investigated the effect of mobile money and other innovations on money velocity in Kenya during the period Q4 2009 – Q4 2019. Mobile money services in Kenya have lowered transaction costs for users, increased access to financial services for everyone and are therefore convenient. According to the literature review, it was evident that researchers have different opinions on velocity of money. This study adopted empirical approach based on modern quantity theory. The findings showed, in the long-run, innovations lower velocity of money in circulation. The CBK should monitor financial sector development and enact policies to make velocity of money and money multiplier stable, which will ensure the money demand function in Kenya remains predictable.

5.4 Areas for further research

Further research should be carried out on the effect of mobile money and other innovations on money multiplier which would then give a conclusive explanation about mobile money services in Kenya. In the appendix, the trends of money multiplier Q4 2009 – Q4 2019 was shown.

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APPENDIX

Figure 8: Money multiplier and COB:M3 stock

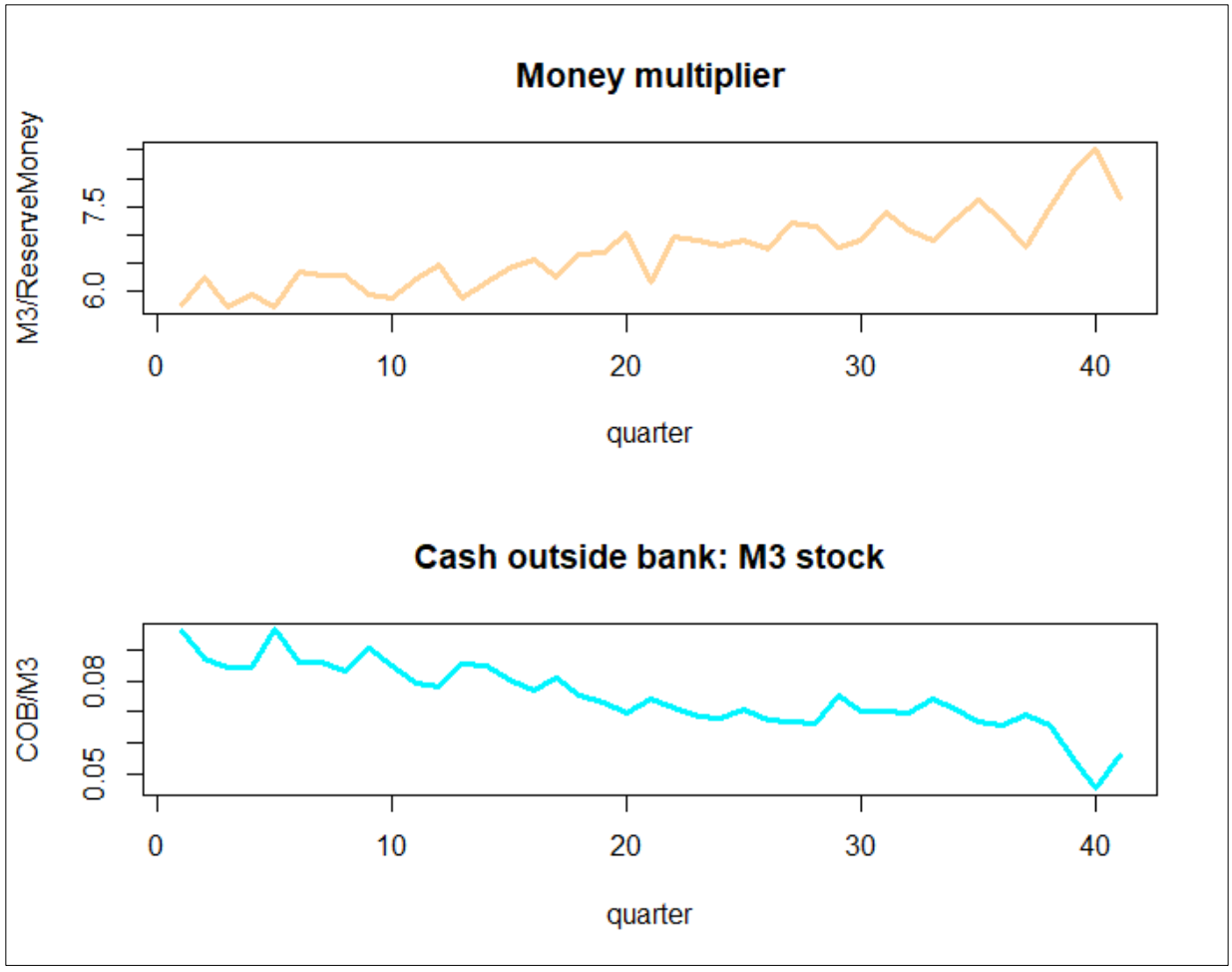

Figure 9: Graph of the residuals